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A multidisciplinary pelvic floor journal

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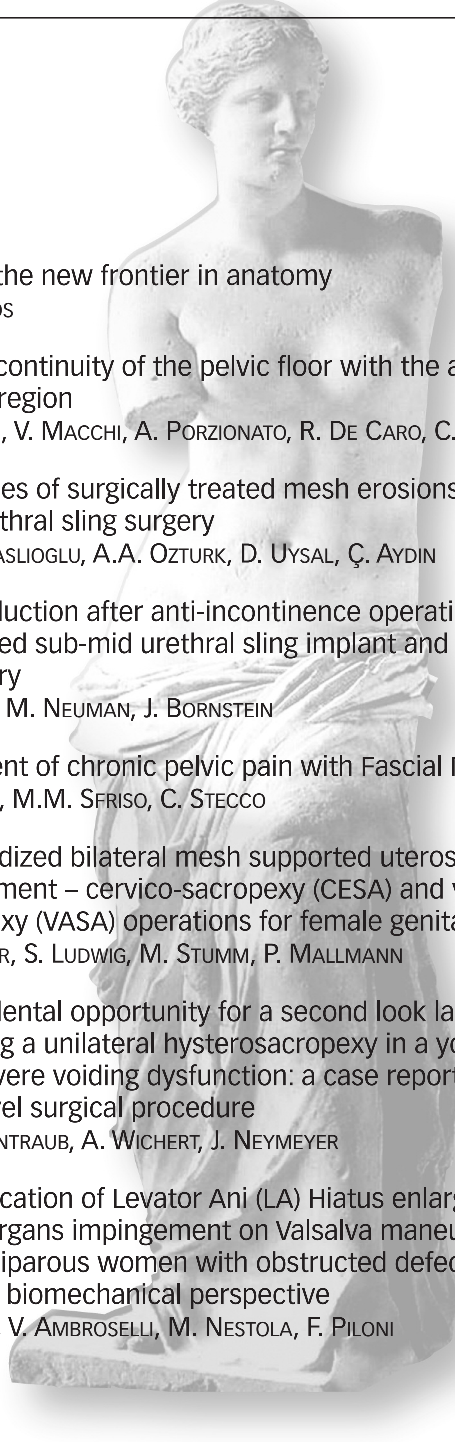

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Editorial

Fascia, the new frontier in anatomy

MAREK JANTOS

The journal Pelviperineology strives to bring the reader content at the forefront of research and clinical developments pertinent to the understanding of pelvic anatomy and function. This first issue for 2016 exemplifies this commitment. In past years, the journal has published several articles which emphasize the role of connective tissue in the genesis of chronic pelvic pain, bladder and bowel dysfunction. This issue introduces two original articles, which highlight the growing research interest in the fascia. Dr Carla Stecco and her collaborators share new and evolving insights into the continuity of the body's fascial system and its impact on the pelvic region. These articles provide further evidence supporting the "theory of a whole-body fascial linkage". Dr Stecco is an Orthopedic Surgeon and Professor of Human Anatomy and Movement Science at Padua University in Italy, and author of the new textbook on fascia, entitled *Functional Atlas of the Human Fascial System*.

Fascia has been labeled in Dr Stecco's text as the "*the forgotten structure"* in anatomy. This poorly understood organ, traditionally referred to as *"the fascia"* or the *"white packing stuff"* is rarely recognized for its important anatomical and functional role. Yet, the fascia is directly implicated in the etiology of pain, regulation of blood flow, dissipation of tensional forces between muscles, bones and joints, perception of movement and peripheral coordination of agonist, antagonist and synergic muscles. Furthermore, based on recent findings it's function as an extensive communication network links the body's anatomy to our sense of wellness and health.

The term *fascia*, whether used in the context of anatomy or classical architecture, derives from the same Latin root, meaning *band*, *bandage* or *binding*. These terms refer to the structural and functional properties of the fascia in holding things together, optimizing their presentation and enhancing the dynamics of local tissue and viscera. Thus, in modern anatomy the structure of the fascia is often described as a complex 3-D matrix of soft tissue, whose architecture challenges classical anatomical concepts and forms a new frontier in the study of human anatomy. This is well illustrated in the study of muscle tissue. Modern anatomy textbook colorfully illustrate muscle tissue in clear red colors (once the fascia is cut away), showing muscles as attaching to bones and functionally moving joints. Yet, as the work of Van de Wal and others has shown, no muscle ever attaches to bones anywhere in the body, without the investing structure of the connective tissue. Likewise no individual muscle moves bones without generating forces that are transmitted well beyond the local region. Many of these oversights need to be corrected.

Since the first International Research Congress held at the Harvard Medical School in 2007, it is evident that fascia is more than a malleable suit providing shape to our bodies, padding and insulation for confort and protection of organs. It is soft tissue, which defines each regional cavity of the body, supports and holds in place the total mass of the bodies' internal organs. The body's organs make up an estimated 12% of the total body's weight and are stabilized and held in place by fascial attachments to the side walls of the cavities that contain them. In the case of the abdominopelvic cavity, it is defined by the respiratory diaphragm, the psoas, transverse abdominis and pelvic muscles, with each muscle and organ not only invested in the fascia but precisely held in its optimal place by this connective tissue. Fascia perfectly holds the whole body together as an integral and functional entity. Other somatic structures, like the muscles, bones and joints, are also protected, embedded and lubricated by the fascia and its extracellular matrix. In addition the fascia also acts as the conduit for lymphatic and neurovascular bundles, which traverse its subcutaneous and deeper layers. As blood vessels and nerves cross the fascial planes, some crossing in a perpendicular fashion following the retinacula, others longitudinally in a very oblique course, all are affected by tension and restrictions in the fascia. Some of these restrictions may arise on account of surgical trauma, muscle generated tension, dehydration or emotional stress. Any such restrictions, resulting in fascial tension, can hypothetically choke the arteries embedded in the tissue and cause change in tissue color and potentially establish an ischemic state, giving rise to hyperalgesia. Likewise these changes in the fascia can lead to inflammatory states mediated by mast cell release of histamine, heparin and serotonin thus affecting the permeability of blood vessels and mediating the release of immunoglobulins.

As an organ of communication the fascia is regarded as the most important perceptual organ in the body. It is richly innervated with sensory receptors that enable exteroception, proprioception, nociception and interoception. The fascia possesses a ten times higher quantity of sensory receptors than muscle tissue. It is estimated that almost 80% of all the free nerve endings terminate in the fascia. Yet, 90% of these slow conducting C-fiber neurons follow different pathways to the brain than those involved in proprioception and are known as interoceptors. Functional imaging studies by Olausson and associates show that most of these C-fiber neurons specifically activate the insular cortex as opposed to the somatosensory cortex. Interoceptors are responsive to social and sensual touch and mediate emotional, hormonal and affiliative responses to physical contact. Human emotions and the sense of wellbeing are directly linked to stimulation of the interoceptors within the fascia.

As a complex organ system the fascia links every bodily structure and function by its continuous 3-D network. Without an appreciation of its important role in human anatomy, the assessment and management of various pathologies would be deficient. A good appreciation of the fascia, its composition, continuity and body-wide networking may hold vital secrets to our understanding of the successful functioning of the human body.

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Review

Fascial continuity of the pelvic floor with the abdominal and lumbar region

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Introduction: The connection between the pelvic floor, abdomen and lower back is clinically recognized but the anatomical basis of this link requires further clarification. The purpose of this work was to review the literature on pelvic fasciae, in order to provide a description of their continuity with the fasciae of abdominal muscles and lower back. *Materials and Methods:* A search of the literature was conducted on the PubMed database, using keywords that contain the term "fascia" in relation to different anatomical regions. The list of articles found was reviewed for relevant publications and a total amount of 41 scientific works was considered suitable for our investigation. For further research we used international reference texts on Anatomy. *Discussion:* The review of the literature confirms our idea of a fascial continuity and describes its development, at several levels: 1) superficial fascia; 2) superficial layer of the deep fascia; 3) deep layer of the deep perineal fascia; this layer can be divided into two separate layers by the levator ani muscle. *Conclusion:* Anatomically, the continuity in the fasciae of the abdominal wall, pelvic floor and lumbar region is plausible. A "new" theory of fascial anatomical continuity could have implications in the understanding of the clinical presentation of pelvic pain, the comprehension of the anatomical link between abdominal-lumbar disorders and pelvic floor, and in the treatment of chronic pain conditions, leading to an enhancement in current anatomical knowledge and therapies.

Keywords: Colles fascia; Urogenital diaphragm; Pelvic floor; Integral theory; Fascia.

INTRODUCTION

The pelvic floor is a well-defined anatomical and functional region including organs[1] and tissues located between the pelvic inlet and the perineum; many of these structures pass through the perineum and develop a mutual dynamic and functional integration. On the basis of this integration, a new idea has been promoted in literature, namely the concept that the clinical presentation of a variety of musculoskeletal disorders may be explained by "fascial communication", which may play a leading role in the transmission of pain.[1] It is therefore plausible to describe the fascia as a source of proprioception and nociception.[2]

However, a general anatomical connection between the fasciae of the pelvic floor, the abdomen and the lower back has not been described nor assumedyetin literature: such concept could lead to the establishment of a "theory of a whole-body fascial linkage", that could explain the presence of referred pain as transmitted through a fascial layer.

The purpose of this study was to review the literature in order to obtain more insight into the status quo of fascial anatomy in the abdominal, lumbar and pelvic regions and to prepare the ground for a new anatomical pattern.

MATERIALS AND METHODS

A search of the literature was conducted using the PubMed database in November 2015. In order to find suitable articles for the literature review, the following keywords were used: "fascia", "pelvic floor", "endopelvic fascia", "perineal membrane", "anatomy", "terminologia anatomica", "nomenclature", "abdominal wall", "retroperitoneal space", "human abdominal fascia", "Colles fascia", "urogenital diaphragm", "pelvic floor dysfunction", "pelvic organ prolapse", "arcus tendineus fasciae pelvis", "parietal presacral fascia", "rectosacral fascia", "Waldeyer's fascia", "membranous layer", "Scarpa's fascia", "transversalis fascia" and "superficial fascia". Search terms were used individually or in combination. Reference lists of identified articles were also reviewed for relevant publications and 41 scientific studies were considered the most related to our work. In addition, the classic reference texts on Anatomy were consulted: Gray's Anatomy, Atlas of Human Anatomy (Netter), Topographic Anatomy Textbook (Testut).

RESULTS

According to Stoker,[9] the pelvic floor constitutes four principal layers: endopelvic fascia, the muscular pelvic diaphragm (commonly referred to as levator plate), the perineal membrane (urogenital diaphragm) and the superficial transverse perineii. The anorectum and pelvic floor have multiple interconnections by fascia and ligaments as well as multiple indirect connections to the bony pelvis. According to Park *et al*.,[10] further, more superficial connections exist. To demonstrate this continuity, Park *et al*.[10] injected five fresh cadavers with contrast material in the space between Dartos and Buck fasciae of the penis, showing that the contrast material filling the scrotal cavity extended posteriorly in the perineum, remained far below the urogenital diaphragm, and reached superiorly to the potential space along Scarpa fascia in all cadavers. During cadaveric dissection, the ink-stained spaces were confined by the fascial planes involving Colles, Buck, Dartos, and Scarpa fasciae. All these fasciae are superficial fascia, placed in the middle of the hypodermis. Colles fascia is in continuity posteriorly with the corrugator cutis ani, a layer of muscular fibers around the anus, which radiates from the orifice. Medially the fibers fade off into the submucous tissue, while laterally they blend with the true skin. By its contraction it raises the skin into ridges around the margin of the anus.[8] This muscle is the homolog of the panniculus carnosus found in mammals, and in humans, corresponds to the superficial fascia.[2]

Martin[11] also described a specific attachment of this subcutaneous layer (or superficial fascia) with the deep fascia, defining some pocket-like diverticulae. The lateral pocket continues into the superficial perineal pouch. The medial pocket, together with the intermediate, occupies the scrotum or labium majus. The intermediate pocket is associated with the spermatic cord or the round ligament of the uterus and blends with their coverings posteriorly. However, in the male it terminates just above the testes.

A second, deeper continuity among the abdominal, pelvic and lumbar fasciae could be recognized and is realized by the Gallaudet fascia (or deep perineal fascia, or superficial investing fascia of the perineum). Indeed this fascia surrounds the bulbospongiosus, ischiocavernosus and superficial transverse perineal muscles. This fascia is attached laterally to the ischiopubic rami and fused anteriorly with the suspensory ligament of the penis or clitoris. According to Gray's anatomy,[8] it is continuous anteriorly with the deep investing fascia of the abdominal wall muscles (in particular with the fascia of the external oblique muscle), and in males, it is continuous with Buck's fascia. Superficial transverse perineal muscle continues with the external anal sphincter[12] and with the anococcygeal ligament. According to Kinugasa *et al*.,[13] the anococcygeal ligament is divided into two layers: a thick ventral layer, rich in thin vessels and extending from the presacral fascia to the conjoint longitudinal layer of the anal canal, and a thin dorsal layer extending between the coccyx and external anal sphincter. A recent paper[14] also confirmed that the anococcygeal ligament (ACL) is formed by two distinct structures: a superficial fibrous band originating from the myosepta of the external anal sphincter and running upwards to the coccyx (the superficial ACL); and a deep fibrous band originating from the periosteum of the coccyx, merging with the thick presacral fascia and attaching to the superior end of the EAS (the deep ACL). From the coccyx and sacral bone the gluteus maximus with its fascia origins is in continuity with the posterior layer of the thoracolumbar fascia.[15]

Finally, a third, deeper fascial continuity could be recognized. Gray (1918) described the urogenital diaphragm as consisting of two dense membranous laminæ which are united along their posterior borders, but are separated in front by intervening structures. The superficial of these two layers, the inferior fascia of the urogenital diaphragm, is triangular in shape, and about 4 cm in depth. Its apex is directed forward, and is separated from the arcuate pubic ligament by an oval opening for the transmission of the deep dorsal vein of the penis. Currently, insights indicate the presence of a musculofascial unilayer structure, while questioning the existence of superior fascia and deep transverse perinei.[9] As a more appropriate alternative, the term perineal membrane is suggested. Stein & DeLancey,[16] examining serial cross-sections, revealed that the perineal membrane is a complex structure that is only one component of a larger interconnected support apparatus. In particular, this study revealed that the perineal membrane has two distinct parts; a dorsal portion and a ventral portion and that the levator ani muscle is intimately connected with this structure. The perineal membrane is posteriorly inserted into the perineal body (also named the central perineal tendon) which is a site of attachment of many structures and therefore has an important function in the complex interaction of the pelvic floor muscles. In the central perineal tendon six muscles converge and are attached: the sphincter ani externus, the bulbocavernosus, the two transversi perinæi superficiales, and the anterior fibers of the levator ani. In actual fact, the central perineal tendon could be considered a point of fusion among the various layers forming the pelvic floor, in a similar manner to the linea alba of the muscular-fascial layer of the abdomen. Gray's Anatomy[8] pointed out that "central nucleus of the perineum" is an inappropriate term, as it is neither central nor tendinous. It is composed of connective tissue, elastin, and smooth muscle, distributed irregularly within the body but becoming almost horizontal toward the rectovaginal septum. The attachment of the levator ani muscles to the perineal membrane and perineal body means that disruption to the midline connection between the perineal membranes of each side though the perineal body allows loss of perineal body support and also lateral displacement of the perineal membrane.[16]

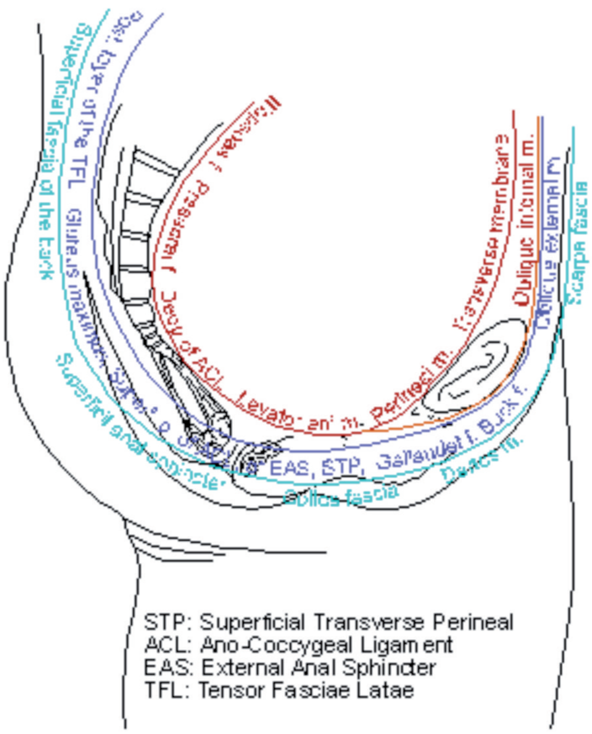

Figure 1. – Scheme of the fascial continuity among the muscular-fascial layers of the pelvic floor, abdomen and back.

According with DeLancey[17] the perineal membrane is a single sheet of fascia extending between the pubic arch and the ischiopubic rami and denoting a boundary between superficial and deep perineal spaces.

Posteriorly, the perineal membrane is connected with the presacral fascia through the deep fibrous band of the anococcygeal ligament (ACL). Indeed this band originates from the periosteum of the coccyx, merging with the thick presacral fascia, and attached to the superior end of the external anal sphincter.[14] Whilst the superficial ACL is composed of very tortuous elastic fibers, with a fine elastic fiber mesh, the deep ACL is composed of almost straight collagen and elastic fibers, intermingled with the coccygeal periosteum. Consequently, the deep component can play an important role, in association with contraction of the longitudinal anal muscle and with the thick presacral fascia, in maintaining a suitable positioning of the anorectum to the coccyx. However, their relative lack of smooth muscles compared with rich elastic fibers indicates that both ACLs may become permanently overextended under conditions of long-term mechanical stress.[14]

DISCUSSION

A careful and thorough analysis of literature supports the idea of a fascial continuity between abdomen, pelvic and the lumbar region.Our literature review and a comparison of anatomical texts allowed us to describe this fascial continuity as follows:

1) superficial layer: in an anteroposterior sequence, it is formed by Scarpa's fascia → Colles' fascia → (sphincter ani) → superficial fascia.

2) superficial layer of the deep fascia: in anteroposterior sequence, formed by the aponeurosis of the external

oblique muscle → (ischiocavenous and bulbospongiosus muscles) in connection with the Gallaudet and Buck's fascia, up to the fascia lata of the thigh → superficial transverse perineal muscle and Gallaudet fascia central tendon of perineum → superficial portion of the external anal sphincter → superficial portion of the anococcygeal ligament → (gluteus maximus) posterior layer of the thoracolumbar fascia.

3) deep layer of the deep fascia: in anteroposterior sequence, formed by the internal oblique and transverse aponeurosis, that blend into each other at the level of pubic symphysis, forming the urogenital diaphragm → central tendon of perineum → (levator ani muscle) → deep portion of the anococcygeal ligament presacral fascia → iliac fascia of the iliopsoas muscle. This deep fascial layer can be divided again into two levels, assuming the levator ani muscle as an ideal boundary line stretching from the urogenital triangle anteriorly to the deep transverse perineal muscle posteriorly. Therefore we can describe: a superficial layer – above the levator ani – formed by the superior band of the pelvic diaphragm that bends posteriorly, through the tendinous arch of pelvic fascia, with the aponeurosis of the internal obturator muscle; and a deep layer including the lower band of the pelvic diaphragm which merges anteriorly with the aponeurosis of the internal oblique abdominal muscle.

CONCLUSION

There is no description in literature of a fascial continuity between abdominal wall, pelvis and lumbar wall; though the topographic anatomy of these anatomical regions is well known. An overview of these fascial structures has not been well established. Our study, through a scientific review and a comparison of anatomy texts, demonstrates that a "fascial continuum" actually exists and such knowledge could improve the understanding of referred pain pathophysiology and mechanisms. However, a deeper and more detailed anatomical study is essential for the validation of this notion, and forms the focus of our future research.

Recently reports have demonstrated that the deep fasciae are well innervated[18,19,20] and capable of transmitting mechanical forces from a distance[21,22]. This concept of a fascial anatomical continuity may have important implications for the understanding of the clinical presentation and treatment of pelvic pain, such as the case of pelvic pain resulting from abdominal (eg. caesarean section, abdominal surgery) or lumbar injuries. Conversely, lower back symptoms might find their origin and explanation in pelvic floor disorders. This new concept could improve the treatment of chronic pain and could lead to an important enhancement of current anatomical knowledge and therapies.

DISCLOSURE STATEMENT

The authors declare that they have no conflict of interest.

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The pelvic floor is a well-recognised anatomical and functional region with its muscles, ligaments and bony structures clearly identified and labeled. As there was a lack of understanding of the complexity of the pelvic fascia and its multilayer continuity throughout the abdomino-lumbar regions, it now became logically identified by Dr Carla Stecco's team. The concept of fascial continuity potentially brings a new insight into a range of disorders associated with the pelvic region, particularly, the poorly understood problem of chronic pelvic pain. Considering the complex interaction between fascia and pelvic muscles, often noted for their dysfunctional state in pelvic disorders, the fascia surrounding the muscles is a potential mechanism, due to which, muscle generates tension and fascia mediates force transmission, that leads to pain. This pain is often misconstrued as having visceral origin and is frequently labeled as referred pain. Based on the significant contributions of DeLancey, Stoker and others, the work of Carla Stecco and her team provides a seminal evidence-base for a new perspective on the anatomy, function, and dysfunctional states of the pelvic region. From the perspective of an anatomist, such discoveries are most welcomed, encouraged and recommended.

PROF RYSZARD MACIEJEWSKI
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Different clinicians have varying views of fascia, for surgeons, it may serve as a boarder for dissection, a stable anchor for sutures or a location of tissue herniation that requires repair. For many, it was that white stuff that needed to be dissected out of the way in cadaver lab, oh-so-many-years-ago, in order to isolate a well delineated structure that would soon have a numbered pin placed in it that required identification for a lab quiz. Like all things in life, fascia and the fascial system holds differing paradigms depending on the viewpoint of the clinician. With the emergence of research we now know that fascia is much more than aponeurotic sheets, ligaments and the ubiquitous packing material occupying space in between anatomic structures. It contains a vast neural network capable of generating signals of proprioception and nociception as well as reacting to and transmitting mechanical loads.

The value of this article lies in the clear stated goal of providing a greater understanding of the continuity of the fascial system between the abdominal wall, pelvic floor and lumbar region which had not previously been established in the literature. The abdominopelvic canister is a functional and anatomical construct based on the continuity of the somatic structures of the abdominal cavity and pelvic basin. The superior boarder of the canister being the respiratory diaphragm and the inferior boarder, the pelvic floor. The canister acts synergistically to support the midline of the body and altered mechanics, be it of a lack of support, altered respiration or excessive motor holding are well established as contributing to the development of pelvic dysfunction.

As medicine has moved away from the Cartesian model – where chronic persistent pain was believed to be a direct result of tissue damage – to a greater understanding that pain is an output from the brain as a result of threat, perceived or real, we must adjust our diagnoses and treatments accordingly. The focus of chronic pelvic pain is also moving away from the paradigm of assumed organ pathology to a greater understanding of the contribution of the musculoskeletal system which includes fascia as a generator of nociception and altered proprioception. Scars of the abdominal wall as well as lumbosacral dysfunction have been reported in the literature as a source of persistent pain. The knowledge of the signaling function of fascia and the new established continuity between the abdomen, pelvic floor and low back provides another area of consideration for potential sources of nociceptive input to the brain.

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It is a pleasure to comment on Dr Stecco's concept of a universal fascial system, in this instance, its relevance to the pelvic floor. The role of connective tissue in pelvic floor function and dysfunction has been a recurent theme in this journal since its inception some 10 years ago. The word 'fascia' is not a well defined concept in pelvic floor anatomy. In a general sense it is a structural component which refers to the connective tissue covering organs, muscles, pelvic side wall. Ligaments have historically been defined as a condensation of this fascia. On dissection 'fascia' appears white and it is often assumed that this is a purely collagenous layer. Nothing could be further from the truth. Biopsies of ligaments, 'fascial' layers of vagina and attachments between organs have all given the same results: collagen, elastin, smooth muscle, blood vessels and nerves, fig1, albeit in different proportions. It follows from figure 1, that all pelvic functions involving the organs muscles and ligaments will involve a cortically co-ordinated contraction or relaxation of the 'fascia' in some way. Fascia is indeed a living contractile tissue.

The Integral Theory intersects with Dr Stecco's holistic concepts. It describes how bladder and bowel are opened and closed by striated pelvic muscles pulling against suspensory ligaments. If the ligaments are loose, organ closure is deficient (incontinence) and also, opening (evacuation problems). The most vulnerable structural components of the ligaments are collagen and elastin, both of which deteriorate with age.

This cortically co-ordinated relationship between striated muscle, smooth muscle and ligaments/fascia explains many so-called mysteries of the pelvic floor. How strips of tape strategically placed on ligaments restore continence (TVT operation): the contractile strength of the urethral closure forces is restored. Pelvic muscles become unbalanced when a forward or backward vector forces is weakened: the opposite vector contracts excessively causing muscle spasm and pain. How inability of loose uterosacral ligaments to be tensioned may cause referred pain along the T11-12 S2-4 nerve plexuses. Clearly the pelvic fascial/ligamentous tissues must be related to the general fascia as described in Dr Stecco's universal theory. This raises two fascinating questions, how and by how much?

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Pelvic Floor Reconstructive Surgeon Sydney

"Fascial continuity of the pelvic floor with the abdominal and lumbar region" in my opinion opens a very interesting addition to the established aspects of the Integral Theory. Due to its extraordinarily detailed review of the recent literature and clinically orientated conclusions it contributes valuably to the understanding of the pelvic floor anatomy and its connection to other regions of the human body in a holistic manner. If anything at all, the critical reader possibly would miss a quick view into Embryology, as one would also find elements of these findings e. g. in some of the publications by H. Fritsch and associates (such as Ann Anat. 1993 Dec;175(6):531-9: "Development and organization of the pelvic connective tissue in the human fetus.", or Surg Radiol Anat. 1994;16(3):259-65: "Topography and subdivision of the pelvic connective tissue in human fetuses and in the adult", or more recently in Adv Anat Embryol Cell Biol. 2004;175:III-IX, 1-64: "Clinical anatomy of the pelvic floor." These papers would as well support the correctness of the conclusions drawn, and I am thoroughly stretched of what influence on clinical practice this will gain in the future.

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Original article

Outcomes of surgically treated mesh erosions secondary to mid-urethral sling surgery

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Abstract: Objective: Mesh erosion is a bothersome complication of mid urethral sling surgery and the aim of this study is to scrutinize the risk factors and results of mesh erosion surgery. *Materials and methods:* This retrospective study evaluates the patients who have have had partial removal of mono-filament polypropylene tape due to the mesh erosion between the dates of July 2012 to July 2015. The data were analyzed with the SPSS package programme. *Results:* The total number of the cases who have had partial removal due to mesh erosion was 28. The majority of cases had had transobturator tape surgery (89.3%). The mean of the time from index mid urethral sling surgery to mesh erosion surgery was 31.2 (24.8) months. The most common presenting symptom was stress urinary incontinence (SUI). The mean of follow up period after the mesh erosion surgery was 14.5 (8.8) months. The number of incontinent and continent patients before the mesh erosion surgery was 10 and 18, respectively. The number of the incontinent patients after surgery increased to 12 patients and the rest of the study population (16) have remained continent. *Conclusion:* Mesh erosion could be seen as late as 102 months after the index operation. Partial removal of mesh is easy and usually does not have a considerable negative impact on continence. Follow ups are essential for patients who have had mid urethral sling surgery.

Keywords: Mesh erosion; Partial mesh removal; Stress urinary incontinence.

INTRODUCTION

Several new techniques have been developed for the surgical treatment of stress urinary incontinence (SUI). Currently, most of the literature are favouring the use of midurethral tapes[1]. However, mesh erosion is a bothersome complication of this surgical treatment and the incidence varies widely (0% vs. 20%)[2]. The presenting symptom of the patients who have erosion can vary such as SUI, persistent vaginal discharge, stinging feeling, voiding dysfunction, vaginal burning sensation, vaginal bleeding, dyspareunia of partner or urgency. Diagnosis is confirmed by visual inspection or palpation of the tape in the vagina. Care must be taken to exclude urethral and bladder erosions that are potentially serious complications and necessitate immediate surgical removal.

The vaginal erosion is caused by multiple factors including inappropriate vaginal dissection, wound infection, bad healing, scarring, markedly atrophied vaginal wall, estrogen deficiency, diabetes mellitus, postoperative urinary retention, postoperative traumatic catheterization, or urethral dilatation[3,4]. The placement of tape under the pubocervicovaginal fascia would prevent erosion formation[5]. This study aims to identify the outcomes of surgically treated mesh erosions in women who have had mid urethral sling surgeries for SUI.

MATERIALS AND METHODS

This retrospective study evaluates the data between the dates of July 2012 to July 2015. All the files of the patients who had had surgically treated mesh erosion were scrutinized with respect to age, parity, menopausal status, symptoms, type of sling surgery, commorbidity and followups. Only the patients who had been operated with the mono-filamentous polypropylene slings were included in the study. The data were analyzed with the SPSS package program.

RESULTS

The total number of the cases who had surgically treated mesh erosion was 28. Twenty-six midurethral sling surgeries were performed at other units and two at our centre. During the study period (3 years) the total number of mid urethral sling surgeries was 147. Hence the erosion rate of our centre was 1,3%. The demographic parameters of the study group are given (Table 1).

We found that the mean duration from mid urethral surgery to erosion diagnosis was 31.2 (24.8) months. Interestingly, one mesh erosion was diagnosed in a patient 102 months after index surgery.

The majority of cases had transobturator tape surgery (89,3%) (Figure 1). A small amount of cases with erosion was seen after TVT (10.7%).The mean of the time from index mid urethral sling surgery to mesh erosion surgery was 31.2 (24.8) months. The most common presenting symptom was stress urinary incontinence (SUI). The mean of follow up period after the mesh erosion surgery is 14.5 (8.8) months. The data have been given (Table 2).

The number of incontinent and continent patients before the mesh erosion surgery was 10 and 18, respectively. The number of the incontinent patients after surgery increased to 12 patients and the rest of the study population (16) have remained continent.

We found that the mean duration from mid urethral surgery to erosion diagnosis was 31.2 (24.8) months. Interestingly, one mesh erosion was diagnosed in a patient 102 months after index surgery.

The most common presenting symptom was stress urinary incontinence, stinging feeling, leucorrhea, emptying difficulty, vaginal burning sensation, dyspareunia of partner and urgency in descending order in our study.

TABLE 1. The demograhic parameters of the study population.

Variable		
Age (years)	54.2 ± 11.6 (min. 32 - max. 78) years	
Parity	Multiparity 28 Nulligravid 1	
Reproductive status	Menapausal 18 Perimenopausal 10	
Comorbidity	No comorbidity Hypertension Diabetes + Hypertension Diabetes	17 (60,7%) 7 (25%) 3 (10,7%) 1 (3,6%)

Table 2. Data related to the midurethral sling surgery.

Variable		
Type of sling surgery	TOT	25 (89,3%)
	TVT	3 (10,7%)
Passed time from the index surgery to the application for treatment (months)	31.2 ± 24.8 (min. 3 - max. 102) months	
Presenting symptoms	SUI	10(35,7%)
	Leucorrhea	5 (17,9%)
	Voiding difficulty	4 (14,2%)
	Stinging feeling	3 (10,8%)
	Vaginal burning sensation	3 (10,8 %)
	Dyspareunia of partner	2 (7,1%)
	Urgency	1 (3,5%)
Follow up period after mesh erosion surgery (months)	14.5 ± 8.8 (min. 1- max.33) months	

The cases were followed up with a mean of 14.5 (8.8) months (min.1- max 33 months).

De novo stress urinary incontinence occurred in two patients. The total number of cases who have had stress urinary incontinence was 12. Four cases out of 12 opted for Burch colposuspension and these cases are continent. Eight patients were given anticholinergic treatment plus extra-corporal magnetic innervation therapy. Four patients out of eight were happy with the treatment modality because they were almost dry, however the other four patients rejected any further treatment and they were incontinent.

The most common presenting symptom was stress urinary incontinence, stinging feeling, leucorrhea, emptying difficulty, vaginal burning sensation, dyspareunia of partner and urgency in descending order in our study.

The cases were followed up with a mean of 14.5 (8.8) months (min. 1-max 33 months).

Figure 1. – Mesh erosion due to transobturator sling surgery.

De novo stress urinary incontinence occurred in two patients. The total number of cases who have had stress urinary incontinence was 12. Four cases out of 12 opted for Burch colposuspension and these cases are continent. Eight patients were given anticholinergic treatment plus extra-corporal magnetic innervation therapy. Four patients out of eight were happy with the treatment modality because they were almost dry, however the other four patients rejected any further treatment and they were incontinent.

Informed patient consent was obtained from the patients and the study was approved by the local ethical committee of the hospital.

DISCUSSION

All of the patients (28) had partial removal of mesh. Complete removal of mesh has not been tried because of two reasons: 1) the tissue integration of monofilament polypropylene meshes is increased, making its complete dissection nearly impossible without any complication to the surrounding structures such as urethra, bladder or connective tissue of the pelvic floor 2) the complete removal of mesh may lead to recurrence of stress urinary incontinence after the surgery.

During the early period of sub urethral sling surgery; the prevalence of mesh erosion was as high as 10-40%. However with improvements in surgical technique and mesh technology, the rate of erosion has dropped to 3%[6]. The management of mesh erosion is either medically or surgically. If the erosion is < 5mm, spontaneous healing within 6-12 weeks can be seeen[7]. However, if the conservative treatment fails or the longest distance of erosion is larger than 1 cm; the exposed part of the mesh is incised and the healthy vaginal mucosa is sutured under local anaesthesia. Topical estrogen usage should be offered to all postmenopausal patients. This study entails the patients who have had partial sling removal due to mesh erosion and all the cases were operated under local anaesthesia and their healthy vaginal tissue was sutured once the partial removal of the mesh had been completed. There was one recurrent case out of 28 cases after the partial removal of mesh (3.5%).

A review of TOT and TVT procedures for SUI found that mesh erosion was more common following TOT procedures compared with TVT procedures[8]. Our result is in accordance with the literature.

In order to get rid of the mesh erosion problems, the pubocervicovaginal fascia should be plicated over the mesh so that mesh would stay under the pubocervicovaginal fascia during mid urethral sling surgery[5].

In the literature, concominant surgery for SUI and POP has not been found to be associated with an increase in mesh releated complications[9]. On the other hand, previous vaginal scar tissue may lead to erosion due to damaged vascularity. Elderly age, BMI >30 kg/m^2, menopausal status, diabetes mellitus, smoking, length of vaginal incision > 2 cm, recurrent vaginal incision for postoperative complications and previous vaginal surgery for pelvic organ prolapse or incontinence were also found to be risk factors for mesh erosion[10].

CONCLUSION

Mesh erosion could be seen as late as 102 months after the index operation. Partial removal of mesh is easy and keeps patient continent. Follow ups are essential for patients who have had mid urethral sling surgery.

DISCLOSURE STATEMENT

There was no conflict of interest.

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Multidisciplinary Uro-Gyne-Procto Editorial Comment

To improve the integration among the three segments of the pelvic floor, some of the articles published in **Pelviperineology** are commented on by **Urologists**, **Gynecologists**, **Proctologists/Colo Rectal Surgeons** or **other Specialists** with their critical opinion and a teaching purpose. Differences, similarities and possible relationships between the data presented and what is known in the three or more fields of competence are stressed, or the absence of any analogy is indicated. The discussion is not a peer review, it concerns concepts, ideas, theories, not the methodology of the presentation.

Uro... Implantation of a synthetic midurethral sling is the most common anti-incontinence procedure in women worldwide. A major problem is the absence of controlled studies on the real incidence of complications, particularly mesh erosions, whose incidence varies from 0% to 41%. Factors for slings erosion fall into three main categories: patient and intraoperative conditions and mesh characteristics. The careful selection of patients and surgical accuracy can reduce the occurrence of this complication and minimize the possibility of a partial sling removal. The effectiveness of partial sling removal on continence needs a long-term follow-up because at the moment there is an absence of evident results in this matter, although the "absence of evidence is not evidence of absence".

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Procto... As well as Urinary Incontinence also Fecal Incontinence can be treated with a sling implant (Pelviperineology 2007;26:108), mostly if associated with rectal prolapse. It's very interesting that, in our personal experience (Pelviperineology 2013;32:9), similar results are obtained. Erosions and dislocations may occur but removal is easy. The internal circular scar following the removal allows a residual continence as well as described in this paper. Infection in posterior slings occurs more frequently and it needs a more important attention.

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Original article

Pain reduction after anti-incontinence operation with a shortened sub-mid urethral sling implant and medial needle trajectory

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Abstract: Aim of the study: We wanted to evaluate the 3 year-efficacy and the reduction in incidence, durability and severity of post-operative pain after trans-obturator sub mid urethral sling implantation with sling shortening and needle trajectory by medial route vs. results in previous studies reported in the medical literature of similar surgery using the Tension-free vaginal tape trans-obturator method. *Methods*: In this retrospective study, 82 patients' pre and post-operative data was collected from the medical records and by a telephone interview questionnaire regarding relief of symptoms and post-operative complications, focusing on post-operative pain. *Results*: Of the eighty two participants, most reported very low incidence and severity of post-operative pain. Two patients (2%) had post-operative moderate dyspareunia, while four patients (3.6%) suffered significant post-operative overactive bladder symptoms. Previously reported data regarding the trans-obturator sub mid urethral sling procedure showed that 11.5% and up to 30% of operated patients suffered post-operative pain, mainly at the thigh, pelvis and vagina, lasting for an average of two weeks. Some had chronic intractable thigh pain related to obturator neuralgia. Surgical attempts to remove the implant failed to improve the outcome. The operative cure rates shown here, evaluated by SUI symptoms persistence, were similar to those previously reported with the trans-obturator sub mid urethral sling procedure. *Conclusion*: The short sub mid urethral sling, positioned according to the FF method, is shown to lower the post-operative pain, while maintaining similar efficiency with SUI cure.

Keywords: Urinary stress incontinence; Trans-obturator sub mid urethral sling; Over-active bladder.

INTRODUCTION

Female urinary stress incontinence (USI) is defined as involuntary leakage of urine during physical activity, sneezing, or coughing.[1,2]

Stress leakage occurs when an increase in intra-abdominal pressure overcomes sphincter closure mechanisms in the absence of bladder contraction.

DeLancey (1993), concluded that the underlying pathophysiology is associated with a defect in bladder neck and urethra due to the laxity of surrounding tissues and insufficiency of the internal sphincter of the urethra.[3]

Stress urinary incontinence is the most common cause of urinary incontinence in younger women, and the second most common cause in older women.[4,5]

This is a significant public health problem, as shown by the 10% lifetime risk a woman has to undergo a surgical intervention to treat this bothersome condition.

The first choice of treatment for SUI is a conservative approach including lifestyle modifications (physical activity, dietary habits, and weight loss), bladder control exercises, and pelvic floor muscle training (PFMT). In the failure of conservative treatment, surgical treatment is necessary.[6]

The retro-pubic open colpo-suspension was widely used until Ulmsten (1996) described a new minimally invasive technique, a tension-free vaginal tape (TVT) for urinary incontinence treatment.[7]

This operation, based on a sub mid-urethral Prolene tape support, has been accepted worldwide as an easy-to-learn, effective and safe surgical technique. Recent prospective randomized studies have reported that the TVT success rate ranges from 80% to 95% with a longer-than-5-year follow-up.[7-12]

However, there have been several rather rare complications during and after the TVT procedure such as: bladder penetration, postoperative urinary outlet obstruction, bowel penetration and intra-operative and post-operative bleeding. These adverse events were attributed to the retro-pubic needle passage, proximal to the bladder, bowel and blood vessels.[13-16]

Modifying the retro-pubic TVT needle pass to the trans-obturator route allows avoidance of the para-vesical space, and reduces the risk of the TVT-related bladder, bowel, and vascular injuries.[14]

Emmanuel Delorme[27] and Jean de Leval[11] were encouraged to design a sub mid-urethral trans-obturator sling (TOT) wherein the TVT needle bypasses the retro-pubic area. Instead, the TOT needle route passes through the relatively safe medial compartment of the obturator fossa area, 2.5-3 cm medially to the obturator vessels and nerve, remote from the pelvic viscera and vessels.[17]

Studies suggest that this new minimally invasive, anti-incontinence operative procedure is associated with high cure rates and lower morbidity rates than TVT over the short term.[17]

As clinical evidence supporting its efficacy and safety at medium/long term has continued to grow, the TOT procedure has become widely adopted by urogynecologists and urologists worldwide.[18]

Nevertheless, pain can occur after retro pubic and trans obturator tape procedures, especially with de-Leval's method[19-21], at a rate of 11.5% up to 30% among operated patients, according to previous studies.

Following trans obturator procedures, pain symptoms are typically experienced by women at the groin/thigh region and are transient in the vast majority of subjects.[21-22]

The source of groin pain after trans-obturator procedures may originate from trauma secondary to the penetration of the dissecting scissors, needles, and/or tape into muscular (i.e. obturator and adductor muscles) and/or aponeurotic (i. e., obturator membrane) structures. It could also be related, however, to a foreign-body reaction to the tape, possibly in proximity to peripheral obturator nerve branches.

Theories of the origin of groin pain after TVT-Obturator sling include direct obturator nerve damage or indirect nerve compression and a myofascial syndrome arising from muscle hypertonia secondary to excessive tension or incorrect placement of the tape.[29]

To address these issues of postoperative groin pain as well as the – rather theoretical – risk of obturator nerve injury and to further improve the original surgery, the original TOT procedure was modified[28] to further reduce TOT-related post-operative thigh pain, by shortening the tape implant (TVT-

Abbrevo®, Ethicon, USA),[24] theorizing that a reduced amount of mesh would decrease post-operative groin pain.[29]

At 1 year follow-up, the modified inside-out trans-obturator sub mid urethral tape procedure was deemed as safe and efficacious as the original TVT-O, and also associated with less immediate postoperative groin pain.[25]

Although short term follow-up has been documented, longer-term evaluation has not appeared in the medical literature. Therefore, we wanted to evaluate the 3 year-efficacy and the reduction in incidence, durability and severity of post-operative pain, comparing patients operated according to a modified trans-obturator sub mid urethral sling procedure (TVT-Abbrevo), using a 12 cm-long polypropylene tape, in comparison with previously-published studies evaluated the same in TVT-O patients.

We expected to find that post-operative pain, severity and durability following the TVT-Abbrevo will be reduced, while other peri-operative complications and the therapeutic efficiency will be unchanged.

PATIENTS AND METHODS

This retrospective study examined the medical records of patients operated at a single center.

Inclusion criterion was the modified TVT-Abbrevo operation for USI, previously diagnosed by the history taking and cough test.

Exclusion criteria included absence of complete medical records and patient's refusal to participate in an interview. All operations were carried out by an experienced surgeon at a private hospital. The study was approved by the hospital's Institutional Review Board.

The operations were performed according to previously reported surgical steps.[28] In short, a 1 cm. longitudinal vaginal cut was made at the sub mid urethral area, sub mucosal lateral tunnels were created up to the inferior pubic ramous, the TVT-Abbrevo needles were passed close to the bone through the medio-anterior compartment of the obturator fossa and out at the covering skin, through the major labia.

Study participants' data regarding relief of symptoms and peri and post-operative complications, focusing on post-operative pain location, severity, duration and frequency, were carefully collected from the medical records. The data had been collected at three years' post-op telephone interview questionnaire regarding relief of symptoms and post-operative complications including post-operative thigh pain. Patients were routinely asked at follow-up visits whether they experience groin pain or inner thigh pain. Charts were reviewed for complaints of post-operative groin pain at any stage of follow up.

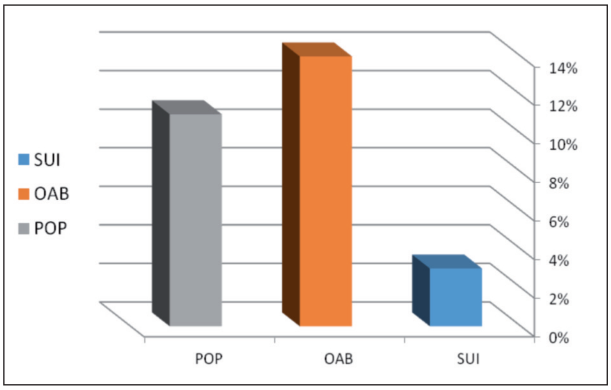

Figure 1. – Post Op clinical data.

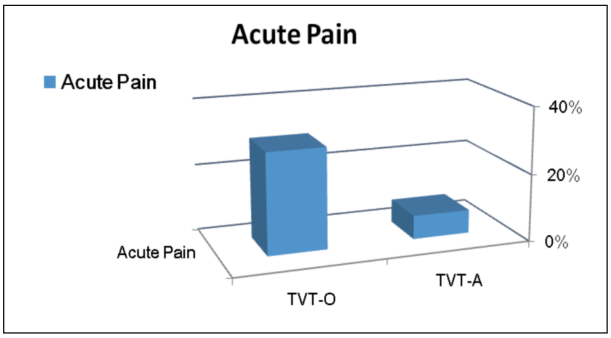

Figure 2. – Early post Op pain.

The percentage of patients with significant pain after surgery was expected to decrease significantly by using a medially placed short sling.

A 95% confidence interval for proportion was calculated for comparison of the expected differences in outcomes (this research vs. the literature): significant pain in no more than 10% of patients who underwent TVT-Abbrevo with modified needle surgery, compared to above 20% for the TVT-O procedure as quoted in the literature.

These results are based on one sample test for Proportions, alpha 5%, 1-sided hypothesis, examination of at least 80 patients is needed to achieve power of 81%.

Data was collected from 102 patients' charts by researchers not involved with the patients' care. Postoperative pain was assessed with a 0-10 Visual Analog Scale (VAS). Normally distributed continuous data were described using means and standard deviations, resorting to the median and inter quartile range for those not matching a normal distribution. Categorical data were described using numbers and percentages.

RESULTS

Between May 2011 and January 2012, a total of 102 patients suffering from SUI underwent TVT-Abbrevo implantation. Of these, 20 patients (20.4%) were lost to follow up after their first postoperative visit. Of the remaining 82 patients, 6 patients (7%) suffered early post-operative thigh pain described as mild, for up to one month after the procedure. Two patients (2%) reported early post-operative mild pelvic pain lasting for 2 weeks, and 3 patients (4%) reported mild dyspareunia which disappeared after two months in 2 patients and 4 months in the third.

Eleven patients (13%) complained of significant sustained post-operative Over Active Bladder (OAB) symptoms. Nine patients (11%) reported bulging symptoms during the third year following the procedure. Of these 9 patients, seven suffered only mild POP symptoms not necessitating any intervention, while 2 suffered moderate symptoms and required therapy. Finally, 2 patients (2.5%) reported mild SUI symptoms at the 3 year-post-operative interview.

The data retrieved from previous studies regarding the TVT-O procedure, showed that 11.5% up to 30% of operated patients suffered post-operative pain, mainly at the thigh, pelvis and vagina. Some had intractable chronic thigh pain related to obturator neuralgia. Surgical attempts to remove the implant failed to improve the pain. The operative cure rates, evaluated by SUI symptoms persistence, were similar to those previously reported for the TVT-O procedure.

DISCUSSION

The main finding of the present study was that while the operative urinary incontinence cure rates reported here are similar to the ones previously reported in the literature for the TVT-O technique, the primary outcome measure of our study, the incidence and duration of postoperative thigh pain, differed significantly.

Postoperative pain may appear as a result of tissue damage at the central obturator region radiating to the thigh, with subsequent spontaneous healing and recovery.

Persistent groin pain after an uncomplicated TVT-O procedure may be explained by damage of a peripheral branch of the obturator nerve. Though such damage is rare, it can occur. According to the FF method, instead of passing the needle tangentially through the central part of the obturator membrane and muscles, it is inserted perpendicularly, through the medial section of these structures, with the purpose of causing less tissue damage by virtue of its remoteness from the obturator nerve, thereby reducing postoperative thigh pain.

The shortened TVT-Abbrevo tape placed at a medial modified position appears to permit fixation in those tissues critical for support, while avoiding the muscles likely related to groin pain.

Our hypothesis regarding the lower rate of postoperative pain with the short sub mid urethral sling positioned according with FF method was confirmed, as well as our assumption regarding the similar cure rates between the two procedures

This trans-obturator sub mid urethral short sling implant method reduced the early post-operative pain to 6% compared to approximately 11.5-30% according to the previous TVT-O method reported in the medical literature.

In conclusion, the short sub mid urethral sling positioned according with the FF method is shown to have both lower post-operative pain and maintain similar efficiency with SUI cure rates.

DISCLOSURE STATEMENTS

There was no conflict of interest and informed patient consent was obtained.

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Original article

Treatment of chronic pelvic pain with Fascial Manipulation®

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Abstract: Chronic pelvic pain represents one of the major challenges for healthcare providers; it is often difficult to arrive at a definitive diagnosis as well as to employ a "gold standard" treatment. In this paper, a new approach regarding to the pelvic pain has been described, basing on the concepts of anatomical continuity of the fasciae of the abdominal wall, the pelvic floor and the lumbar region. The method applied is Fascial Manipulation®, which consists in the treatment of specific points selected within the fascial continuity. To explain this hypothesis two case reports have been considered: the patients reported chronic pelvic pain, even if they also suffered for low back and inferior limbs. The understanding of the fascial continuity between the pelvis, the back and the thigh, permits the development of treatments that could be suitable for the therapy of pelvic pain and, at the same time, for back and inferior limbs pain.

Keywords: Manual therapy; Fascial manipulation; Pelvic floor; Pelvic pain; Integral theory.

INTRODUCTION

Chronic pelvic pain is defined as non-malignant pain which could persist for more than six months and it is perceived in the pelvic region[1]. It represents one of the major therapeutic challenges for healthcare providers, such as general practitioners, physiotherapists and specialist physicians to whom is often difficult to arrive at a definitive diagnosis[2-3]. The pain located in the pelvis or in the lower abdomen is usually associated with a wide range of conditions involving the reproductive, gastrointestinal, genitourinary, and musculoskeletal systems[4]. Apte G *et al*.[1] define pelvic pain syndrome as recurrent or persistent pain associated with symptoms suggesting the involvement of the musculoskeletal, gynecological, urological or gastrointestinal systems in absence of inflammation or other specific pathologies.

Recently, the focus has been directed to the implication of fasciae as a possible cause of chronic pelvic pain[5,6,7]. It was demonstrated that the deep fasciae are well innervated[8,9,10] and are able to transmit the mechanical forces for long distances[11,12]. A defective sliding, or a densification of the loose connective tissue between the fascial layers can change the capacity of contraction of the muscle. Many manual methods suggest how to release the fascial densification in order to restore the normal fascial sliding to support the muscle activation and movement[13,14].

Bernstein et al. affirm that the myofascial Trigger Points (TrPs) appeared to be linked to hypertonicity of pelvic muscles and to inability of patients to relax and exert adequate voluntary control[15]. In contrast, the physical therapy of pelvic floor usually consists in electrical stimulation and active contraction of the internal muscles[16]. In this way, the goal of physical therapy is only to improve hypotonicity of the pelvic floor muscles, which is directly opposed to that of the TrPs hypothesis.

The fascial continuity concept complements the "integral theory", according which a balance of tension in the pelvic floor is the key to normal function of the pelvic organs[17,18]. To restore balance in dysfunctional states, where there is no organic problem, it is necessary to release fascial densification or restrictions, thus recreating the perfect equilibrium of forces. Moreover, the fascial system has been shown to be involved in muscle coordination, supporting the right timing and the activation of pelvic muscles. As myofascial pain, also the treatment of the pelvic region has to focus on both the muscles and fasciae. According to the Fascial Manipulation technique, pelvic fasciae are maintained in a precise tension through the presence of fascial connections between muscles of the abdomen, back and inferior limbs[19]. Their dysfunction can arise from fascial changes that could occur also in distant disctricts. These fascial connections have precise anatomical bases which are also described by Ramin *et al*.[20]. There are also well defined fascial connections with different viscera. In the lesser pelvis, from anterior to posterior, the connections include the urinary bladder, the uterus (prostate in male) and the rectum. The rectovesical fascia, for example, is a membranous layer that connects the prostate, the urinary bladder and the rectum and covers the seminal vessels[21]. It has been demonstrated that fasciae support the interconnections between the viscera, providing not only a proper isolation but, at the same time, guarantee the appropriate motility of the organs. Additionally, the fascia connects various organs with the muscles of the trunk. It has the capability to transmit forces and, in particular, to regulate possible imbalances that could interfere with the normal motility and mobility of the organs. As a result, sometimes organs from different systems can reflect different dysfunctions at the same time.

The key concept of the Fascial Manipulation® method is that a correct tension of the pelvic fasciae can be obtained by also treating distant fasciae, resulting in relief of pelvic pain.

The Fascial Manipulation treatment is specific for each person, basing on the symptoms and the clinical history. Consequently, a standard description of the treatment for chronic pelvic pain is impossible, but, to explain this new theory, two examples of treatments are reported.

The first case report concerns a female patient D. G., 17 years old, affected by dysmenorrhea since the beginning of menarche (6 years before the treatment). She complained constant pelvic pain of low intensity, rated as 2 on a 0 to 10 Verbal Analogue Scale (VAS), which usually increased two days before menstruation and remained high during the first 3-4 days of the menstrual cycle (VAS 7-8/10) such that requiring the use of painkillers. The pain was always located in the lower abdomen and during the menstrual period when it reached a peak of 7-8/10 VAS spreading to the low back and to the anterior part of the thighs. Gynecological visits resulted always negative, and an endometriosis was reasonably ruled out by ultrasound and magnetic resonance investigations. It had been proposed the diagnosis of Chronic Pelvic Pain (CPP) and dysmenorrhea. D.G. had sporadic episodes of acute low-back pain (LBP). She complained of bilateral knee pain with ratings of 3/10 (VAS) while resting, escalating to 7/10 (VAS) when walking for more than 10 minutes. The pain was localized in the anterior area of the knees and bending movements, such as climbing the stairs or squatting, resulted so dangerous to stop her dancing. MRI investigations of both the knees reported no abnormalities. Treatments included laser-therapy, and physical therapy focusing on reinforcement of the quadriceps muscles and stretching of the muscle chains of the legs showed no positive results. Her history included surgery in 2004 to remove a birthmark extending from the posterior portion of the right breast to the base of the ipsilateral ribcage. The post-surgical scar was extensive but without pain during movement.

The treatment performed followed the fundamentals of Fascial Manipulation®. The first session focused on the anterior part of the body. The first step consisted of checking all the points codified by the Fascial Maniulation® technique in the thoracic and abdominal regions including the inferior limbs. Irregularities of the fascial tissue (stiffness or roughness) were found in fascia of the internal and external oblique muscles (approximately located over the 11th and 12th ribs) on the left side, in the external oblique muscle on the right side, and in the the antero-medial portion of the right thigh (continuity of the pelvic fasciae with the iliopsoas fascia). Other two densifications were found in the ankle region over the retinacula that are in continuity due to the crural fascia (Fig. 1). The treatment has been performed with back and forward deep massages to release the densifications. It started with the release of the three densifications in the abdominal region. After the complete release of these areas the patient felt a sense of lightness in the left lower abdomen, and pain while squatting was improved 50% bilaterally. To balance and complete the treatment, the session continued handling the right thigh and the areas in the ankle. With the release of these densification the patient reported an 80% of improving in knee pain during squatting and lightness in the pelvic region on both sides. After the first month the follow up of the patient reported that the pain in the pelvic region was still absent and the pain in the knees was still 80% improved. After 3 months and one year the improvements continued to be maintained except during the menstrual periods. In facts, during the menstrual cycle the pain was of lower intensity (VAS 2/10), and did not interfere with activities of daily living (ADL's). Improvement in knee pain has been maintained and D.G. reported that she can walk, run and squat without pain.

The second case is about a 38 year old male (M.C.). He complained of pelvic pain, and referred pain to the groin for 6 years (4 years before the treatment). The pain was constant when standing or sitting, with a VAS of 5/10, which increased during the night, with VAS of 6-7/10. He also complained of urinary urgency and frequency with episodes of nocturia since six months after the appearance of the pelvic pain. Urine test, cystoscopy, ultrasound of the lesser pelvic region and other specialist examinations were all negative. M.C. had significant LBP for 4 years. He experienced acute low-back while lacing the shoes that persisted for three months. After various manual treatments, such as chiropractic and low-back massage the pain improved and he started to move more freely. Nevertheless, he still had constant pain rated 4-6/10 on the VAS, and experienced restriction in the range of motion (ROM) of his lower-back. He stated that he could not lift more than 10 kg of weight without having a new episode of acute low-back pain. He complained sense of heaviness in his legs, mostly above the ankle where it felt as if he had a lace around the

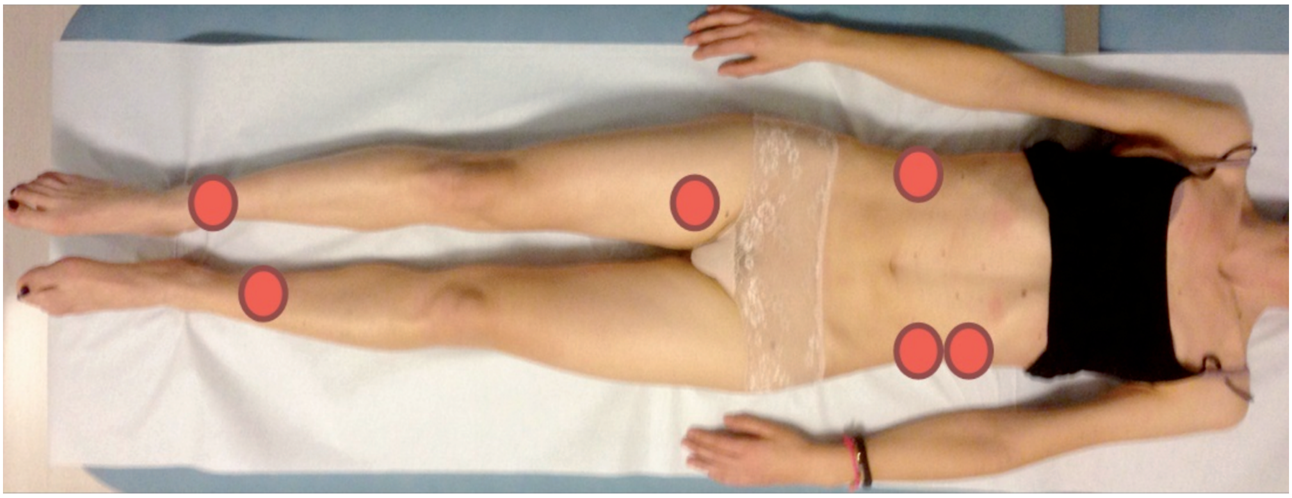

Figure 1. –Treated areas of 1st case report.

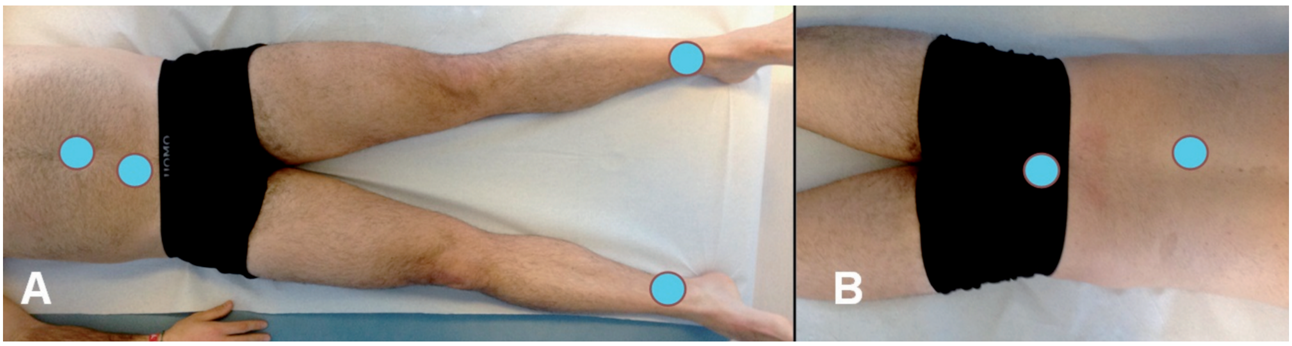

Figure 2. –Treated areas of 2nd case report. A) anteriorly, B) posteriorly.

joints. In the anamnesis he reported acute prostatitis with a bacterial infection that lasted for two months in 2009. He took antibiotics for three months.

The treatment was performed following the principals of Fascial Manipulation®. After a manual evaluation of both the anterior and posterior walls of the pelvic region and of the inferior limbs, some densifications/alterations of fascial sliding were found (Fig. 2). In this patient, the back and forward manual technique was carried out over specific areas along the linea alba, the space between the spinous processes and the paravertebral muscles, over the sacrum, and over the retinacula of the ankle, until complete release was achieved.

After the treatment, the patient reported an immediate sense of lightness in the pelvic and groin region. After one week he reported that the pelvic and groin pain and urinary urgency, and the legs were getting better. After one, three, and twelve months from the treatment, the pelvic pain and urinary dysfunction did not return, and LBP and problems in the lower limbs no longer existed.

DISCUSSION

These two examples of treatment highlight the importance of underlying fascial continuity in relation to activities and pain in patients.

In the first case, the removal of the birthmark may have created a lack of sliding of the pectoralis major fascia that is in continuity with the fascia of the oblique muscles. As a result of the connections of oblique muscles fascia with the pelvic floor muscle and the thoracolumbar fascia, external oblique fascia densification caused LBP and pelvic pain. The anatomical connection of the pelvic fasciae with the gluteus maximus and with the iliac fascia of the iliopsoas muscle at a later time caused knees pain. This case highlights the importance of treating the fasciae of the extremities in order to achieve long lasting results. The lower extremities represent one of the elements that defines the tension of the pelvic floor fasciae. Release of the only densification in the lumbar region improves the pain but an unbalanced condition remained. After the treatment of the thigh and extremities the pain continued to improve more symmetrically. Most often, pelvic pain and knee pain are considered two separate problems, and are evaluated by different specialists and treated in very different ways. However, if we consider that the deep fascia of the thigh connects the pelvic floor with the knee, we can understand how the two problems are connected. In this way a deeper analysis of the patients with pelvic pain in combination with other types of pain, surgery, or traumas, should be performed in more detail. Understanding these connections it is possible to treat more than one problem at the same time.

The second case confirms the importance of the correct tension in the inferior limbs fasciae to maintain a balance in the pelvic floor. Besides, it highlights the strong relationship between the musculoskeletal system and the internal organs of the pelvic region.

In the second case there is evidence of viscero-somatic compensation. The prolonged prostate inflammation and infection increased the stiffness of the fasciae around the organs of the lesser pelvis. Initially, following treatment for prostatitis the patient did not feel any symptoms. However, with the passing of time, tension spread to pelvic floor muscles and the groin region, due to the anatomical connections of the central tendon of the perineum with the iliac/iliopsoas fascia[22,23]. This altered fascial tension caused urinary bladder dyssynergia[24] due to the lack of adaptability of the bladder wall. The fascial continuity of the bladder fascia with the iliac fascia spreads the tension to the posterior wall causing LBP extending to fasciae of the lower limbs, causing pain and disturbances in the legs and ankles.

CONCLUSION

Understanding the continuity of fascial anatomy introduces a change of perspective, suggesting that the musculoskeletal system is often involved in cases of CPP. Consequently, when a patient complains pelvic pain, it is important to investigate if there is also low-back pain, groin pain, problems to the inferior limbs, etc. The severity and chronological sequence of various pains could be useful to identifying the primary problem and subsequent compensations. Clearly, through a global analysis and treatment of the patients problems, analyzed in accordance with the concepts of fascial continuity, will complete and durable results be achieved.

DISCLOSURE STATEMENTS

There was no conflict of interest; informed patients consent was obtained.

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Multidisciplinary Comments

To improve the integration among the three segments of the pelvic floor, some of the articles published in *Pelviperineology* are commented on by **Urologists, Gynecologists, Proctologists/Colo Rectal Surgeons** or **other Specialists**, with their critical opinion and a teaching purpose. Differences, similarities and possible relationships between the data presented and what is known in the three fields of competence are stressed, or the absence of any analogy is indicated. The discussion is not a peer review, it concerns concepts, ideas, theories, not the methodology of the presentation.

The article by Andrea Pasini, Maria Martina Sfriso and Carla Stecco deals with the important, and challenging problem of Chronic Pelvic Pain (CPP). CPP is difficult to diagnose and to treat using a generalized therapeutic approach. Given these challenges the more important and valuable approach, as proposed by the Authors, aims at a comprehensive, anatomical and functional approach to the management of CPP problems. It is significant that the densification of connective tissue which is the fascia has negative impact on the functioning of the locomotory system and internal organs and interaction of these structures. In the light of the latest scientific research,the role of fasciabecomes a priority for therapy of patients with CPP. It is also advisable to consider the vital role of the endocrine system, and of the thyroid gland in the etiology of fascial disorders, a point, omitted by the Authors and a possible contributing factor in the firstcase report, and often occurring chronic menstrual pain. In such cases, adequate levels of vitamin D3, K2 and C should not be overlooked. Scar tissue and the resulting functional restrictions are also worth mentioning, especially scars around the trunk and pelvis, as highlighted in the first case report. Inadequate physiotherapy procedures may also result in harmful distribution oftensions and increase the number of areas covered by fascia densification, as highlighted in the article. The occurrence of inflammation contributes to changes in the fascia, and needs to be kept in mind when dealing with any chronic pain conditions in the human body. Pain can be amplified by a tense psychological state, resulting in an increase in muscle tone influencing the fascial disorder. Stress,difficult life situations will affect the functionof internal organs and aggravate tense muscles, and this factor should be underlined in patients with chronic pain, and pelvic floor dysfunction.

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"Treatment of chronic pelvic pain utilising *Fascial Manipulation*®" certainly goes with time, firstly regarding modern holistic fascia understanding and treatment in physiotherapy, secondly offering to avoid operative treatment, and thirdly as an additional option especially in therapy-non-responding patients. However, this treatment is – as I understand it – symptomatic rather than causal, as it is based on diminishing a reflex response of the body on an irritation, which can be caused by a wide range of reasons. The CPP will return, if the reason is not found and/or eliminated. Patients can improve, but they cannot be cured, as long as the cause of the pain (such as a laxity in the uterosacral ligaments) is still present. Therefore, Fascial Manipulation would possibly not be able to replace Integral-Theory-based operative procedures. However, it may play an important role in all patients, who have had a successful therapy, as a very effective method to shorten their time of recovery. This makes it a respectable achievement, and a desirable method for all units treating pelvic floor dysfunction conditions.

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Original article

Standardized bilateral mesh supported uterosacral ligament replacement – cervico-sacropexy (CESA) and vagino-sacropexy (VASA) operations for female genital prolapse

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Abstract: *Aim*: The treatment of female genital prolapse is often associated by urinary incontinence. Based upon the important role of the uterosacral ligaments as part of the female genital holding apparatus we developed a surgical procedure to replace these ligaments. *Methods*: Women with genital prolapse were operated by means of cervico-sacropexy (CESA) or vagino-sacropexy (VASA). Polyvinylidene fluoride (PVDF) tapes of defined length were used to replace the uterosacral ligaments (USL). The patients were clinically examined at several time intervals after surgery. The data were analysed retrospectively. *Results*: The follow-up period ranged between 4 and 36 months with a median observation time of 20 months. 76 patients were operated for POP-Q stage II-IV using the CESA and VASA techniques. After surgery in all patients POP-Q stage 0 was observed. Before surgery in 66 patients an anterior colporrhaphy was indicated based on a POP-Q stage II of the cystocele. CESA and VASA led to a reduction of the cystocele so that no additional colporrhaphy had to be performed. Before surgery 49 patients were suffering from urgency urinary incontinence symptoms. After surgery 70% of these patients were cured of their incontinence. *Conclusion*: CESA and VASA operations led to an anatomical repair of genital prolapse. In 90% of patients a concomitant cystocele disappeared. CESA and VASA cured urge urinary incontinence and mixed urinary incontinence in 70% of these patients. Since CESA and VASA were standardized with identical steps in every patient these operations can be identically performed by every surgeon.

Keywords: Genital prolapse; Incontinence; Ligaments; USL; PUL.

INTRODUCTION

The treatment of female genital prolapse offers numerous surgical alternatives[1]. In case of uterus prolapse most often a vaginal hysterectomy is performed in combination with a colporrhaphy[2]. In patients with prolapse of the vaginal apex several suspension techniques have been developed which basically fix the prolapsed vaginal apex at different anatomical structures in the pelvis[1]. Because most of these patients have completed their childbearing all of these operations are aimed only to anatomically reconstruct the vagina.

However, all these prolapse operations lead to a high rate of urinary incontinence thereafter. That was demonstrated for sacrocolpopexy (SCP), sacrospinous fixation (SSF) and even for vaginal hysterectomy (VH). The CARE study reported an incontinence rate of more than 80% in previously continent women within 7 years after sacrocolpopexy[3]. In another multicenter trial the "de novo" incontinence rate was lately reported with 25% de novo stress incontinence and 14% urgency already one year after sacrospinous fixation[4]. Furthermore, also vaginal hysterectomy for treatment of uterus prolapse led to the development of urinary incontinence in more than 50% of patients within a few years after surgery[5,6].

Prolapse is caused by a defect of the pelvic "holding apparatus"[7,8]. The uterosacral ligaments (USL) play a critical role in that respect and may cause urinary incontinence as proposed by Petros and Ulmsten[9,10].

Because SCP, SSF and VH do not repair or replace the USL we hypothesized that all these procedures were "unphysiological" and thereby responsible for urinary incontinence. We therefore attempted to develop a surgical procedure which replaced the USL[11]. This bilateral replacement of the USL should lead to an anatomical correction of the prolapse and prevent urinary incontinence.

We now report about the cervico-sacropexy (CESA) and the vagino-sacropexy (VASA) as treatment for female genital prolapse with and without urinary incontinence.

MATERIALS AND METHODS

This study was a retrospective analysis of the outcome of cervico-sacropexy (CESA) and vagino-sacropexy (VASA). Follow-up examinations were performed at 2, 4, 8 and 16 weeks and at yearly intervals after CESA or VASA. Patients who could not come to the institution for a yearly clinical examination had telephone interviews once a year after surgery. A relapse of prolapse was defined as POP-Q stage > I.

Women with symptomatic genital apical prolapse POP-Q stage II, III and IV underwent surgical treatment by means of CESA and VASA between 2012 and 2014 at the Division of Urogynecology, University Hospital of Cologne, Germany. Pelvic organ prolapse was routinely measured according to the POP-Q system[12].

Based on our previous experience with CERESA and VARESA an anterior colporrhaphy was not routinely performed in this study. The indication for a colporrhaphy was therefore made in the operating theatre (OT) during the vaginal examination immediately after CESA or VASA with the patients under general anaesthesia. In this situation the indication for an anterior colporrhaphy was defined when Point Ba was ≥ –1cm. The only exception for that rule was when Point Ba had increased of at least 2 cm compared to the examinations before surgery.

For this purpose POP-Q measurements were performed in the OT under general anaesthesia, with neuromuscular blockades and endotracheal intubation, immediately before and after surgery. A clamp was horizontally fixed at the cervix or the vaginal vault and in order to standardize the measurements the clamp was pulled in the vaginal axis with defined traction of 10 Newton (1 kilogram) controlled by a portable electronic scale (Shenzhen Oway Technology Co., Ltd, Guangdong, China).

Before VASA and under general anaesthesia a vaginal dilator was placed in the vagina in order to stretch the vaginal apex during intra-abdominal suturing of the structure on the vaginal apex.

The augmentation of the uterosacral ligaments was performed using a narrow but open pore sling structure of 4

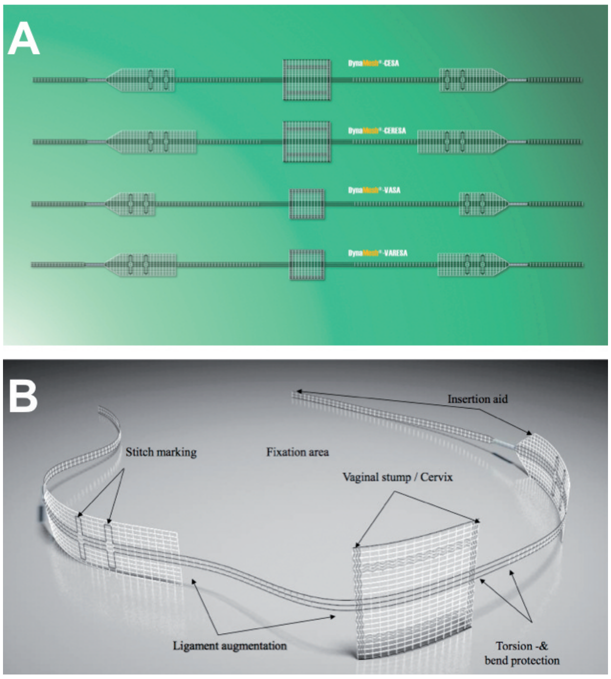

Figure 1A. – The structures for replacement for the uterosacral ligaments have been developed. They differ in length (CESA / CERESA 8.8 cm; VASA / VARESA 9.3 cm) and in the dimension in size of the fixation area.
Figure 1B. – Details of a CESA structure: the stitch markings at the posterior side show where the sutures must be placed. The insertion aid is cut after placement of the structure.

mm width made with high strength PVDF-filaments (Dynamesh CESA, Dynamesh CERESA, Dynamesh VASA and Dynamesh VARESA, FEG Textiltechnik mbH, Aachen, Germany) (Fig. 1A). Compared to the CERESA and VARESA tapes the new "USL-tapes" included the fixation side, thereby preventing an isolated rupture of the structures from the underlying tissue (Fig. 1B). One day before surgery the patients had a bowel cleansing as if for a colonoscopy. Before surgery cephalosporines were administered as a single dose injection. The CESA, CERESA, VASA and VARESA techniques have been described in detail (www.cesa-vasa.com). In summary the two new USL-tapes were fixed at the cervix or at the vaginal stump, pulled beneath the peritoneal fold of the USL on both sides of the pelvis and sutured at the pre-vertebral fascia at S1 and S2 (Fig. 2). After supracervical hysterectomy the anterior fixation area was fixed with 4 non-resorbable sutures

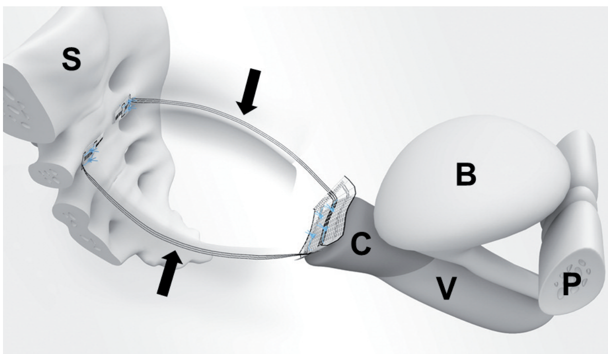

Figure 2. – The drawing shows the placed Dynamesh CESA tape. The tape is sutured with 4 non-resorbable sutures at the cervix (C), led through the peritoneal fold of the USL (black arrows) and sutured at the marked sides of the tape with two sutures to the prevertebral fascia on each side of S2 (S); Vagina (V); Bladder (B).

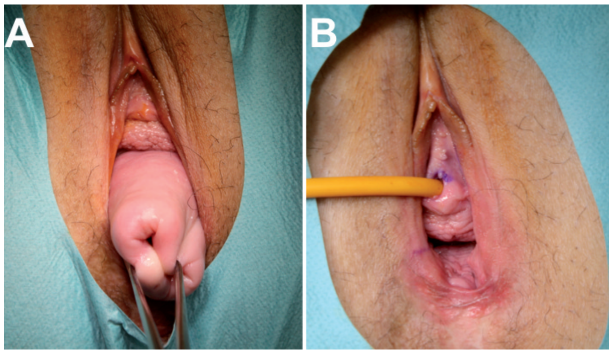

Figure 3. – Partial prolapse of the uterus before surgery.
Figure 3B. – Postoperative view after the CESA operation (note: without anterior colporrhaphy)

at the cervical stump (in VASA and VARESA the respective fixation sites were sutured to the vaginal stump) (Fig. 3A, 4A-D). The presacral fixation sites in front of S1/S2 were prepared (Fig. E). Two non-resorbable fixation sutures were placed in the prevertebral fascia (Fig. 4F). A TVT trocar was placed through the peritoneal fold of the USL to the origin of the USL (Fig. 5A). The insertion aid of the structure was put through the hole of the TVT trocar and the trocar was pulled backwards (Fig. 5B). Thereby the new USL structure was placed in the correct peritoneal fold and sutured (Fig. 5C). The same procedure was identically performed on the left side (Fig. 5D). All insertion sites were peritonealized with resorbable sutures (Fig. 5E, 3B).

The post-void residual urine volume (PVR) was measured by means of ultrasound.

Urinary incontinence (UI) was defined according to the recommendation of the ICS [13]**.** Validated urinary incontinence questionnaires (BBUSQ-22 and ICIQ-UI-SF) were answered before surgery, 4 months and one year after surgery. Cure was defined as the absence of any UI after CESA or VASA.

Patients who were still suffering from urinary incontinence after CESA or VASA were offered a transobturator tape (TOT).

Ethical approval for this study was obtained from the Local Ethics Commission (LEC) of the Faculty (No. 11-016). After 10 and 20 patients the LEC decided on basis of the comparison between these results and the results obtained by CERESA and VARESA (interim analysis) about the further continuation of the study.

Metric variables are presented as mean ± standard deviation (SD), if normally distributed. The Mann-Whitney-U-test was applied for comparisons of independent groups and the Wilcoxon signed rank test for paired samples since most variables were not normally distributed. For categorical data absolute and relative frequencies were calculated and compared by Chi-squared-test or Fisher's exact test. The two-sided significance level was set at 0.01. IBM SPSS Statistics 22 was used for the statistical analyses.

RESULTS

Seventy-six patients were treated by means of CESA and VASA according to the study protocol. Forty-two patients suffering from uterus prolapse underwent surgical treatment by CESA and 34 patients had a vaginal vault prolapse and underwent surgical treatment by VASA. Sixty-four patients suffered from POP-Q stage II prolapse while 12 patients from stage III and IV respectively. The distribution of POP-Q stages II–IV is shown in Table 1 and Figure 6.

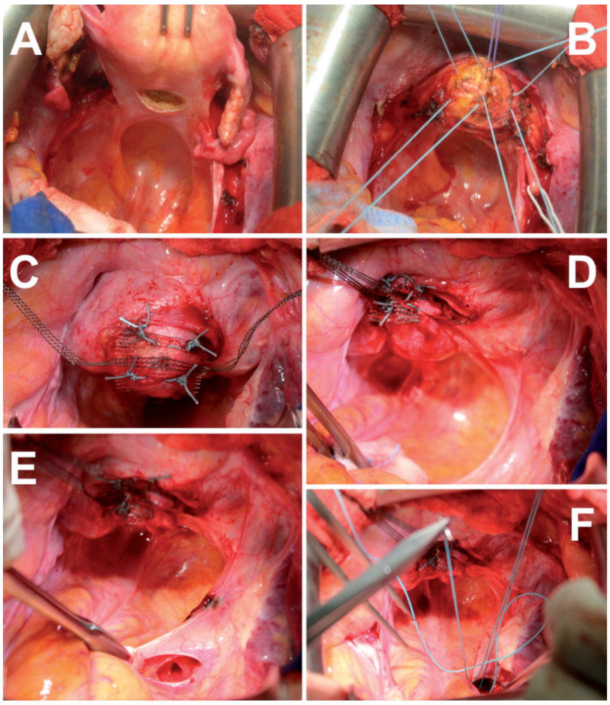

Figure 4. – In CESA the corpus is resected 0.5 cm above the insertion site of the uterosacral ligaments. Therefore, at the start of surgery the level of resection is incised.
Figure 4B. – Four nonresorbable sutures 2-0 are placed at all 4 quadrants of the cervical stump (in the case of VASA, these sutures are placed below and above the scar of the vaginal vault).
Figure 4C. – After placing the CESA (or VASA) tape the sutures are pulled through the net structure between the USL ("bridge") and tied.
Figure 4D. – The end of the USL at the sacrum is defined by pulling the cervix or uterus in the contra lateral direction and pushing the rectum with a swab in the height of S2 in the same direction.
Figure 4E. – The sacral end of the USL is defined and the incision of the peritoneum in front of the sacrum is placed horizontally 0.5 cm above that end. That is usually above the first (S1) or second sacral vertebra (S2).
Figure 4F. – From these incisions the pre-vertebral fascia is prepared. Two nonresorbable sutures 2-0 are placed horizontally in this fascia at each side of the rectum. Care has to be taken to avoid injuries of the peritoneal fold of the USL.

Four months after CESA and VASA 76 patients (100%) had POP-Q stage 0. Point C was in all patients between –6 cm and –10 cm (Fig. 6). The total vaginal length of the patients was between 8 cm to 13 cm. After the apical fixation by CESA and VASA we found a reduced size of the cystoceles.

Before surgery, in 50 patients (66%) Point Aa was ≥ –1 cm, in 66 patients (87%) Point Ba was ≥ –1cm. After CESA and VASA Point Aa was relocated to –3 cm in 48 patients (63%) and in 25 patients (33%) to –2 cm. Point Ba was also relocated to –3 cm in 47 patients (62%) and in 24 patients (32%) to –2 cm (Fig. 6).

During the immediate post-CESA / VASA vaginal examination in the OT in none of the 76 patients an indication for an anterior colporrhaphy was given. After 4 months of follow-up 5 patients (7%) required further surgical treatment by anterior colporrhaphy. So far none of the remaining patients needed a further repair. No de-novo urinary incontinence was observed in the pre-operative continent women. The anatomical results remained identical during the follow-up period.

Before surgery 51 patients (67%) complained about the sensation of incomplete bladder emptying and had elevated

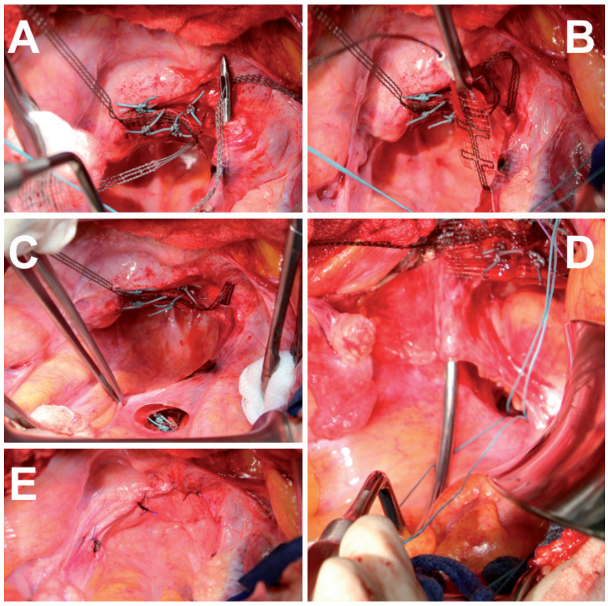

Figure 5A. – A small trocar, as usually used for a TVT placement, is pulled through the right peritoneal fold of the USL from the back to the base. The insertion aid of the tape is pulled through the hole at the top.
Figure 5B. – The trocar, guiding the tape, is pulled backwards to the sacrum.
Figure 5C. – The previously-placed sutures are pulled through the marked fixation sides at the tape, the insertion aid is cut and the sutures are tied. That is done on both sides of the rectum.
Figure 5D. – A small trocar is pulled through the left peritoneal fold of the USL from the back to the base.
Figure 5E. – The incisions at the sacrum are closed with resorbable sutures 4-0 at both sides. Thereafter in CESA the cervical stump is peritonealized with the bladder and Douglas peritoneum.

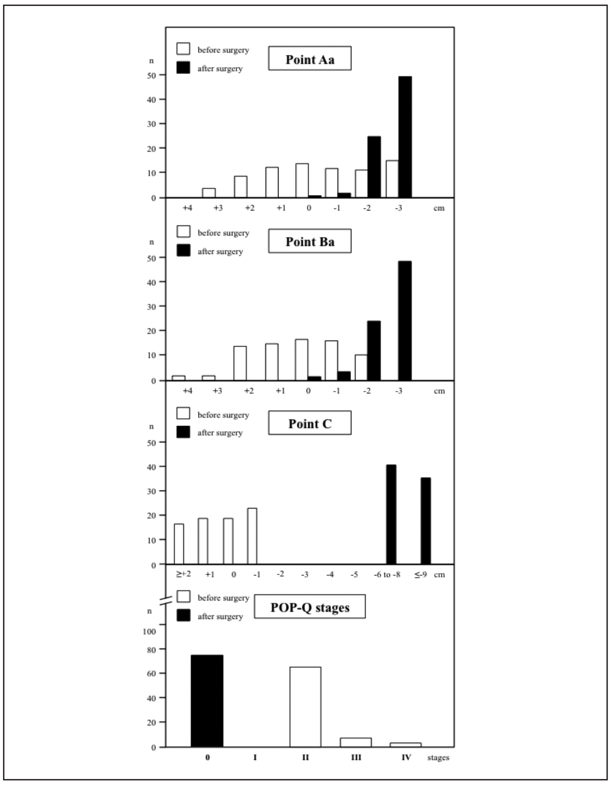

Figure 6. – Distribution of POP-Q Points Aa, Ba, C and stages of the 76 patients in the study before (white columns) and after surgery (black columns). Note the interrupted scale for POP-Q stages.

TABLE 1. Baseline clinical parameters of the 76 women in the study at the time of surgery.

Parameter	Total cohort (n=76)	CESA group (n=42)	VASA group (n=34)	p-value
Age at surgery, years, mean, ±SD (range)	64.9 ± 12.8 (31 - 92)	63.7 ± 13.8 (31 - 89)	67.0 ± 10.8 (50 - 92)	NS
Body mass index, mean, ±SD (range)	25.1 ± 3.9 (16.7-33.3)	24.6 ± 4.0 (16.7-30.3)	25.9 ± 3.8 (19.8-32.8)	NS
Parity, no. (%)				
Nulliparous	9 (11.9)	6 (14.3)	3 (8.8)	NS
Primiparous	16 (21.0)	10 (23.8)	4 (11.8)	
Multiparous	51 (67.1)	26 (61.9)	27 (79.4)	
Menopausal status, no. (%)				
Premenopausal	11 (14.5)	9 (21.4)	2 (5.9)	NS
Postmenopausal	65 (85.5)	33 (78.6)	32 (94.1)	
POP-Q stages, no. (%)				
Stage 0	0 (0)	0 (0)	0 (0)	NS
Stage I	0 (0)	0 (0)	0 (0)	
Stage II	60 (79)	35 (83)	25 (74)	
Stage III	13 (17)	5 (12)	8 (24)	
Stage IV	3 (4)	2 (5)	1 (2)	

NS, not significant.

PVR. After CESA and VASA all patients (100%) showed adequate bladder emptying.

According to the validated questionnaires 49 patients (65%) were suffering from UI before CESA and VASA. All of these patients had urgency urinary incontinence (UUI) and stress urinary incontinence (SUI) symptoms and these were defined according to their urinary incontinence as mixed urinary incontinence (MUI).

In 18 of the 24 (75%) patients who were operated upon CESA and 16 of the 25 (64%) patients who were operated by the VASA technique complete UI was re-established. Thereby 34 (70%) of the 49 incontinent patients were successfully treated (cured) by CESA / VASA surgery. After the 4-months examination 15 patients were still urinary incontinent. 11 of these patients agreed to a TOT. All 6 VASA patients and all 5 CESA patients were cured of their UI thereafter. Thereby in 45 out of 49 patients continence was restored by the combined treatment by CESA / VASA and TOT (92%) (Table 2).

The follow-up period ranged between 4 and 36 months with a median observation time of 20 months. During that time 4 patients in the VASA group and one patient in the CESA group developed a cystocele (point Ba > –1 cm) 4 months after surgeries and needed an anterior colporrhaphy. No change of the continence status was observed. No mesh erosion was detected. No rupture of the fixation sides from the underlying cervix or vaginal stump was found by postoperative ultrasound examinations or by new clinical complaints.

During this study no major side effects were observed. The ureters were never injured. The hypogastric nerves were always visualized and injury was avoided.

DISCUSSION

During the last 40 years several changes in the view of the uterovaginal suspension and new insights in the pathophysiology of pelvic organ prolapse (POP) continued to emerge. In 1976 Richardson s research emphasised on breaks and tears of the endopelvic fascia which led to side-specific operations[14].

In 1992 and 1993 the examinations of DeLancey et al. then directed the interests towards the different levels of the pelvic floor and especially the apical support (uterosacral

TABLE 2. Urinary incontinence status before and after CESA (cervico-sacropexy) and VASA (vagino-sacropexy).

Type of urinary incontinence	CESA group (n=42) no. / total no. (%) before surgery	after surgery	p-value	VASA group (n=34) no. / total no. (%) before surgery	after surgery	p-value
Overall urinary incontinence	24 / 42	6 / 42	<0.01	25 / 34	9 / 34	<0.01
Mixed urinary incontinence (MUI)	24 / 24 (100)	6 / 24 (25)	<0.01	25 / 25 (100)	9 / 25 (36)	<0.01
Urgency urinary incontinence (UUI)	0 / 24 (0)	0 / 24 (0)	–	0 / 25 (0)	0 / 25 (0)	–
Stress urinary incontinence (SUI)	0 / 24 (0)	0 / 24 (0)	–	0 / 25 (0)	0 / 25 (0)	–

Urinary incontinence status before and 4 months after CESA (cervico-sacropexy) and VASA (vagino-sacropexy). No de novo UUI or SUI were noted.

cardinal ligament complex)[7,8]. The sacrospinous fixation was reborn and the laparoscopical sacro-colpopexy was[15].

In 1993 Petros and Ulmsten hypothesized the association between genital prolapse and UI. According to their Integral Theory the repair of the USL and the pubourethral ligaments (PUL) should cure UI[10]. However, this paradigm shift was not unequivocally accepted because several methods of apical fixation did not lead to a cure of UUI. Especially the long-term results of sacrocolpopexy were nearly contradicting this hypothesis. The CARE study demonstrated that already two years after sacrocolpopexy 66% of patients had developed UI and 59% of patients in the treatment arm of the study were suffering from UI even after a prophylactic Burch operation[16]. The results of the unilateral sacrospinous fixation were in the same range[4]. The latest report of the CARE study reported an even higher rate after 7 years of 80% urinary incontinent women after SCP[3].

The outcome of the bilateral replacement of the USL by CESA and VASA operations led us to assume that this kind of replacement surgery led to a “physiological” repair and a restoration of function[11].

The anatomical results after VASA and CESA according to our intentions could be described as POP-Q stage 0. CERESA or VARESA were only performed in patients with additional fecal incontinence (data not included).

Siddique et al. had published a physiological length of 8.8 cm. Therefore, we decided to take that length for the USL structures for CESA[17]. For VASA we considered that the vagina was shortened by hysterectomy and deliberately decided to lengthen these structure to 9.3 cm.

According to the obstetrical textbooks and the MRT measurements by Rizk *et al*. the distances between the bony structures of the small pelvis are identical in all women irrespective of weight, parity or racial derivation[18]. Therefore, the identical lengths of the structures were used in all women operated by CESA or VASA.

This is one of the main aspects why these operations were called “standardized” because the localization of the tapes, the fixation sides and the lengths were defined to be identical in all patients!

After CESA or VASA a “cystocele” disappeared in 93% of all patients. We therefore abstained from immediate anterior colporrhaphy in these patients. During follow-up only 2 women developed a recurrent cystocele which needed surgical repair.

We expected a good anatomical repair of the apical fixation by CESA and VASA; however, we were excited to follow the outcome on urinary incontinence.

70% of the incontinent patients with prolapse and UI were cured just by CESA and VASA. De novo UI was not observed in the other patients after a median follow-up of 20 months. These were important observations because they indicated a striking difference to the above mentioned side-effects of SCP, SSF or VH.

We hypothesize that this was caused by our intention of a "physiological" replacement of the USL considering the bilateral course, the length, the anatomical position and probably the vectors in the small pelvis. These effects on UI definitively need further evaluation.

The CESA and VASA surgical procedures are safe in the hands of a pelvic surgeon. The points of risk – ureter, veins and arteries, hypogastric nerve – are all clearly visible during surgery. It is important to note that no major adverse side effects were observed during CESA or VASA in this study. After surgery the bulging symptoms had totally disappeared in all patients. None of the patients reported dyspareunia.

The CESA and VASA operations imitate the physiological structures in the female small pelvis as close as possible. The operations were standardized so that every pelvic surgeon can perform the operation in an identical way. The length of the implanted tapes was identical in every patient.

The standardized CESA and VASA operations offer a great chance to compare the outcome of different centres worldwide. New operations techniques can be tested and be compared with the standardized CESA and VASA operations. That will definitively contribute to a better understanding of pelvic floor disorders and UI, which on the long-term perspective aims to cure patients suffering from these disorders.

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DISCLOSURES

W. Jaeger receives an honorarium for teaching courses and giving lectures from the FEG Textiltechnik mbH, Aachen, Germany. S. Ludwig receives reimbursement for travel expenses for teaching courses outside of Cologne, Germany. M. Stumm and P. Mallmann report no conflict of interests.

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Case report

An incidental opportunity for a second look laparoscopy following a unilateral hysterosacropexy in a young women with severe voiding dysfunction: a case report and description of a novel surgical procedure

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We present the findings of a diagnostic laparoscopy performed three months after a novel procedure of laparoscopic unilateral sacropexy using a narrow, needled, mesh sling with a reusable tunneling device. This is a case of a 20 year old generally healthy patient, with severe voiding dysfunction of six months. She was referred to our urogynecological clinic after an episode of acute pyelonephritis with complaints of urinary retention. The diagnostic laparoscopy that was performed during the investigation of abdominal pain had no remarkable findings; however, it gave us a rare opportunity for a second look following the unilateral hysterosacropexy procedure. Laparoscopic unilateral sacropexy has good anatomical and functional results.

Keywords: Voiding Dysfunction; Laparoscopic Hysterosacropexy; Reusable Tunneling Device; Mri Visible Mesh.

INTRODUCTION

Lower urinary tract dysfunction and urinary incontinence are common conditions and the associated symptoms are known to have a significant effect on quality of life.[1] Female voiding dysfunction (VD) is defined by the International Continence Society and International Urogynaecological Association as “abnormally slow and/or incomplete micturition based on symptoms and urodynamic investigations.” and urinary retention was defined as “complaint of the inability to pass urine despite persistent effort”.[2] Voiding symptoms are less common in women and include hesitancy, poor stream and incomplete emptying, although, may also be associated with symptoms of incontinence secondary to retention and overflow. Younger women may present with lower urinary tract symptoms associated with sexual intercourse or recurrent urinary tract infection.[3]

The causes of female VD could be divided into detrusor underactivity and outflow obstruction. Urogenital prolapse has been considered an independent risk factor for post-void residuals >100 ml.[4] It is possible that chronic urinary retention may lead to partial autonomic denervation of the detrusor and this may lead to further functional impairment of contractility in addition outflow obstruction may alter the contraction properties of the detrusor by changing cell-to-cell propagation of electrical activity and changing membrane potential leading to an increased cell irritability.[1]

The management of women with VD should be individualized to address the underlying cause and etiology. Many women may be asymptomatic and a conservative approach is appropriate. In those women with VD secondary to urogenital prolapse surgical correction has been reported to improve voiding difficulties. Petros and Ulmsten described the “integral theory” that proposes that the distal and mid urethra are key players in the continence mechanism, and the mid-urethral point controls the maximal urethral closure pressure.[5] This theory strengthens the notion that supporting the mid urethra may improve VD.

After we have consulted the local IRB, this manuscript was exempt from an IRB approval. The patient has however signed willingly an informed consent.

CASE PRESENTATION

A 19 year old normally healthy female presented to our urogynecology clinic complaining of an existing bladder dysfunction and urinary retention of unknown origin. The problem was so severe she used self catheterization since 05/2014. She complained about suprapubic pain fitting the diagnosis of chronic cystitis and light stress incontinence upon coughing.

In her medical history there was nothing remarkable besides acute pyelonephritis a month earlier with growth of coagulase negative *E coli* in urine culture. The patient underwent an appendectomy two years earlier. Her BMI was 23.67 and had no apparent risk factors for voiding dysfunction.

She reported using a safety pad during the day but not at night and reported 4 micturations during the day and once at night. She had normal urinary flow.

Her evaluation included a physical and gynecological examination. The vagina and perineum were unremarkable for pathological findings. The uterus was retroflected, a mild vertical descent of the pelvic organs was noted, the cervix was smooth and featureless, and she had a grade 1 cystocele. Stress test was negative. However, she had 400ml of post void residual urine.

Perineal sonography demonstrated a vertically mobile urethra. Vaginal sonography demonstrated a retroflected uterus, inconspicuous adnexas, a right ovarian cyst of 2cm was noted. Abdominal sonography demonstrated no renal congestion.

We recommended conservative treatment options for three months after which if no improvement was noted surgical treatment to repair the level 1 defect would be considered. She was offered bladder training including pelvic floor physiotherapy with biofeedback. Periodical micturation every 2-3h was suggested. For urinary tract infection (UTI) prophylaxis, we recommend taking cranberry pills twice daily. In addition, Uro-Vaxom® an extract of *E coli*, to stimulate the immune system in order to increase the body’s natural defenses against a wide spectrum of urinary pathogens was administered.

Three months later there was no improvement in her condition. She was still using self catheterization and there was

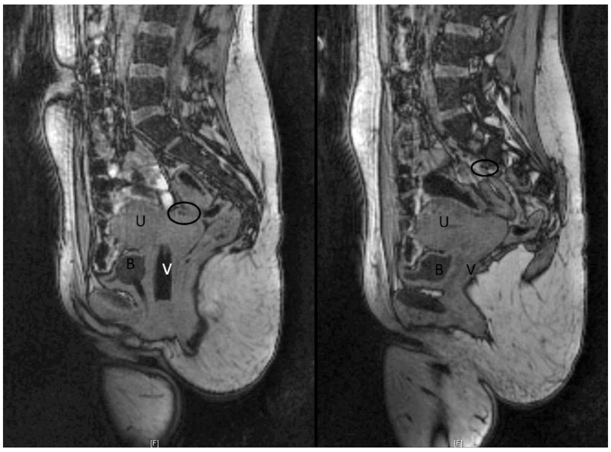

Figure 1. – MRI images of the MESH fixation points on the cervix (fig. 1a) and promontorium (fig. 1b) with regard to the location of the bladder (b), uterus (u) and vagina (v).

no improvement under Uro-Vaxom®. Physical and gynecological examinations including sonographic examination were unchanged from the previous exam. Lumbar puncture and magnetic resonance imaging (MRI) were performed to rule out Multiple sclerosis. She was asked to fill a urinary diary with a tampon test to investigate the feasibility of surgical intervention. She used tampons for two weeks and the two weeks without a tampon to verify the benefit of possible surgery. A month later she reported improvement with the tampon indicating that surgical elevation would be beneficial.

Five months after her primary presentation to our clinic since the tampon test was positive and she suffered from persistent complaints we recommended surgical treatment of prolapse. A pelvic floor reconstruction with a hysterosacropexy and Round ligament fixation to anteflect the uterus was recommended. She was scheduled to undergo a laparoscopic unilateral hysterosacropexy after a detaild conversation regarding possible complications and outcomes.

LAPAROSCOPIC UNILATERAL HYSTEROSACROPEXY

The procedure was conducted under general anaesthesia with the patient supine in semi-lithotomy and in the Trandelenburg position. A pneumoperitoneum was created, and three laparoscopic ports were placed: one 10-mm umbilical port and two 5-mm lateral ports. The uterus and right adnexa were suspended with sutures to the abdominal wall.

A small 1-2 cm peritoneal incision was performed on the right anterior area of the sacral promontory with scissors. The right ureter was identified transperitonealy, and a narrow, needled, mesh sling was introduced into the abdomen through the umbilical port. The right broad ligament at the level of the cervicouterine junction was opened at the medial aspect. Two horizontal sutures (back and forth) were made with the needled mesh sling on the posterior cervix at the level of the cervicouterine junction at the base of the sacro-uterine ligaments.

A small 0.5 cm incision was made on the abdomen suprapubicaly and a reusable helical tunnelling device with an opening in the end was inserted into the abdomen. A rotatory manoeuvre of the helical device was used to create a subperitoneal tunnel along the path of the sacro-uterine ligament between the promontory opening and the cervical opening. Both (needled and blunt) ends of the mesh sling were inserted into the opening in the end of the helical tunnelling device. The helical device was then retrieved so that both ends of the sling exited the sub-peritoneal tunnel at the promontory opening.

The sacral promontory and the cervical opening were reperitonised with absorbable sutures to completely cover the mesh. A suture was made with the sling needle on the anterior longitudinal ligament and the sling was knotted to achieve moderate tension so that the uterus was elevated and the cervix repositioned at the vaginal apex.

In addition bilateral round ligament fixation was performed using a soluble suture.

The uterus and right adnexa were released from their suspension. The abdomen was deflated and sutures were applied to the skin incisions. We left a catheter and tamponade for 24 hours post operatively for better hemostasis. The patient was recommended using tampons for six weeks post operatively.

FOLLOW UP VISIT

Six weeks postoperative follow up showed great improvement in her condition. She reported subjective improvement since the surgery. She did not need any self catheterization however she still suffered from UTI. She had no more episodes of stress a semi-colon incontinence needed no safety pads and reported a normal urinary flow.

Physical and gynecological examinations were unremarkable. On vaginal examination the vagina and perineum were unremarkable. Good fixation, smooth and featureless cervix, and the uterus was anteflected. Stress test was negative. Perineal sonography demonstrated a slightly vertically mobile urethra. Vaginal sonography reviled a normal appearing uterus, and unremarkable adnexas. Abdominal sonography showed no renal congestion. Her post void residual urine was normal (<50ml).

FOLLOWING VISIT

A month later the patient presented once again with severe abdominal pain. She had no fever upon presentation and her blood work was normal. The working diagnosis was of ascending UTI and antibiotics were administered accordingly, however, an MRI was performed to rule out possible abdominal or pelvic pathology that was normal. Due to persistent pain a diagnostic laparoscopy was indicated.

DIAGNOSTIC LAPAROSCOPY

The procedure was conducted under general anaesthesia with the patient supine in semi-lithotomy and in the

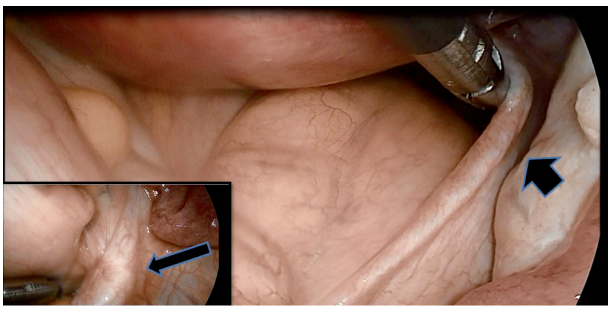

Figure 2. – The covered inserted MESH along the anatomical path of the sacro-uterine ligament (short thick arrow), in the box the covered MESH fixation point the promontorium (long thin arrow).

Trandelenburg position. A pneumoperitoneum was created, and three laparoscopic ports were placed: one 10-mm umbilical port and two 5-mm lateral ports. Abdominal and pelvic organ scan reviled no apparent pathology apart from some fine adhesions between the sigmoid colon and the left pelvic wall that were lysed easily. The uterus was fixed in the anatomical position. The sutures used for the round ligament fixation were completely resolved.

The abdomen was deflated and sutures were applied to the skin incisions. We left a catheter and for 24 hours post operatively.

In the word following the surgery the patient had elevated fever up to 38.7C. We continued the antibiotic treatment and eventually the diagnosis of pyelonephritis was confirmed. Urine cultures came back positive for coagulase negative E. Coli in addition PCR for STD was positive for Chlamydia. Five days later she was well, afibrile, without any pain and was discharged with a prescription for completion of two weeks of antibiotic treatment and antibiotic prophylaxis thereafter.

DISCUSSION

This unique case focuses on three major issues: 1) this unusual clinical presentation; 2) the novel laparoscopic hysterosacropexy procedure; and 3) the rare opportunity for an MRI and second look laparoscopy that enabled us to inspectus the results of our novel procedure.

This was a very unusual case of a young women with sever VD in the presence of mild level 1 defect. After ruling out other possibilities the probable etiology was either infectious or weakened pelvic organ support giving rise to this clinical presentation. After failure of conservative treatment, surgical reconstruction of her pelvic organ support was undertaken.

The remarkable post operative improvement that was noted fortified the diagnosis of pelvic organ support weakness as the cause of her condition. Even in hindsight conservative measures had to be exhausted before turning to surgery.

Uterine sacropexy for treatment of POP is gaining popularity worldwide.[6] Nevertheless, complications such as new onset bowel, voiding, and sexual dysfunction, de-novo stress incontinence, obstructed defecation syndrome and mesh erosion after sacropexy have been reported and may have a negative effect on patient's satisfaction.[7-8]

One of the biggest technical challenges in performing this procedure is creating a tunnel for the mesh under the peritoneum. We performed a novel procedure using a reusable helical tunneling device to create a sub-peritoneal tunnel along the path of the sacro-uterine ligament. This enabled us to restore the normal anatomy.

This novel procedure has many advantages besides those universally attributed to laparoscopic procedures (minimal blood loss, reduced pain, shorter hospital stay and fast recovery time). It is easy to perform, easy to teach, has a short operating time. Using the mesh sling offers the advantages of a minimal mesh area reducing the risk of erosion and it is MRI visible.

Although this was not the indication for MRI and diagnostic laparoscopy this evaluation of abdominal pain that was presented here gave us the rare opportunity for a second look at the anatomic results of our novel procedure. Both the patients' post operative follow up visit and the MRI and direct vision in laparoscopy indicate that unilateral hystrosacropexy in this case gave excellent anatomic and functional results.

We believe this novel procedure provides better anatomic reconstruction while minimizing mesh-related complications.

CONCLUSION

In severe and puzzling cases of VD, after exhausting conservative measures, surgical reconstruction of the pelvic organ support should be considered.

DISCLOSURE STATEMENTS

The Authors declare no conflict of interest and informed patients consent was obtained.

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Original article

Quantification of Levator Ani (LA) Hiatus enlargement and pelvic organs impingement on Valsalva maneuver in parous and nulliparous women with obstructed defecation syndrome (ODS): a biomechanical perspective

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Abstract: Aim: to standardize a method for axial MR multislice image acquisition of female levator ani hiatus on straining in the steady state. *Subjects and Method*: The clinical and imaging series of 41 symptomatic women with evacuation dysfunction, aged 22-56 yrs. (mean 43± 4.1 yrs, median, 43 yrs.) referred for static and dynamic MR imaging between July 2013-June 2014, were reviewed. Of them, 13 were nulliparous (mean age 37±2 yr), the remaining 28 were parous by either vaginal delivery (15, mean age 46±8 yr), cesarean section (8, mean age 46±3 yr), or both (5, mean age 45±5 yr). MR Imaging (Philips, Achieva, 1.5 T, horizontally oriented, the Netherland) was obtained at rest, on evacuation of acoustic gel and during Valsalva maneuver in the steady state using axial, sagittal and coronal sections. Image analysis in the midsagittal plane included (1) quantification of pelvic organs position relative to the hymen plane (mm above [-], or below [+]); and (2) measurement of levator hiatus area (cm^2) at rest and on straining in the axial plane from three key images passing through the midsymphysis (level I); tangent to the inferior border of the symphysis (level II); and at the point of the maximal anterior rectal wall bulging (level III), respectively. Characterization of levator ani muscle defects, included presence of thinning, discontinuity and/or focal increase in the MR signal intensity compared to that of the obturator internus muscle. Classification of ODS at MRI into five degrees was used as described in a previous report. Statistics included, among others, the correlation coefficient between hiatus area at rest and on maximal straining in search for potential prediction of hiatus enlargement under the effect of abdominal pressure. *Results:* At rest, considerable overlap occurred in the average values of levator hiatus areas of parous and nulliparous groups (range 17.1±1.4 cm^2 to 19.6±3.5 cm^2, $p > 0.005$) as opposed to the significant increase (range 108-134%) in all groups seen on Valsalva; however, despite mild difference between parous and nulliparous, a surprising overlap between subjects with vaginal and cesarean delivery (43.1±14.9 cm^2 vs 44.2±9.1 cm^2, p ns) was noted; in addition, values at rest did not correlate with those on Valsalva (Pearson's correlation coefficient, $Y = 0.37 + 19.27$, $R^2=0.14$), indicating that in no case was it possible to predict the actual hiatus enlargement on the basis of resting values. Finally, regardless of parity or not (8/10 nulliparous; 5/8 with cesarean delivery; and 6/15 with vaginal delivery) the levator hiatus ballooning and organs impingement involved mainly the posterior compartment and were most frequently associated with difficulty in rectal emptying and trapping of contrast; interestingly, focal anatomical defects affecting both the muscular and fascial component was seen more frequently in women who delivered vaginally compared to nulliparous and cesarean groups (10/15 [66.6%] vs 2/13 [15.3%] and 1/8 [12.5%], respectively). *Conclusions*: Regardless of parity, delivery history and the onset of symptoms, the existence of difficult evacuation in women makes it unpredictable to establish the actual levator ani hiatus deformity and pelvic organ impingement under the effect of abdominal vector forces until using static and dynamic pelvic MRI.

Keywords: Fast MR pelvic imaging; Childbirth-related defects of pelvic floor; Biomechanics of levator hiatus; Evacuation dysfunctions; Pelvic organ prolapse.

INTRODUCTION

Quantification of the pelvic descent process with use of fast MR imaging having value in surgical planning and post-surgical follow-up, was described for the first time by Yang *et al*. in 1991.[1] From that time on, several studies followed until Lienemann *et al*.[2] published their study on the MR imaging of dynamic rectal evacuation using sonographic gel as contrast, an examination subsequently called MR-defecography. Despite the potential disadvantage of its less physiologic nature when compared to conventional X-ray defecography (the patient is usually examined supine), the examination has rapidly gained widespread acceptance throughout the world mainly due to the lack of ionizing radiation and its multiplanar evaluation of all pelvic contents including muscles, fascia, ligaments and fat recesses. Besides depicting in exquisite detail the emptying function of bladder and rectum in a cine-loop presentation, a distinct advantage of MR over other currently available imaging modalities, such as ultrasonography and X-ray contrast studies, lies in the fact that the grading of pelvic organs descent has also become possible relative to consistent anatomic landmarks using the HMO classification system, as described by Comiter *et al*. in 1999.[3] In particular, the "H-line", which measures the distance from the pubis to the posterior margin of the anorectal junction on sagittal MR images, was rapidly adopted almost invariably in most current studies as it closely reflects the change of the maximum anteroposterior diameter of the levator hiatus either at rest, on straining or during evacuation. On the other hand, with the exception of the papers by Tunn *et al*.,[4] only limited attention has been given to the measurement of hiatus width as seen on axial MR images,[5-7] which were considered not particularly helpful by Yang because the anatomic plane shifts during pelvic strain, or even scarcely reproducible by Hoyte[8] in case of minimal slice tilt angle during image acquisition. The first aim of the present paper was to describe a strategy for standardizing the strain effort during MRI scan in a more proficient way than that described by Tumbarello *et al*.;[9] secondly, a systematic comparative analysis between axial MR images taken at rest and on straining is described, which can be used in perspective to explore important biomechanical properties of biological systems, such as friction, adhesion, wear-resistance, and load producing reciprocal sliding motion until damage or failure occur.

SUBJECTS AND METHODS

Patients

The medical records and imaging series of 41 symptomatic women with evacuation dysfunction and obstructive defecation syndrome (ODS), aged 22-56 years, mean 43± 4.1 yrs, median 43 years, referred to our diagnostic center between July 2013 and June 2014 for static and dynamic MR imaging, were reviewed by both phone interview and retrieval of original pictures. Of them, 13 were nulliparous (mean age 37±2 years), the remaining 28 were parous by either vaginal delivery (15, mean age 46±8 years), cesarean section (8, mean age 46±3 years), or both (5, mean age 45±5 years). Symptoms of ODS, defined as difficulty in expulsion, straining at stool for more than 25% of the time, prolonged toilet time, hard feces and need for self digitation, were diagnosed by the referring physician on the basis of medical history and clinical examination. At interview (AV and NM), women were asked to provide information on their delivery data, if any, (including mean gestation at delivery, induction of labour, episiotomy, mean birth weight, shoulder dystocia, median duration of 2nd stage, perineal tear, repair technique, time interval to recovery of daily activity) and current symptoms or impact of MR examination on subsequent treatment.

Imaging Technique

All MR imaging studies were performed (PV) on a 1.5 T scanner (Philips; Achieva Sinergy model, SENSE XL TORSO coil, The Netherland) in the supine position. Following rectal filling with up to 300 mL of acoustic gel, the dynamic fast images were immediately obtained with a *singleslice*-technique in the midsagittal plane using the balance fast field echo (BBFE) pulse sequence (TR,2.7 msec; TE, 1.3 msec; 45° flip angle; 30-mm-thick section; FOV,

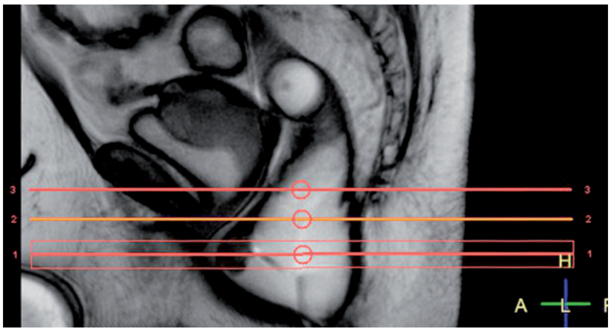

Figure 1. – (A) Positioning of three contiguous, horizontal 10-mm- thick- sections relative to the symphysis pubis and to the deepest position of pelvic organs for standard MR image acquisition in the axial plane of the levator hiatus on straining: section n° 3 = level of midsymphysis; section n° 2 = level of arcuate ligament; section n° 1 = level of the most prominent bulging of anterior rectal wall. (B) Levator hiatus enlargement under the effect of straining in a steady state. A = area; numbers are square mm.

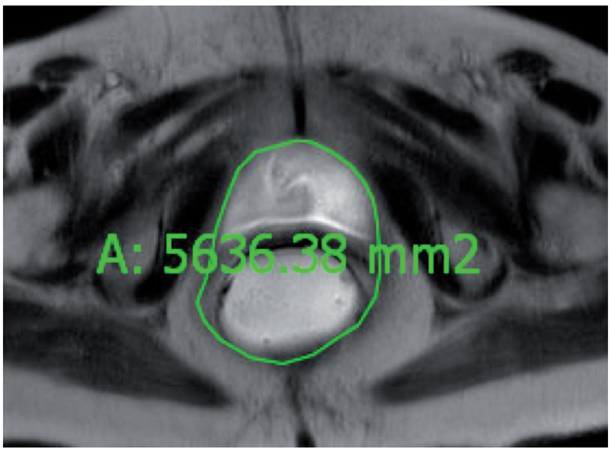

Figure 1. – (B).

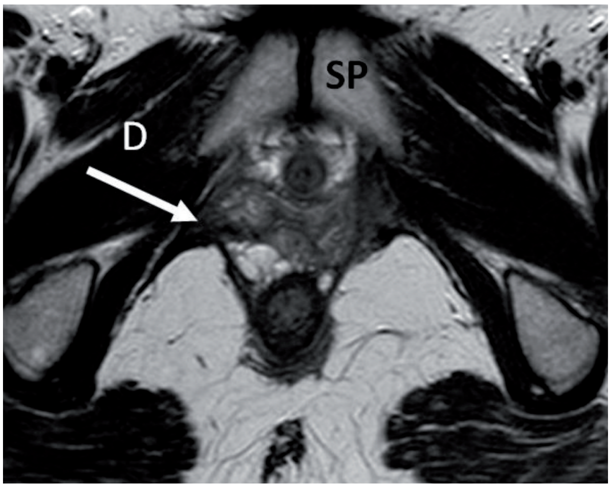

Figure 2. – Axial T2-weighted view at rest of the levator hiatus for imaging of urethra, vaginal and paravaginal supports, and anal canal. SP = symphysis pubis; D = defect of pubococcygeus muscle and posterior paravaginal attachment (arrow).

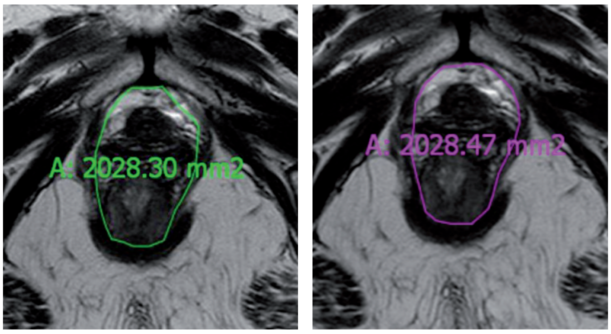

Figure 3. – First (A - green) and second (B - pink) measurement of the hiatus area with the manual contour tracking technique from section n° 2 demonstrate good reproducibility (test and retest correlation coefficient, r = 0.94).

300 mm; 256x256 matrix and two averages; 1 im/0.768 sec over 43 seconds) during evacuation of the contrast. Then, the dynamic sequence was repeated with use of the same parameters in the midcoronal plane passing through the ano-rectal axis for better evidence of any abnormalitiy. Thereafter, given the shift of anatomic planes during pelvic strain, a different strategy was chosen for the dynamic acquisition in the axial plane, as follows: images were obtained during Valsalva maneuver in a steady state with use of a*multislice* technique (TR, 4.1msec; TE, 1.4 msec; flip angle, 45°; 10-mm-thick section; 256x 256 matrix and two averages; FOV, 300 mm; 2.7 sec/slice over 13 seconds) taking the pubic bone as reference at the following three different contiguous levels: (a) through the midsymphysis (level I); (b) tangent to the inferior border of the symphysis (level II); and (c) at the point of the maximal anterior rectal wall bulging (level III), respectively (Figure 1). Sections were taken horizontally, perpendicular to the long axis of the body with no need for adjusting the angle of acquisition. The specific instruction for pelvic strain was the following: "take a deep inspiration so as to maintain enough air inside the chest for 15 seconds; now bend down to produce your maximal pelvic strain, starting now and holding that position without interrupting the maneuver until told to breath and relax". To ensure both maximal voluntary effort and collection of any rectal content without discomfort o embarrassment, patients were placed on a waterproof pad with their underclothing removed and were asked to void at least 1 hour prior to imaging, so as to have the bladder on-

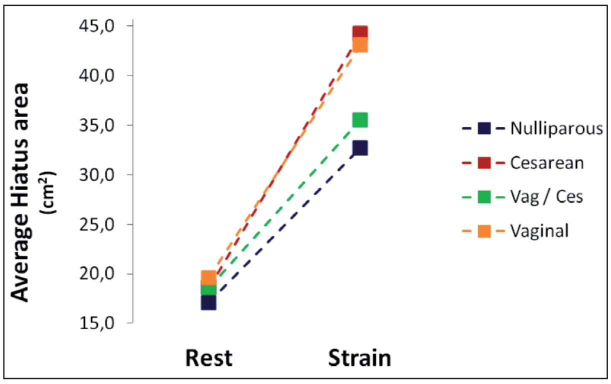

Figure 4. – Data showing results of levator hiatus area measurement in parous and nulliparous women with evacuation dysfunction. Average values of different groups are seen to overlap at rest and can be better distinguished on maximal straining with the exception of women who delivered vaginally and by cesarean section.

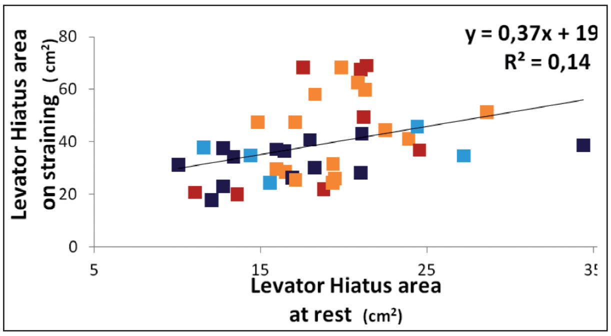

Figure 5. – Graph showing lack of correlation (Pearson coefficient y, 0.37; r^2, 0.14) between resting and maximal straining values of the levator hiatus area, regardless of the patient group.

ly half full. After the dynamic series, routine resting axial, sagittal and coronal turbo spin-echo (TSE) T2-weighted 4-mm-thick sections (TR, 4630 msec; TE,90 msec; flip angle, 90°; thickness, 4 mm, 444/310 matrix and four averages; FOV, 350 mm, acq. time, 3.37 min; total images, 25) were also obtained to define anatomy, exclude other pelvic disease and determine residue of contrast, if any, inside the rectal ampulla. Occasionally, axial proton density (PD) was also obtained for better depiction of ligaments and fascial supporting structures.

Image Analysis

On sagittal MR images, the hymen plane is consistently and precisely identified by drawing a horizontal line tangent to the most inferior border of the symphysis pubis and extending backward to join the external urethral orifice and vaginal introitus. That line, as described in a previous paper,[10] was used as a reference and preferred to both the pubococcygeal line (PCL), defined as a line extending from the inferior border of the pubic bone to the last sacrococcygeal joint, or the midpubic line (MPL) defined as a line drawn through the longitudinal axis of the pubic bone, because independent of pelvic bone tilting and credited with widespread acceptance among clinicians and researchers when defining the position of pelvic organs.[11,12] Quantitative description of the anatomic position of bladder, cervix and rectum relative to the reference line is calculated at the point of their maximal descent during emptying of rectal contrast by measuring the vertical distance from the line to the most dependent margin of the (a) bladder base; (b) cervix or vaginal cuff in posthysterectomy patients; and (c) anorectal joint. Values are expressed as millimeters above (negative number) or millimeters below (positive number) the hymen. On axial images, the area of the levator hiatus was calculated at rest and on straining using a manual contour tracking technique from the pubic bone to the posterior rectal wall and between the medial margin of the right and left levator ani (LA) muscle. For evaluation of the LA integrity, the signal intensity was compared to that of the obturator internus (OI) muscle on the T2-weighted and PD sequences and described as being the same, higher or lower; also, the thickness and continuity of the LA muscle fibers were noted and any thinning or defect in both the pubococcygeus and iliococcygeus muscles was recorded. Alteration in normal H-shaped vaginal configuration with or without lateral shift was interpreted as evidence of focal defect of the endopelvic fascia (Figure 2). Quantification of ODS at MR with a 1-5 point scale was done according to established diagnostic criteria described in a previous report.[13] Measurements were made on line using an internal scale. Distances were expressed in mm, angles in degrees and areas in square cm. Values were given as mean ± SD, and were compared by absolute differences and percentage variations.

Statistical analysis

Simple statistics of mean, median, standard deviation (SD) and range were calculated (PF) for all measurements, and the data were compared between groups. Differences between means of various parameters at rest and on straining were analyzed by the paired Student t-test. In order to assess the reliability of the technique when measuring the hiatus area, in 12 subjects measurements were made on two consecutive reading sessions (Figure 3) and the intraobserver reproducibility of repeated measurement was calculated by the intraclass correlation coefficient. In addition, to evaluate the relationship among the various parameters and whether or not the area at rest could enable prediction of the maximal strain, Pearson's correlation coefficient was calculated. Differences were considered statistically significant at a probability value of $p < 0.05$. Data are reported as mean ± standard deviation (SD). Calculations were performed with SPSS/PC + software.

RESULTS

All patients gave vocal consent to the phone interview and cooperated actively with the two interviewers to fill in the questionnaire investigating the aspect of their delivery data, and acceptance of MR examination. In particular, it emerged that the MR examination was well tolerated by all patients who were always capable to perform the Valsalva maneuver during image acquisition according to the instructions of the examiner after proper coaching at the moment of the preliminary interview (average time, 5 minutes). On emptying, in 3 out of 41 cases, no more than a weak stream of contrast was obtained and in 2 no expulsion at all occurred, despite repeated attempts. More particularly, while a complete expulsion was seen in 7/41 (17.07%) subjects, a residue of 2/3 the total amount injected was observed in 16/41 (39.02%); 1/2 in 14/41 (34.14%); and < 1/3 in 4/41(9.75%). Nevertheless, even in case of failed contrast emptying ,it was always possible to properly measure the maximum downward displacement of bladder, cervix and rectal floor so as to allow taking their deepest visible position as a measure and grading of the prolapsed pelvic organ. Overall, the position of various organs relative to the hymen plane on straining varied significantly in singular cases as follows: the bladder base ranged from –30.40 mm (above) to +26.90 mm (below); the cervix or vaginal vault from – 72.60mm to + 43.30 mm and the rectal floor from –

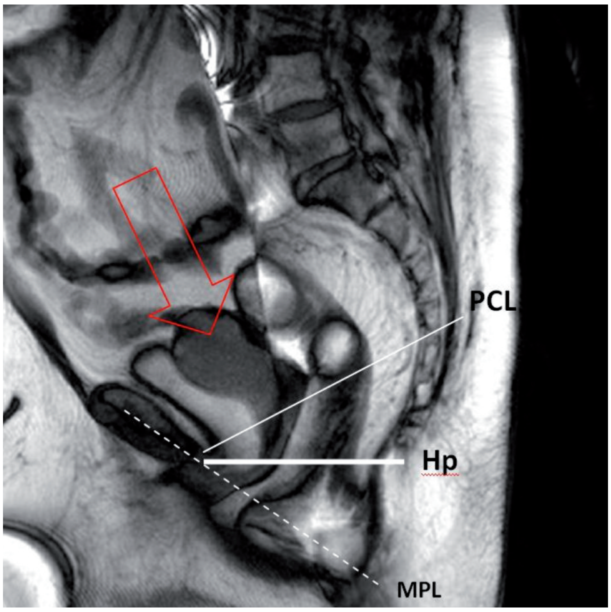

Figure 6. – The downward displacement of pelvic organs under the effect of vector forces (large arrow) from above is quantitated differently depending on the reference line in use. PCL = pubococcygeal line; MPL = midpubic line; Hp = Hymen plane.

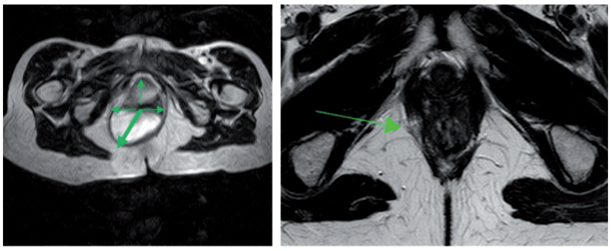

Figure 7. – (A) Asymmetric ballooning of levator hiatus on Valsalva reflecting the different capacity of its peripheral boundaries to counteract the radial forces from inside the abdomen in a similar way (arrows of different length). (B) A fibrofatty focal defect (arrow) was found in the right pubococcygeal muscle on the corresponding axial T2-weighted static sequence.

43.30 mm to + 55.0 mm. While the average hiatus area at rest was 18.3± 5 cm^2 with only minimal differences among groups, that on straining was 39.11± 14.6 cm^2 (percentage increase, 117%), allowing better discrimination with the exception of a surprising overlap between women who delivered vaginally and by cesarean section (Figure 4). The mean difference between two intrasession measurements of the levator hiatus area showed only minimal variation (see Figure 3) and high intraobserver reproducibility rate (intraclass correlation coefficient r, 0.94); on the other hand, the Pearson correlation coefficient between resting and maximal straining values of levator hiatus areas was only 0.37, r^2=0.14 (Figure 5), indicating lack of substantial correlation between the two variables. In addition, the presence of ODS, irrespective of severity, annulled the effect of any difference in hiatus size between groups. A complete summary of the clinical and imaging data in the patient population is shown in Table 1.

Table 1. Clinical and MR Imaging data in the patient population (n° 41)

Note* including abnormal presentation, prolonged second-stage labor, operative vaginal delivery, fetal macrosomia; ** either muscular, fascial or both. *** According to Piloni *et al* [13]

	Item	Group				
		Nulliparous	Cesarean	Vaginal	Vag/Cesar	*P*
clinical	N° subjects	13	8	15	5	< 0.005
	Age (yr)					
	average	37± 2	46± 3	46± 8	45± 5	< 0.005
	median	38	48	49	43	
	range	22-47	36-55	29-56	40-52	
	Parity (n)					
	average		1.5 ± 0.8	1.7 ± 0.4	2.6 ± 0.6	< 0.005
	median	/	1.0	2.0	2.0	
	range		1-3	1-3	2-5	
	Adverse Obstetric Factors *	/	/	10	4	ns
MR imaging	Defect **	2	1	10	2	< 0.005
	ODS degree ***					
	1st	3	1	1	1	ns
	2nd	2	1	1	/	ns
	3rd	2	3	5	4	< 0.005
	4th	3	2	8	2	< 0.005
	5th	2	/	/	/	
	PO Impingement					
	anterior	2	1	6	1	
	middle	4	2	7	1	ns
	posterior	8	5	6	1	
	Hiatus area *resting* (cm^2)					
	average	17.1±1.4	18.6±2.6	19.6±3.5	18.6±6.8	ns
	median	16.4	19.9	19.3	15.5	
	range	10-34.4	11-24.5	14.8-28.6	11.6-27.2	
	Hiatus area *straining* (cm^2)					
	average	32.7±3.7	44.2± 9.1	43.1±14.9	35.5±7.6	< 0.005
	median	34.3	43.1	44.5	34.9	
	range	17.9-43.1	20.0-69.0	24.4-68.4	24.5-45.8	
	% increase	104	134	122	108	

DISCUSSION

Although the boundaries of the levator ani hiatus are easily palpable on pelvic examination, determining its size with a ruler to the nearest 0.5 cm and producing the area of an oval, as it is commonly assessed by the gynecologist, remains an approximate method indeed. In his classic paper,[14] DeLancey demonstrated that the urogenital size is larger in women with prolapse than in those with normal support, even though such difference may persist in some women after surgical repair, thus indicating that an enlarged hiatus does not necessarily reflect *per se* the presence of prolapse. Current opinions and evidence by the literature suggest that changes in the closure mechanism of the levator hiatus are most frequently associated with defective connective tissue support occurring with or without damage of the muscular component.[15-17] The advent of fast MR imaging in the early 90^s has radically changed the approach of modern medicine to the assessment and treatment of pelvic pathologic conditions. Also it was no longer necessary to administer hypotonic drugs or ask patients to maintain a light respiration during image acquisition, so as to avoid substantial degradation of image quality from either gut peristaltic activity or abdominal wall movement. Besides better depiction and characterization of various pathologic processes including endometriosis, primary and metastatic malignancy, and infectious diseases of the lower urinary tract, genital system and distal gut, it soon became possible to extend the use of MR imaging to the assessment of functional disorders of pelvic floor as well. More specifically, technical advances registered in the field of image acquisition up to 16 times faster than with the standard Spin echo (SE) pulse sequence were followed by concurrent quicker image reconstruction, ultimately leading to the development of a "real-time" visualization and cinematic display of imaging series obtained during bladder and rectal emptying. In addition, MRI seems ideally suited to depict the pelvic floor anatomy in its entirety, including the extensive fibro-elastic network which is thought to play a major role in obtaining "the suspension" of pelvic organs within the pelvis. That structure is consistently and clearly seen on routine images, starting just below the skin and penetrating fat recesses, muscles and organs, which are interconnected with each other by means of fascia and ligaments and are anchored to the bony pelvis, giving also support to the kinetic activity of multiple muscular chains. Currently, despite great debate and lack of uniformity still existing among authors regarding the optimal technique and diagnostic criteria to be adopted, the only recognized drawback of the examination seems to be the potential disadvantage of its less physiological nature: the examination is usually performed with the patient supine instead of sitting on a commode, due to the horizontal configuration of most conventional MR scanner in use. It can be argued however that, despite an identical position assumed by the patient, performing the Valsalva maneuver during the physical examination is less reliable and difficult to be replicated by examiners. Conversely, a unique advantage of MRI relies on its ability to depict the expulsion of rectal contrast and repeat it until obtaining the maximum potential descent of pelvic organs, thus providing objective grading of prolapse with superior accuracy when compared to the physical examination. Not by chance, until recently the interest of most authors has been focused almost exclusively on the analysis and quantification of (a) the upward-downward displacement of pelvic organs under the effect of the squeeze/strain maneuvers; and (b) the progressive emptying of the bladder and rectal ampulla. Special consideration is deserved to explain the rationale behind our choice of the hymeneal plane as reference for prolapse quantification, the reasons being: first of all, it remains the only universally accepted reference system allowing efficient and precise communication between clinicians and radiologists; secondly, despite the bulk of papers published on this issue, definite agreement among researchers is still lacking and a number of reference lines have been proposed, each with its pros and cons, and with high risk to overestimate or underestimate of the extent of organs descent when using PCL or MPL, respectively. In any case, to obtain the depiction of downward displacement, the radiologist utilizes the so-called "single slice, multiple maneuver technique" which consists of stimulating the same midsagittal or midcoronal body section properly chosen from the region of interest during the rest-strain-emptying cycle at a rate of 1 image/every 0.786 seconds. By adjusting the speed of image review in a cine-loop replay, information are obtained with regard to the motile activity of distal gut and lower urinary tract, i.e. the *cinematic function*. On the other hand, the same fast imaging technique can be applied to depict the pelvis in the axial plane, as shown in the present study, during continuous, maximum Valsalva maneuver in the steady state, so as to develop what we called a " multislice, single maneuver technique". In practice, after selecting three different 10 mm-thick body sections relative to the symphysis pubis, the straining series were compared with those at rest by the same anatomic landmarks, allowing detection of (a) the geometrical deformity and enlargement of the levator hiatus; and (b) the impingement of various organs by compartment. The adoption of the method of the three horizontal axes relative to fixed and consistent anatomic landmarks was chosen by us for two reasons. Firstly, to minimize the systematic error generated by the measurement performed using a flat plane in a complex, 3D structure such as that of pelvic floor muscles and hiatus. Secondly, due to the impact of even minimal slice tilt angles on measurement reproducibility, to avoid the need for adjusting arbitrarily the angle of acquisition from a plane axial to the body to a plane parallel to the direction of the puborectalis muscle (also called the plane of minimal hiatal dimensions). Although we admit that the best technique on how to measure the levator hiatus with axial MRI sequences is still a matter of great debate, this strategy proved worth in obtaining satisfactory reproducibility from repeated measurements of hiatus area in our patient population. Besides this, the most striking results of the present study seem to be (1) the overlap in resting hiatus size at MR imaging between nulliparous and parous women, regardless of the fact that the latter group delivered vaginally or by cesarean section; (2) the lack of correlation between resting and straining values, indicating that, contrary to what has been described by Dietz *et al*.[18] the levator area at rest seemed to predict descent on Valsalva, in no case could the actual hiatus enlargement be predicted on the basis of either the physical examination alone or delivery history, especially when symptoms of evacuation disorders and ODS are present; and (3) the geometrical deformity of hiatus boundaries and organs impingement on it closely reflect the action of a vector quantity from above, i.e the force of abdominal pressure (Figure 6), that tends to produce an acceleration of various structures in the direction of its application against the resistance of hard (like bone) and soft tissues (like skin, tendon, muscle and fat). Under this perspective, a new kind of information can be generated from the analysis of axial MR images applied to the study of the mechanical principles of living organisms, i.e. the *biomechanics,* particularly their movement and structure. Conceptually, it can be assumed that pelvic organs and supporting structures are subjected to complex phenomena such as intermittent repetitive load and reciprocal sliding motion, which involve important properties of biological systems including lubrication (layered interposition material), adhesion (attraction force), friction (interlock between surfaces), wear (degradation) and potential failure. All the above is part of the so called "Tribology", a new interdisciplinary field of research combining methods and knowledge of physics, chemistry, mechanics and biology.[19-21] According to the scientific principles of contact mechanics, the geometrical deformations of hard tissues are hardly visible and should be analyzed with the theory of linear elasticity; conversely, soft tissue usually undergoes large deformations and, as such, their analysis relies on the finite strain theory and computer simulation, making magnetic resonance imaging an ideal tool which helps in understanding the equilibrium between active and binding forces (Figure 7) affecting structures subjected to reciprocal slide motion within the pelvis. Future studies will tell us if trends observed here will continue.

CONCLUSIONS

A variety of factors are responsible for the enlargement of levator hiatus in women under the effect of increased intra-abdominal pressure, including mainly the defective connective supports and focal damages in the muscular components. Although vaginal delivery is the strongest established risk factor, the presence of ODS adds a note of complexity to the issue, making it difficult to recognize an index having discriminatory effect between parous and nulliparous women. Nevertheless, any geometrical deformity seen at MR imaging affecting the pelvic organs muscles, fascia, tendons, ligaments and fat on straining, has a potential biomechanical significance attached to it and should be taken in consideration. Overall, a comprehensive understanding of complex phenomena occurring when two biological systems interact with each other can only be achieved through the cross-fertilization of ideas from different disciplines and the systematic flow of information among research groups.

DISCLOSURE STATEMENTS

The authors declare no conflicts of interest and the patients informed consent was obtained.

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Multidisciplinary UroGyneProcto Editorial Comment

To improve the integration among the three segments of the pelvic floor, some of the articles published in *Pelviperineology* are commented on by **Urologists, Gynecologists, Proctologists/Colo Rectal Surgeons** or **other Specialists**, with their critical opinion and a teaching purpose. Differences, similarities and possible relationships between the data presented and what is known in the three fields of competence are stressed, or the absence of any analogy is indicated. The discussion is not a peer review, it concerns concepts, ideas, theories, not the methodology of the presentation.

Gyneco... MRI imaging of the pelvic floor is still an emerging science. This is article by Professor Piloni has several levels of interpretation. Firstly, Professor Piloni continues his pioneering quest to lay down reproducible landmarks. This is a difficult but important quest. Difficult, as shown by his findings of overlap in resting hiatus size at MR imaging between nulliparous and parous women, regardless of the fact that the latter group delivered vaginally or by cesarean section and the lack of correlation between resting and straining values. Important, because the MRI findings can be used to confirm or invalidate theories of organ function. MRI was a key tool in the confirmation of an external striated muscle open ing mechanism for defecation (1). Piloni et al have shown definitively that the area of the levator hiatus at rest cannot predict descent on Valsalva manoeuvre. I agree with his comment that changes in the closure mechanism of the levator hiatus are most frequently associated with defective connective tissue support. I do not agree with the comment *"the geometrical deformity of hiatus boundaries and organs impingement on it closely reflect the action of a vector quantity from above, i.e the force of abdominal pressure*". This comment implies causation by pressure. Our considered view based on video xray, EMG and mathematical models is that intrabdominal pressure is secondary. Since 100 years, it has been known that the abdominal pressure is secondary to contraction for the anterior abdominal wall which contracts reciprocally with the pelvic floor diaphragm (2,3). The anterior abdominal wall and pelvic floor embryologically derive from the same myotomes, Power (4), giving an anatomical basis for the observations by Paramore (1908) and Sturmdorf (1919) of simultaneous reciprocal contractions of this group of muscles. On the basis of the above, it is suggested that the observed increase in abdominal pressure is due to the simultaneous reciprocal contraction of the abdominal muscles in response to the pelvic floor contraction and vice versa. We have demonstrated in a mathematical model with regard to micturition, that a pressure 100 times greater than that recorded would be required to overcome the inherent closure forces of the urethra and adjoining tissues. A practical validation is that paraplegics cannot micturate spontaneously because the external striated muscles cannot open the urethra (or anus). This mathematical model is a confirmation of Professor Piloni's vision, that MRI will be a key tool in future biomechanical studies of the pelvic floor. To this we would add flow mechanics, tissue and bioengineering (6-8). Important in this new direction will be the knowledge that the pelvic floor is complex, non-linear and exponentially determined, with complex reflex feedback mechanisms controlling every aspect of function (9). It is also important to realize that 'obstructive micturition' and 'obstructive defecation' are not caused by anatomical obstruction. It is a functional obstruction, caused by inability of external striated muscle vectors to open out the outflow tubes of the urethra and anus.

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Procto... Based on a static and dynamic MRI study particularly evaluating the levator ani hiatus enlargement, the Author stresses the impossibility of predicting the onset of obstructed defecation in patients either nulliparous or undergoing a caesarean or vaginal delivery. The topic sounds quite intriguing for the proctologist and the colorectal surgeon as these findings suggest an opportunity for a detailed clinical study concerning the differences in the occurrence of female obstructed defecation in relation to method of birth, and subsequently possible imaging predictors to such a kind of unsatisfactory defecation. In the short term obstructive symptoms don't seem so directly related to trauma from childbirth. Other variables should be considered as the timing of symptoms and their variability, the coexistence of pelvic floor dyssynergia, abnormal rectal sensitivity, onset of a low rectocele or of a posterior colpocele, or finally other types of constipation. A morphological abnormality as documented by the imaging of a rectocele, or internal mucosal prolapse or of an intussusception should not be absolute indications for surgery. Only a careful clinical and instrumental evaluation may suggest the therapeutic strategy more suited to the individual case, pondering the cost benefits of a medical- rehabilitation treatment vs surgery, and, a most important item, planning a long term follow up.

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Autore's replay. The comment to the paper by dr Ferraro demonstrates how distant entities information and communication are. Information is no more than a means for sending and receiving news and messages. On the other hand, communication implies the exchange of thoughts. In simple terms, information can be regarded as *what I say*, while communication is *what is understood* as result of what I said. Nevertheless, in the course of my professional life, I was rarely witness before of such a complete upsetting of an (original) message of mine. Consequently, It seems worth spending few more words in the hope to better clarify the central message of the paper, as follows: firstly, the lack of correlation between resting and straining levator hiatus values at MR imaging and the consequent inability to predict its size do not necessarily indicate the superiority of physical examination over imaging. Rather, it simply means that in no case the actual hiatus enlargement can be assessed **until performing** such a study; secondly, and most important, the advent of obstructed defecation syndrome (and not the impossibility to predict its onset) can nullify any discriminatory capacity between parous and nulliparous women when calculating the hiatus enlargement on straining. This, in turn, suggests the need for better characterization of the biomechanical properties of living tissues in the pelvis.

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החברה הישראלית לאורוגינקולוגיה ורצפת האגן

THEME for 2016 CHRONIC PELVIC PAIN

Preliminary program

Wednesday 21 September

08:00-12:00 **Workshops**

08:00-09:00 Workshop registration

1 The Integral System - *Peter Petros*

2 Pelvic floor Ultrasound - *TBD*

3 Chronic Urogenital Pain (CUP), Diagnosis and treatment - *Marek Jantos*

4 Urology for urogyneclogiests

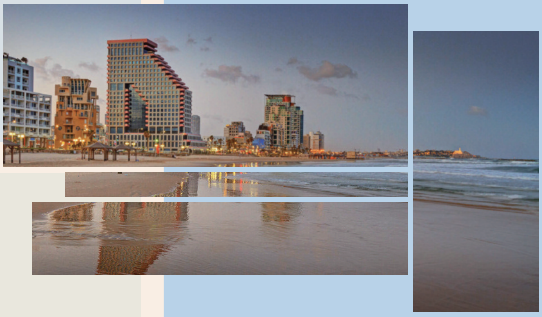
Fistula repair - *Dimitri Pushkar*

Male SUI - *TBD*

IC and Painful bladder - *TBD*

5 Colorectal surgery for urogynecologists - *Daren Gold*

Lunch



ISPP Annual conference

14:00-15:00 Registration

15:00-15:15 Opening

15:15-18:00 First Plenary session - Chronic pelvic pain

Thursday 22 September

10:30-11:00 Second plenary session - for Urology pain (OAB, IC)

11:00-13:00 Coffee break

13:00-14:00 Third plenary session - Posterior compartment

14:00-16:00 Lunch

16:00-16:30 Forth plenary session - Implants for POP and SUI repair

16:30-18:00 Coffee break

Fifth plenary session - Tips and Tricks in urogynecology

Gala dinner

Friday 23 September

08:00-13:00 **Live surgery**

* Urinary incontinence - different TVT slings

Emanuel Delorm & David Waltregny

* Pelvic organ prolapse: vaginal mesh, Starr operation

Michel Cosson & Antonio Longo

* Lap Sacrocolpopexy

Peter von Theobald & Joerg Neymeyer

* Fistula repair

Dimitri Pushkar

Lunch

Saturday 24 September

Jerusalem tour

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