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Sling Surgery for Female Incontinence

Karl-Dietrich Sievert [a,b,*], ***Mohammad Abufaraj*** [b,c], ***Karoline Kernig*** [a], ***Desiree-Luise Dräger*** [a], ***Mija Blaganje*** [d], ***Oliver Hakenberg*** [a], ***Karim Mansy*** [b], ***Bernhard Liedl*** [e], ***Tufan Tarcan*** [f], ***Dirk de Ridder*** [g]

[a] *Department of Urology, University Medical Center, Rostock, Germany;* [b] *Department of Urology, Medical University of Vienna, Vienna, Austria;* [c] *Division of Urology, Department of Special Surgery, Jordan University Hospital, The University of Jordan, Amman, Jordan;* [d] *Division of Gynecology, University Medical Centre Ljubljana, Ljubljana, Slovenia;* [e] *Beckenbodenzentrum München, München, Germany;* [f] *Department of Urology, Marmara University, Istanbul, Turkey;* [g] *Department of Urology, University Hospital, Leuven, Belgium*

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Abstract

The pelvic floor is at an increased risk of damage during the lifespan of women. Pregnancy, vaginal delivery, aging, menopause, previous pelvic surgery, and lifestyle factors have a negative influence on the connective tissue and muscular components of the pelvic floor leading to urinary incontinence (UI). Pregnancy and vaginal delivery have been identified as the most important risk factors for incontinence. Cystocele, rectocele, uterine, vault prolapse, and/or incontinence can occur due to lacerations of the connective tissue support at different levels. Moreover, muscular damage of the levator complex can lead to widening of the levator hiatus, giving way to the descent of pelvic organs resulting in UI. Although some genetic abnormalities have been identified, their clinical implications remain unclear. Diagnostic evaluations should be performed in accordance with established evidence-based guidelines. Although short-term results of single-incision midurethral slings indicate similar efficacy to conventional midurethral slings, their long-term outcome is still not determined. Scientists continue to investigate the exact causes of stress UI as well as the optimum substitute material using the best surgical reconstructive approach. The recent European Association of Urology consensus statement underlines an imperative requirement for an optimal solution using minimal amount of material related to the indication and higher competence of surgeons for this surgery. High-quality trials with a longer follow-up are currently an unmet need.

* Corresponding author. Department of Urology, University Medical Center, Rostock, Germany. Tel. +49 381 494 7854.
E-mail address: kd_sievert@hotmail.com (K.-D. Sievert).

1. Introduction

The female pelvic floor experiences several changes during lifetime. Pregnancy and vaginal delivery (VD) have a significant impact on the muscular, neurovascular, and ligamentous components of the pelvic floor leading to different degrees of alterations. These changes become more pronounced in the 2nd and 3rd decades of life. After menopause or pelvic surgery, the pelvic floor may further deteriorate at both structural and functional levels. Lifestyle

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factors such as obesity have detrimental effects on the pelvic floor support mechanism leading to urinary incontinence (UI) and/or fecal incontinence.

Female UI represents a contemporary challenge as approximately 20% of women in the western countries have undergone surgery for UI [1]. More than 50% of incontinent women have pure stress urinary incontinence (SUI) and a further 30% experience mixed incontinence [2]. Interestingly, recent reports indicate that a high proportion of women do not seek medical advice [3].

Surgeons initially believed that performing a colpocleisis, as described by Gustav Simon in 1862, was the best and most secure way to treat UI. It took until the beginning of the 20th century when Kelly reported anterior colporrhaphy in combination with deep mattress sutures through the bladder neck. Later this procedure was further developed when the idea of using an autologous sling was introduced with the Goebell–Frangenheim–Stoeckel procedure [4], which was later modified by Aldridge [5] and Schultheiss et al. [6]. At that time, surgeons were convinced that continence could be controlled by contraction of the rectus muscle. Other techniques such as the Marshall–Machetti–Krantz technique and Burch [7] procedure were subsequently introduced, and are still performed today. New techniques have been subsequently introduced and further modified, such as the Stamey [8] and Pereyra [9] needle techniques. Other techniques have been developed, but their long-term functional outcomes were not satisfactory.

After the recognition and adoption of mesh materials in hernia repair, sling materials became an attractive option and were widely introduced. Initially, they provided good functional results [10], making it a "blockbuster" as a medical device. However, surgical learning curves are still considered steep due to insufficient anatomical and biochemical understanding, as well as a lack of predictability of the interaction between these foreign materials and the body. Our improved understanding of tissue biomechanics will elucidate important aspects of pelvic floor reconstruction and enhance our approach to pelvic floor dysfunction [11]. In the early 1990s, a major "game changer" appeared with the introduction of the tension-free vaginal tape (TVT) by Ulmsten and Petros [12], based on Petros' integral theory.

2. Functional anatomy of urinary incontinence

In comparison with the male, the female has a less complex anatomic sphincteric mechanism surrounding a 4–6 cm urethra with no definitive smooth muscle sphincter [13]. The urethra's mucosa and underlying tissue are primarily responsible for the female continence mechanism. Dilation of the submucosal venous system increases the urethral closing pressure and guarantees a watertight seal [14]. Indeed, the external urinary sphincter (also known as rhabdosphincter) plays an important role in continence mechanism by exerting sustained tone over a prolonged period of time. Importantly, the rhabdosphincter's function depends on the integrity of its attachments to the levator ani muscle (LAM) [15]. When the LAM loses its functional integrity, external urinary sphincter dysfunction also occurs. Furthermore, the striated rhabdosphincter surrounds the circular smooth muscle fibers that are primarily condensed in the midurethra and inserts into the trigonal plate. In addition to the previously discussed mechanisms, the paired paraurethral musculature with their medial attachments into anterolateral vaginal walls comprises the pubococcygeus (medial fibers of the LAM) muscle to pull the distal vagina forward to close the distal urethra. These fibers can maintain sustained tone as well as rapid urethral closure [16,17].

The bladder and posterior vaginal wall are pulled backward by the levator plate and downward by the longitudinal muscles of the anus. Petros and Ulmsten [18] demonstrated that the urethra is stretched and angulated to "kink" at the proximal level when they investigated muscle actions and the movement of vaginal walls during voiding. They proved that voiding begins with active muscle contraction at the posterior fornix that opens the bladder neck and proximal urethra. Bush et al [19] confirmed that without this active opening, bladder pressures would increase significantly. These findings indicate that slings should not be placed in the bladder neck or proximal urethra in order to maintain a physiological micturition process. In fact, another investigation demonstrated that the maximal urethral closure pressure is located at the midurethra and decreases with age [20].

A widely used classification for stress incontinence is the Green/McGuire/Blaivas/Olsson classification, which was first introduced by Green in 1961 and was modified several times [21,22]. This classification system for SUI in its original form was based on the shape of the bladder neck descent and the integrity of the intrinsic sphincteric mechanism assessed by fluoroscopy at rest as well as during straining. McGuire included type III SUI that is characterized by proximal urethral malfunction. In women with type III SUI, urethral pressure is markedly decreased and the bladder neck is open at rest. Blaivas and Olsson [21] modified this classification system by adding type 0 SUI and dividing type II SUI into two categories (Table 1). This classification system was used for patients counseling and treatment decision. In fact, Blaivas and Olsson [21] recommended retropubic urethropexy as an ideal treatment for patients with type 0–II SUI. On the contrary, midurethral sling (MUS) was advocated for patients with type III SUI [22].

3. Etiology

Pregnancy and VD are the primary physiological causes of UI in the female; however, a number of other factors contribute to UI as well as pelvic organ prolapse (POP). In fact, POP is often associated with UI in terms of manifestations and etiological factors [23].

3.1. *Pregnancy*

Approximately 40% of healthy women experience some degree of UI during pregnancy, especially during the second trimester [24]. Age, high body mass index (BMI), and other lifestyle factors such as smoking contribute to a higher risk of UI during pregnancy. In addition, the change in hormonal