

What is it for?

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The Urologist/Anatomist Salvador Gil Vernet (1892 – 1987) made many outstanding contributions to anatomical knowledge and urological surgery. He was greatly admired by his fellow urologist, the Canadian-American Charles Brenton Huggins, Nobel Laureate. Gil Vernet's famous statement was that an answer was required to the question of "what is it for?"

The question "what is it for?"

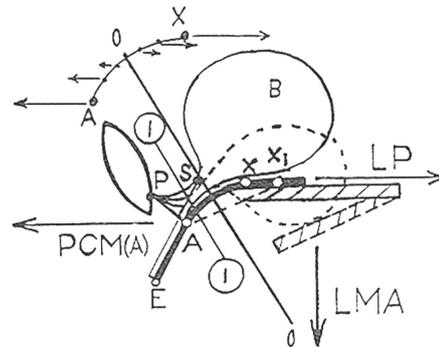
The authors never cease to be astounded at the answers received to our question, "How does the midurethral sling (MUS) work?" The standard reply is "It reinforces the pubourethral ligament"(PUL). A frequent reply to the next question, "What is the mechanism of urethral closure" is typically answered by "Intraabdominal pressure transmission". Usually there is no answer to subsequent questions, "How does PUL reconstruction restore the closure mechanisms?" Or "How does the MUS restore intraabdominal pressure transmission" or "Have you read the original studies which led to the MUS?"

How MUS works- original descriptions

The mechanics of urethral closure (Fig. 1) is an original 1990 figure which explained the mechanism for urethral closure. It is based on the urodynamic, dynamic ultrasound, xray and prototype MUS surgical studies described in 79 pages of the 1990 ACTA Obstetrica et Gynecologica Scandinavica¹. These studies scientifically underpinned the prototype MUS and the Integral Theory on which the MUS is based¹. The key discoveries from the experiments detailed in ¹ which led to the midurethral sling were: 3 directional muscle forces contract against competent pubourethral ligaments (PUL) to close the distal urethra and bladder neck, fig1; that loose pubourethral ligaments cause urinary stress incontinence (USI); that collagen damage causes loose ligaments; that a precisely inserted tape creates new collagen to repair the PUL. All subsequent surgeries which use tapes for ligament repair, whether for USI, prolapse or other symptoms are based on this concept, repair of collagen damage to the ligaments².

The mechanics of urinary stress incontinence (USI). In the original description for USI causation¹, a loose PUL, fig1, cannot support the vagina (heavy black line) or urethra. On effort, the pubourethral ligament 'P-A' elongates and the system enters "open mode", exactly the same as what occurs during micturition when PCM(A) relaxes¹; the posterior vectors LP/LMA funnel bladder base/urethra between X₁ (bladder base) and A (insertion point of PUL) and urine is lost. In the prototype operation, the pubourethral ligament length P-A was restored by the MUS tape, which also restored the two closure mechanisms, distal and bladder neck¹.

Independent validation of the mechanics of continence restoration This mechanism for restoration, first demonstrated clinically, with dynamic ultrasound and xrays in 1990, was independently validated by a well documented 3D ultrasound study by Wen et al in 2018, 28 years later³. Wen et al. confirmed several predictions of the original 1990 Integral Theory¹: 3 directional vector forces acting around point 0-0; that point P-A (pubourethral ligament) 'PUL' lengthens with USI; that P-A is shortened in patients cured of USI and remains lengthened in those not cured of USI. None of the findings from the original studies, nor Wen et al's



1990 diagram urethral closure copy

Urethral closure mechanism as described in 1990 (1) - Original diagram. I-I is the resting position of bladder neck. The heavy black line represents the vagina. During effort PCM (A) the anterior portion of m.pubococcygeus pulls the distal vagina A-E forwards against the pubourethral ligament 'P-A' to close distal urethra from behind and firmly anchor the distal urethra. Levator plate (LP) pulls backwards against P-A extending the the upper vagina from X to X1 and bladder neck to 0-0. X is the vesico-vaginal ligamentous attachment of bladder base to the anterior vaginal wall immediately below the cervix. P-S is the pubovesical ligament which inserts into 'S', a fibro-muscular thickening in the lower anterior wall of bladder 'B' known as the 'pre-cervical arc of Gil Vernet'. LMA (conjoint longitudinal muscle of the anus) contracts downwards against the cardinal/uterosacral ligaments to pull down on the anterior border of LP. This pulls down X1 and bladder around the arc of Gilvernet 'S', to effect closure at bladder neck (O-O) much like kinking a hose.

confirmation thereof, nor the following video demonstration of the distal and proximal closure mechanisms by a 'virtual' or 'simulated' operation can be explained by pressure transmission theories. (see video 'virtual op.' <https://youtu.be/0UZuJtajCQU>). The video shows partial control with midurethral support, but requires folding of the suburethral vagina for complete continence.

A final comment from Salvador Gil Vernet : "Precise, almost mathematical knowledge of anatomy is a highly fertile source of surgical applications, suggesting new techniques and helping perfect and simplify existing surgical methods, making them less mutilating and more benign and, in short, raising surgery to the rank of true science."

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