Dear Editor, why do women have stress urinary incontinence? DeLancey asked this question in 2010, 16 years after he introduced the hammock hypothesis. DeLancey wrote, "Improving our understanding of factors affecting urethral closure may lead to novel treatments targeting the urethra and improved understanding of the small but persistent failure rate of current surgery." In this letter I present a theory that answers some of DeLancey's questions. The theory is called the "urethral hanging theory" (UHT).

Despite great advances, female urinary continence is not fully understood. One phenomenon that lacks explanation is urethral funneling (UF). This typical formation of the proximal urethra is consistently associated with female stress urinary incontinence (SUI) if optimal methods are used for evaluation. UF/SUI is also found in women with normal urethral morphology and resting pressure profiles.

In the 1991 manual (BS Bergström) for the continence unit at Mora Hospital in Sweden, the urethral hanging theory was first described. The following is an excerpt from the manual (text and Fig. 1a and b, translated from Swedish).

The forced funneling of the collapsed inner urethra ("flow controlling zone") overcomes the high urethral opening pressure. When the diameter of the inner urethra expands, the bladder leak point pressure (LPP) forces the urethra to distend and pass urine. Formula F = (LPP) / area. The rate of flow increases abruptly. Furthermore, low urethral closure pressure at rest (low urethral resistance) facilitates urethral opening and urine leakage.

According to the UHT, a prerequisite of UF is that the proximal urethra descends further than the bladder neck. If the proximal urethra and bladder neck descend to a similar extent, the urethra will not hang upon the bladder neck. Instead, the bladder neck–proximal urethra complex will be compressed due to the backboard effect caused by the stretched anterior

Fig. 1. a. Anatomy: Blåsa = bladder, slida = vagina, livmoder = uterus, blygden = os pubis. b. Trattformning = (urethral) funneling, ansträngningsinkontinens = SUI.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

Potential conflicts of interest: Nothing to disclose.

Dr. Roger Dmochowski led the peer-review process as the Associate Editor responsible for the paper.

© 2016 The Authors. Neurourology and Urodynamics Published by Wiley Periodicals, Inc.
vaginal wall or the posterior vaginal wall. When the proximal urethra descends further than the bladder neck, the posterior urethrovessical angle is increased.

The UHT explains the theoretical grounding of valsala leak point pressure (VLPP). The VLPP corresponds to the pressure needed to force the urethra downward to a hanging position that pulls open the inner urethra. VLPP/UF/SUI covaries with poor urethral support in relation to the bladder neck. Without vaginal support the urethra is chronically burdened by withstanding the intra-abdominal pressure and is thereby traumatized and eventually evolves intrinsic sphincter deficiency (ISD).

It has long been known that the emergence of a cystocele can lessen or eliminate existing SUI. The opposite also applies, that is, surgical overcorrection of a cystocele can cause SUI. In the first case, the urethra is stopped from hanging upon the bladder neck. In the second case, the opposite occurs. The mobility of the proximal urethra in relation to the bladder neck is vital. A distally placed suburethral support does not block the downward movement of the proximal urethra.

In a follow-up study of 106 women who underwent surgery using a tension free vaginal tape technique (TVT), 15 uncured women had UF with unchanged width and depth, and 21 of 91 cured women had UF with unchanged width but shorter depth. Seventy cured women had no UF. If the UHT is applied to the outcomes of surgery, this would suggest that the suburethral support was placed excessively distal in the 15 uncured women with unchanged UF and was placed more distal than optimal in the 21 cured women with reduced UF—given that the tape to urethra distance at rest is correct i.e. the tape is not undue loosely set.

The UHT postulates that UF/SUI emerges when the proximal urethra is forced downward in relation to the bladder neck until it is stopped by hanging on the bladder neck and is thereby funneled by pulling forces. Normally, the suburethral support beneath the proximal urethra creates a backboard that both stops the downward movement and compresses the urethra. The posterior pubourethral ligaments have a broad attachment to the pararethral tissues at the junction of the upper one-third and the distal two-thirds of the urethra,9 and this junction is likely also the optimal position for the TVT net.

Urethral support starting 0.5–1 cm from the outer urethral opening is not optimal, and the failure rate is 0–33%.9 The author of this letter placed the net (TVT) starting 1.0–1.5 cm from the bladder neck (Fig. 2).

A follow-up of 69 TVT operations was planned in connection with a prospective, controlled, randomized study in 1999 involving prolapse surgery and TVT surgery performed under local anesthesia. Regrettably, the study was halted before it began, even though it was approved by the ethics committee of Uppsala Hospital. Policymakers decided that prolapse surgery under local anesthesia was suboptimal healthcare, which meant that economics was prioritized ahead of patient interest.10

Bo S. Bergström
Department of Obstetrics & Gynecology
Nordfjordeid Hospital
Nordfjordeid, Norway

REFERENCES
1. DeLancey JOL. Structural support of the urethra as it relates to stress urinary incontinence: The hammock hypothesis. Am J Obstet Gynecol 1994;170:1713–20.
2. DeLancey JOL. Why do women have stress urinary incontinence? Neurourol Urodynam 2010;29:S13–7.
3. Tunn R, Goldammer K, Gauruder-Burmester A, et al. Pathogenesis of urethral funneling in women with stress urinary incontinence assessed by introital ultrasound. Ultrasound Obstet Gynecol 2005;26:287–92.
4. Schaer GN, Perucchini D, Munz E, et al. Sonographic evaluation of the bladder neck in continent and stress-incontinent women. Obstet Gynecol 1999;93:412–6.
5. Schaer GN, Koechli OR, Schuessler B, et al. Improvement of perineal sonographic bladder neck imaging with ultrasound contrast medium. Obstet Gynecol 1995;86:950–4.
6. Tunn R, Petri E. Introital and transvaginal ultrasound as the main tool in the assessment of urogenital and pelvic floor dysfunction. An imaging panel and practical approach. Ultrasound Obstet Gynecol 2003;22:205–13.
7. Wlazlak E, Viereck V, Szkorkot G, et al. The significance of urethral funneling and urine flow (pf-ultrasound) in evaluating stress urinary incontinence [Abstract]. Poster ICS 2014; Rio de Janeiro 20th–24th October 2014. Available from: www.ics.org/Abstracts/Publish/218/000234.pdf
8. Zacharin RF. The anatomic supports of the female urethra. Obstet Gynecol 1968;32:754–9.
9. Schraffordt Koops SE. Tension-free vaginal tape (TVT). Utrecht: Proefschrift Universiteit Utrecht; 2006.
10. Bergström BS. Vårdutveckling i Mora gav resultat, men stoppades. Lakartidningen 2015;112:pii:DP69. (in Swedish)