Received: 14 March 2022 | Accepted: 2 June 2022

DOI: 10.1002/nau.24988

DEBATE

Neurourology Urodynamics | SUFU Society of Urodynamics, Female Pelvic Medicine & Urogenital Reconstruction | WILEY

THE CASE AGAINST urethral failure is not a critical factor in female urinary incontinence. Now what? The integral theory system

Peter Petros DSc, DS (UWA), PhD (Uppsala), MB, BS, MD (Syd), FRCOG (Lond)

Mechanical and biomechanical engineering, University of Western Australia School of Engineering and Mathematical Sciences, Perth, Western Australia, Australia

Correspondence
Peter Petros, DSc, DS (UWA), PhD (Uppsala), MB, BS, MD (Syd), FRCOG (Lond), 31/93 Elizabeth Bay Rd, Elizabeth Bay, Sydney, NSW 2011, Australia.
Email: pp@kvinno.com and www.integraltheory.org

Abstract

Subject of the Debate: *"Urethral failure is a critical factor in female urinary incontinence Now what?"* The CASE FOR by Hokanson, DeLancey pinpointed inadequacy of bladder causation for urgency urinary incontinence (UUI) and poor urethral support for stress urinary incontinence (SUI) as responsible for long-standing lack of progress in incontinence science. They proposed "Urethral failure" as causation for SUI and UUI. The CASE AGAINST, by Peter Petros agrees "abnormal detrusor function as cause for (UUI) is a failed concept, and SUI surgery results are sometimes suboptimal, but rejects "urethral failure" as cause for UUI and SUI. In answer to, "Now what?," Petros presents the Integral Theory System. SUI and UUI are dysfunctions of the bladder's binary control mechanism, mainly ligament laxity because of defective collagen/elastin. The urethra is an emptying tube. Pelvic muscle forces reflexly contract against ligaments to close urethra, open it (micturition) and stretch the vagina underlying urethelial stretch receptors to mechanically support them, preventing premature activation of micturition (UUI). High validated cure rates for SUI and UUI by repair of weakened ligaments question viability of the "urethral failure" concept.

Conclusions: The major achievement of this debate (both sides) is not what causes UUI or SUI, or what doesn't, though clearly, this is important. It is calling out a 50-year ossification of the whole construct of UUI, ranging from flawed definitions to systematic denial of known cures, all of which have stalled treatment of the one billion women who suffer with incontinence. The time has come for change.

KEYWORDS

integral theory, pubourethral, SUI, urethral failure, urethral resistance, urge urinary incontinence, uterosacral ligaments

Popper takes falsifiability as his criterion for demarcating science from nonscience: it is logically impossible to verify a universal proposition by reference to experience (as Hume saw clearly), but a single genuine counter-instance falsifies the corresponding universal law. In a word, an exception, far from "proving" a rule, conclusively refutes it.

1 | BACKGROUND

The background to my CASE AGAINST was the virtual seminar convened by the NIDDK over 7-week titled: "Female Urethral Function and Failure: Advancing Basic and Translational Research for Genitourinary Conditions."[1,2] This meeting was to all intents and purposes a crisis meeting convened to seek answers to what it termed "failure to achieve a higher level of success," blaming constrictions from the **"two factor model**," abnormal detrusor function as cause for urgency urinary incontinence (UUI) and poor urethral support as cause for stress urinary incontinence (SUI). There was a seeming acceptance of the seminar to propose "urethral failure" as the cause of both SUI and UUI, presented as a "**three-factor paradigm**" to explain both SUI and UUI.[3]

2 | INTRODUCTION

I thank Roger Dmochowski, Editor-in-Chief of Neurourology and Urodynamics, for this invitation. In my "Case Against," I will follow Oxford University Union's rules for debate which discusses two opposing viewpoints, suitably modified for science and this journal: (1) Introduction and opening argument. (2) Develop the argument with valid evidence and logical reasoning. (3) Rebut the opposition argument. (4) Wrap up and conclude. As per the debating rules, the "FOR" case must be given the opportunity to rebut my arguments and summarize their case.

In my presentation, I will try to follow criteria for sound scientific argument[4] and Popper's falsification criteria for rebuttal.[5] The "FOR" case, *"Urethral failure is a critical factor in female urinary incontinence. Now what?,"* has already been presented by James A. Hokanson John O. L. DeLancey.[3] Here I take an opposing view, *Urethral failure is not a critical factor in female urinary incontinence. Now what? The Integral Theory System*.

3 | OPENING ARGUMENT

I begin the CASE AGAINST with high praise for the NIDDK[1,2] and my colleagues Hokanson and DeLancey,[3] for calling out the unsustainable UUI (OAB) paradigm. I agree that UUI (OAB) causation from the detrusor is a failed concept.[6] We differ in how to solve the problem. The evidence for a crisis is in plain sight: almost one billion women on the planet suffer from some form of bladder/bowel problem, *and this figure increases as the population ages*. Learned bodies state pathogenesis is unknown and there is no cure.[7] Anticholinergics, the 1st line of treatment may cause Alzheimer's disease.[8] To question structural failure as a cause for SUI[9] when there are 10 000 000 operations since 1996[10] for SUI based on repairing weak pubourethral ligaments (PUL) is a brave statement. However, I cannot but agree that midurethral sling (MUS) surgery as practised at the coalface today, leaves much to be desired.[3] Pathogenesis of UUI and SUI will be addressed by the Integral Theory System's (ITS) anatomical binary concept[9] (Figure 1). I will address the "failed urethra," the "three-factor paradigm" and other proposals from the "FOR" case[3] in my rebuttal.

4 | THESIS AND EVIDENCE

My thesis is based on the Integral Theory paradigm which states stress and urge incontinence are dysfunctions of the bladder's binary control mechanism, Figure 1, the main cause being laxity in the vagina or its supporting ligaments, a consequence of defective collagen/elastin.[9,11–15] PUL/USL (uterosacral) ligament repair has led to surgical cure of both SUI and UUI since almost 25 years.[15–38] These data alone question "urethral failure" pathogenesis for SUI and UUI.

5 | NORMAL FUNCTION

Bladder control is binary, with two reflexes, EITHER closed OR open (micturition), Figure 1. Figure 1 works like an electric switch controlling two different circuits, one at a time, *either* closed or open. The closure reflex, comprising integrated cortical and peripheral elements, Figure 1 is dominant. When urine evacuation is required, the closure reflex is shut down by the cortex and the micturition reflex is activated (Figure 1).[39,40]

5.1 | The closure reflex

The closure reflex works by direct cortical suppression (white arrows, Figure 1) and peripherally, by three reflex muscle forces (large arrows, Figure 1), stretching the vagina in opposite directions around PUL, to close the urethra distally and at bladder neck, Figures 2 and 3.

5.2 | Validation of muscle-activated closure reflex

Figure 2B, video X-ray myogram shows three directional muscle forces closing the urethra distally and at bladder

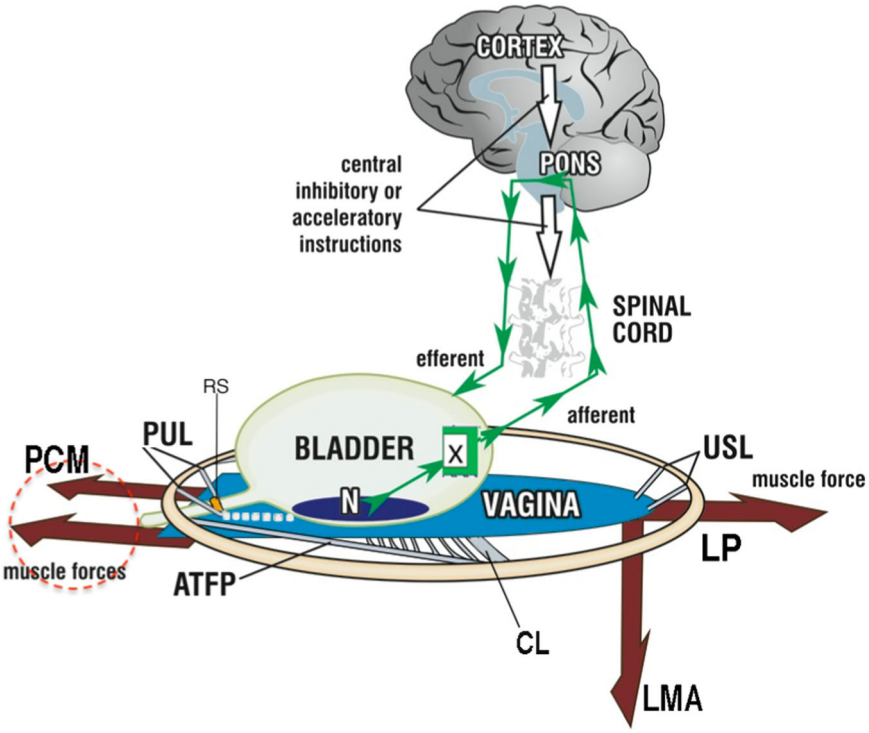

FIGURE 1 Binary model summarizes the anatomical basis for OAB control. Schematic 3D sagittal view System in normal closed mode. broken circle represents relaxation of PCM prior to micturition; CL, cardinal ligament; LP, levator plate muscle; LMA, conjoint longitudinal muscle of the anus; PUL, pubourethral ligament; PCM, pubococcygeus muscle; N, urothelial stretch receptors; RS, rhabdosphincter; USL, uterosacral ligament; X, quantum of afferent impulses from N; white arrows, cortical suppression of X

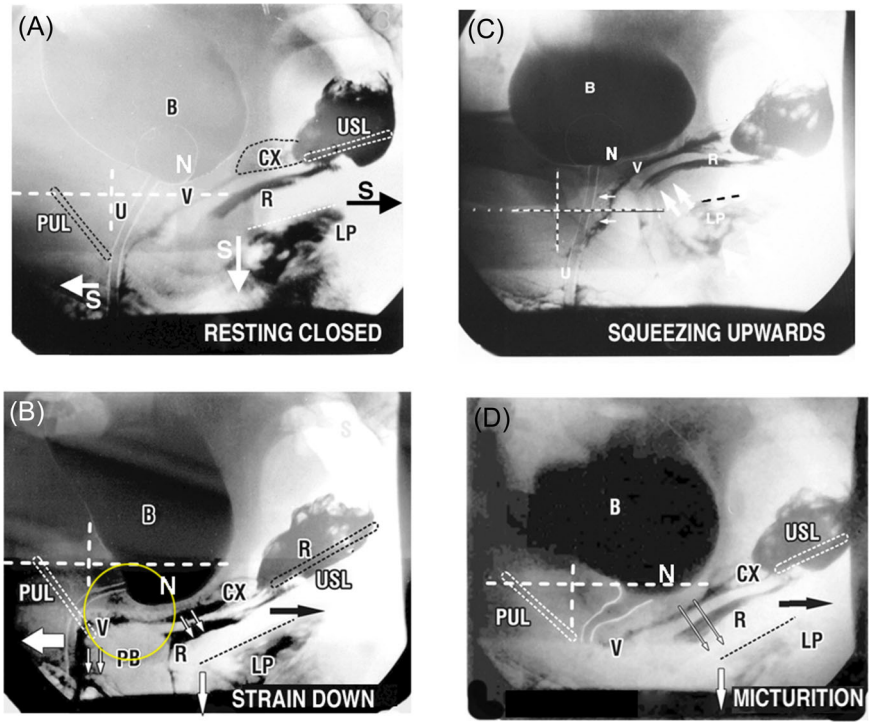

FIGURE 2 Sitting X-rays. Role of the levator plate in bladder/anorectal closure and micturition. Vertical and horizontal lines are bony co-ordinates. **(A) RESTING CLOSED**: S = opposite directional slow twitch muscles; radio-opaque dye inserted into bladder (B), rectum (R), vagina (V) and levator plate (LP). **(B) STRAIN**: Note 3 fast-twitch opposite directional forces (arrows); downward angulation of LP by LMA rotates bladder "B" around PUL and rectum "R" around PRM for rectal closure; yellow circle is the "zone of critical elasticity" of the vagina, necessary to allow the separate function of the opposite muscle forces (arrows) **(D) MICTURITION**: Forward force relaxed (urethra pulled behind vertical co-ordinate by LP); angulation of LP by LMA (downward arrow) pulls open posterior urethral wall. **(C) SQUEEZING UPWARDS**: Note LP lifted upwards and forwards from below (by PRM). CX, cervix; LMA, conjoint longitudinal muscle of the anus; PCM, pubococcygeus muscle; PUL, pubourethral ligaments; USL, uterosacral ligaments

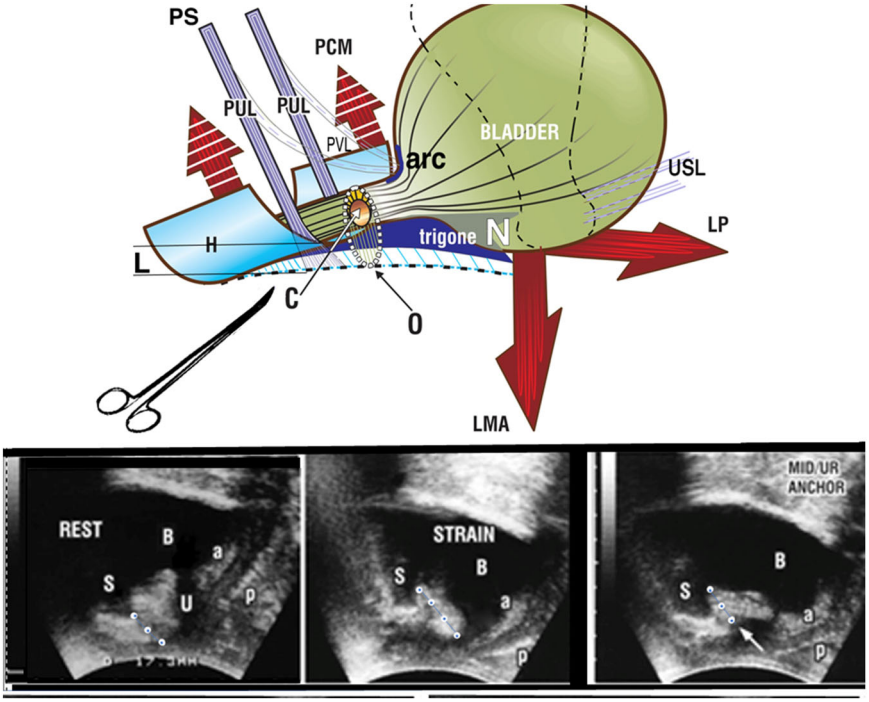

FIGURE 3 Role of pubourethral ligament (PUL) in continence and stress urinary incontinence. PVL, pubovesical ligament; arc, arc of Gilvernet; L, extension of a loose or weak PUL on effort; LP/LMA, pull open posterior urethral wall to open urethra from closed "C" to open "O", exactly as happens during micturition. Lower figure 2D transperinal ultrasound. S, symphysis; B, bladder; U, urethra; "a" represent anterior vaginal wall; 'p' represent posterior vaginal wall; white circles, pubourethral ligament. White arrow right US frame, hemostat

neck, as does Video 1 (https://www.youtube.com/watch?v=3vJx2OvUYe0.[39,40] *Note*: To see the distal and bladder neck closure clearly, put the video on "pause" and move it forward frame by frame).

5.3 | Opening reflex (micturition)

Urothelial stretch receptors "N", are cells with "neuron-like" properties which respond to mechanical and chemical stimuli.[39,41] They are activated by hydrostatic or other pressure. At a critical mass of afferent "X" impulses from "N", Figure 1, the micturition reflex is activated. The closure reflex is suppressed. Relaxation of forward vector PCM relieves the closure force behind the distal urethra and allows backward/downward vectors to actively pull open the posterior urethral wall. Opening urethra exponentially lowers resistance to urine outflow inversely by the 4th power of the radius[41–44]; detrusor contracts to empty.

5.4 | Validation of "N" as stretch receptors

Video 2 shows bladder base stretch receptors are sensitive to pressure. Digital pressure activates the micturition reflex, resulting in urine loss (https://youtu.be/dWi4_OdhewA; by permission Dr Monteiro, Portugal).

5.5 | Validation of opening reflex (micturition)

See Figure 2D and Video 3 (https://www.youtube.com/watch?v=eiF4G1mk6EA%26feature=youtu.be).

5.6 | Sensations of urgency

Sensations of urgency indicate afferent impulses "X" from bladder stretch receptors "N" have stimulated the micturition reflex (Figure 1). The urge symptom is the same, whether from a normal woman "hanging on" too long or a woman with "OAB" who gets urge at a (full for her), low bladder volume.[9,11–14]

5.7 | Control of urge

Control of urge (Figure 1) is by direct cortical suppression, and by opposite muscle forces (large arrows), reflexly stretching vagina like a membrane of a drum to mechanically support the urothelial stretch receptors "N" from below, to decrease afferent impulses "X" to the micturition center.

Cortical control of OAB Afferent impulses "X" from urothelial stretch receptors "N" are reflexly suppressed cortically (white arrows). When required, the cortex activates the micturition reflex. RS = rhabdosphincter; CL = cardinal ligament.

Closure reflex has two components, cortical and peripheral. *Peripheral control of OAB* is by reflex muscle forces (large arrows) which respond to cortical efferent impulses (small arrows). Three directional muscle forces, forward, pubococcygeus muscle "PCM, 'backward, levator plate' LP," and downward, conjoint longitudinal muscle of the anus "LMA" contract against the supporting ligaments, PUL (pubourethral) and USL (uterosacral), to close urethra, stretch vagina tightly, like the membrane of a drum to support the urine column, controlling afferent stretch receptor impulses to the cortex.

Micturition Central control (white arrows) relaxes, as does PCM (broken red circle); this allows the posterior muscles LP and LMA to unrestrictedly open out the posterior wall of urethra (white broken lines) just before bladder evacuation by global detrusor muscle contraction. Opening exponentially reduces resistance to evacuation, as per Figure 5. CX = cervix; CL = cardinal ligament; ATFP = arcus tendineus fascia pelvis.

Dysfunction Weakness in the muscles PCM, LP, LMA and/or the ligaments they contract against, PUL, USL, will affect the ability of the peripheral control mechanism to mechanically close urethra (incontinence), open it (obstructed micturition) or control micturition by bilateral stretching of vagina by the three opposite muscle forces to support "N" (urge incontinence).

6 | DYSFUNCTION

UUI and SUI, are caused by anatomical failure *somewhere along the binary control mechanism* (Figure 1).

6.1 | Urge urinary incontinence (UUI)

UUI is urodynamically identical to a normal micturition,[12] as in Figure 2D, except it is premature, and activated at low bladder volume. Because control is binary, anything causing excess afferent impulses from "N", Figure 1, (loose ligaments, bladder cancer, inflammation), or blocking efferent inhibitory instructions (e.g., multiple sclerosis) may cause UUI, *if the closure reflex cannot shut it down*. In clinical practice,[9–40,45–48] UUI is mainly caused by loose ligaments disabling pelvic muscle forces from stretching the vagina sufficiently to support "N". It follows, UUI in these circumstances is potentially curable surgically.[15–38,45]

6.2 | Validation of external control of UUI

Video 4 by permission Dr Monteiro, Portugal. Mechanical support of stretch receptors "N" at bladder base, or PUL at midurethra,[46] stops urine leakage from an already actioned micturition reflex (https://youtu.be/1VO7kY7T7Ec). Abatement of urge symptoms following digital support of bladder base as per Figure 4 (left) was noted in 18 of the 20 patients.[13] The urge disappeared between 3 and 8 s (mean: 5.4) and returned on removal of that support in a comparable period of time. Speculum support of USLs and "N", Figure 4 right,[48] relieves urge and pain in 70–80% of cases. The ultimate test of the Theory's predictions were reports of 85% cure of SUI and UUI with ligament repair slings,[15–38,45] as per the multicentre study ($n = 611$)[23] % Cure at 12 months was: prolapse 90%; urge incontinence 85%; frequency 83%; nocturia 68%.

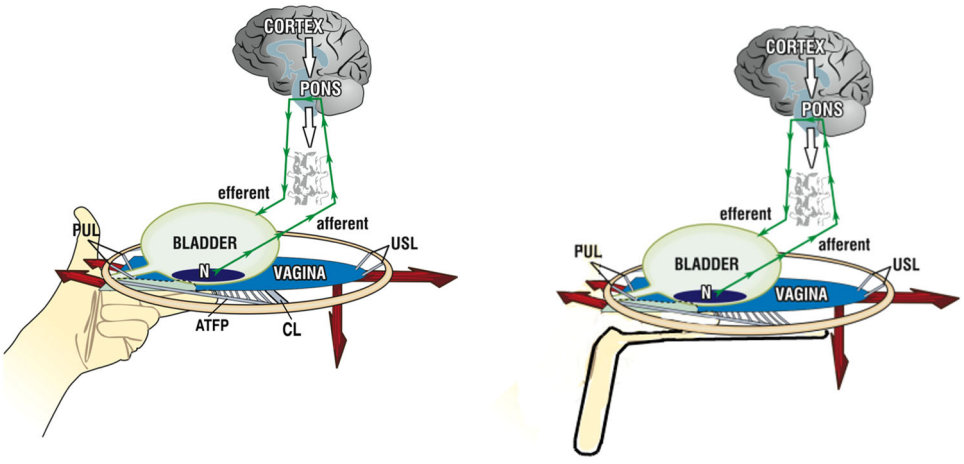

FIGURE 4 "Simulated operations to control urgency. Left: Digital support of urothelial stretch receptors "N" prevent afferent impulses to the cortex. Right: The speculum supports "N" and also, uterosacral ligaments (USL) to diminish urge impulses[48]

6.3 | Stress urinary incontinence "SUI"

Weak PULs cannot sustain LP/LMA closure forces acting against them and elongate by "L" (Figure 3).[9,46] LP/LMA stretch the trigone backwards/downwards to open out the whole posterior urethral wall from "C" (closed position of urethra) to "O" (open position), Figure 3 ultrasound.

6.4 | Validation of urethral and bladder neck closure mechanisms

Mechanically supporting PUL retropubically Video 5 (https://youtu.be/0UZuJtajCQU),[46] prevents SUI on coughing and restores normal geometry, white arrow, Figure 3 ultrasound. Video shows the importance of BOTH a competent PUL and an adequately tight suburethral vagina "H", Figure 3, in closure. Closure is exponentially determined. Narrowing the urethral diameter increases resistance to urine exiting bladder inversely by the 4th power of the radius (Poiseuille's Law).[41–44] Figure 5.

The ultimate validation of PUL's importance in causation of SUI is the 10 000 000 MUS operations performed to date[10] which work by harnessing the wound reaction[47] of an implanted tape to create new collagen to support the weak PUL (Figure 3).

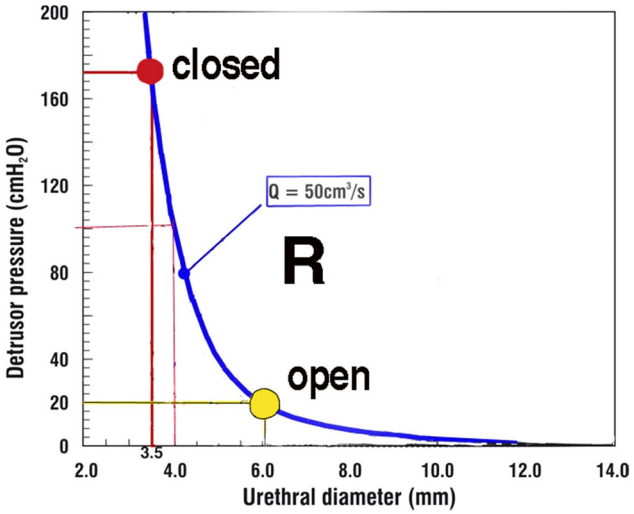

FIGURE 5 Exponential nature of urine flow is related to urethral diameter (Poiseuille's Law). For a flow rate of 50 ml/s (thick blue line), opening the urethral diameter from 3.5 to 4 mm reduces the head of pressure required by detrusor to expel the urine from 172 to 100 cmH2O). Expanding to 6 mm (yellow lines), reduces the head of pressure to 20 cmH2O. The blue line is the total urethral resistance to flow

6.5 | Mixed urinary incontinence (stress plus urge)

Mixed urinary incontinence (stress plus urge) is not a contraindication for MUS repair. A MUS repair will cure the SUI and up to 50% of co-existing UUI.[18] The hemostat test which controls SUI to predict cure by MUS, may also predict urge cure if urge is also diminished.

6.6 | Anatomical role of a weak PUL in SUI pathogenesis and cure

Longitudinal smooth muscle extends uninterruptedly from bladder to urethra (Figure 3, top). The trigone extends from bladder base to external meatus. Backward tensioning of the trigone by LP/LMA stiffens the posterior smooth muscle of urethra and bladder, a prerequisite for urethral closure and micturition. *Distal urethral closure*[9]: forward vector PCM (pubococcygeus muscle) stretches the suburethral vaginal hammock "H" forwards against a competent PUL to close the distal urethra. *Bladder neck closure*: LP (levator plate) contracts backwards, tensioning PUL PVL (pubovesical ligament) trigone and proximal urethra into a semi-rigid state; PVL insertion into the arc of Gilvernet anchors the anterior bladder wall in preparation for the downward rotation of bladder base by LMA (conjoint longitudinal muscle of the anus) around the arc which closes off proximal urethra at bladder neck. *Micturition* PCM relaxes (broken lines). LP/LMA stretch trigone to pull down posterior urethral wall like a trapdoor, opening urethra from "C" (closed) to "O" (open), exponentially reducing resistance to flow inversely by the 4th power of the radius "R" according to Poiseuille's Law ($Dp = 8mLQ/pR^4$). *Stress urinary incontinence* Same geometry as micturition. If PUL is weak or lax, PUL elongates by "L"; it cannot sustain the LP/LMA closure forces which pull on the trigone to stretch the posterior urethral wall from "C", closed position to "O", open position along the whole urethra, as demonstrated by the ultrasound.

White circles represent PUL (Figure 3, lower). Note apparent elongation of PUL on straining, funnelling of bladder neck and expansion of urethral diameter along the whole urethra, lowering urethral resistance to urine flow. White arrow in far right image shows site of hemostat as in Video 5 (https://youtu.be/0UZuJtajCQU). Hemostat supports weak PUL, prevents elongation "L" and opening by LP/LMA to cause SUI.

7 | REBUTTAL

The first issue is "urethral failure,"[3] not a known medical condition, not defined, not "universally recognized" according to Kuhn's definition in "Structure of Scientific Revolutions."[49]

The Second issue is anatomical. The longitudinal bladder smooth muscle and trigone extend to urethra, Figure 3, to form a single functional unit. It is not possible to have a "failed" urethra "without failed" bladder.

"Why has the urethra escaped scientific scrutiny for so long?[3]" It hasn't. The urethra is an emptying tube from bladder to outside. For continence, the urethra is closed by three opposite muscle forces contracting against PUL and USL, Figure 2B, exponentially **increasing** resistance to urine flow, Figure 5.[41–44] For evacuation, the posterior urethral wall is pulled open by LP/LMA contracting against USL before micturition, Figure 2D, exponentially **decreasing** resistance to urine flow, Figure 5.[41–44] As regards UUI, as a prematurely activated, uncontrolled micturition,[12] the urethra is opened out as during micturition Figure 2D: PCM relaxes; LP/LMA open out urethra; detrusor contracts.

"Measuring urethral pressure did not change outcomes led to the false assumption that urethral failure was not clinically important."[3] The 1st part of the statement has been confirmed in ISD (intrinsic sphincter defect) studies, 85–90% cure for ISD with sling repairs of PUL,.[15,50,51] "False assumption," is surely by the authors, as there is no hypothesis to show how "urethral failure" could cause SUI and UUI.

The "**three-factor paradigm**" ignores the seminal role of urethral resistance, Figure 5[41–44] in closure, evacuation, UUI and obstructed micturition. Rather there seems an emphasis on low urethral pressure, which did not prevent ISD cure.[15,50,51] This is unsurprising. The determinant for the binary system's "open" and "closed" modes is not pressure, but urethral resistance, Figure 5, exponentially determined by Poiseuille's Law, $Dp = 8mLQ/pR^4$,[41–44] R^4 being the 4th power of the radius "R". Pressure is not sufficiently sensitive as it measures only to the 2nd power of R:. P = Force/urethral area (pR^2).

What is meant by "urethral failure"? If "urethral failure" means the detrimental effect on urethral resistance to flow, Figure 5, by muscle or ligament weakness,[9] then the ITS, "three theory paradigm" and "urethral failure" proposals may (possibly) all be "on the same page," if the "urethral failure" concept accords with ITS for function[9,11] and dysfunction.[52]

7.1 | Predictive modeling

The Integral Theory Diagnostic System's clinical decision tree, Figure 6, and mathematical modeling[13,41–44,53,54] accord with the CASE FOR's criteria[3] for predictive modeling.

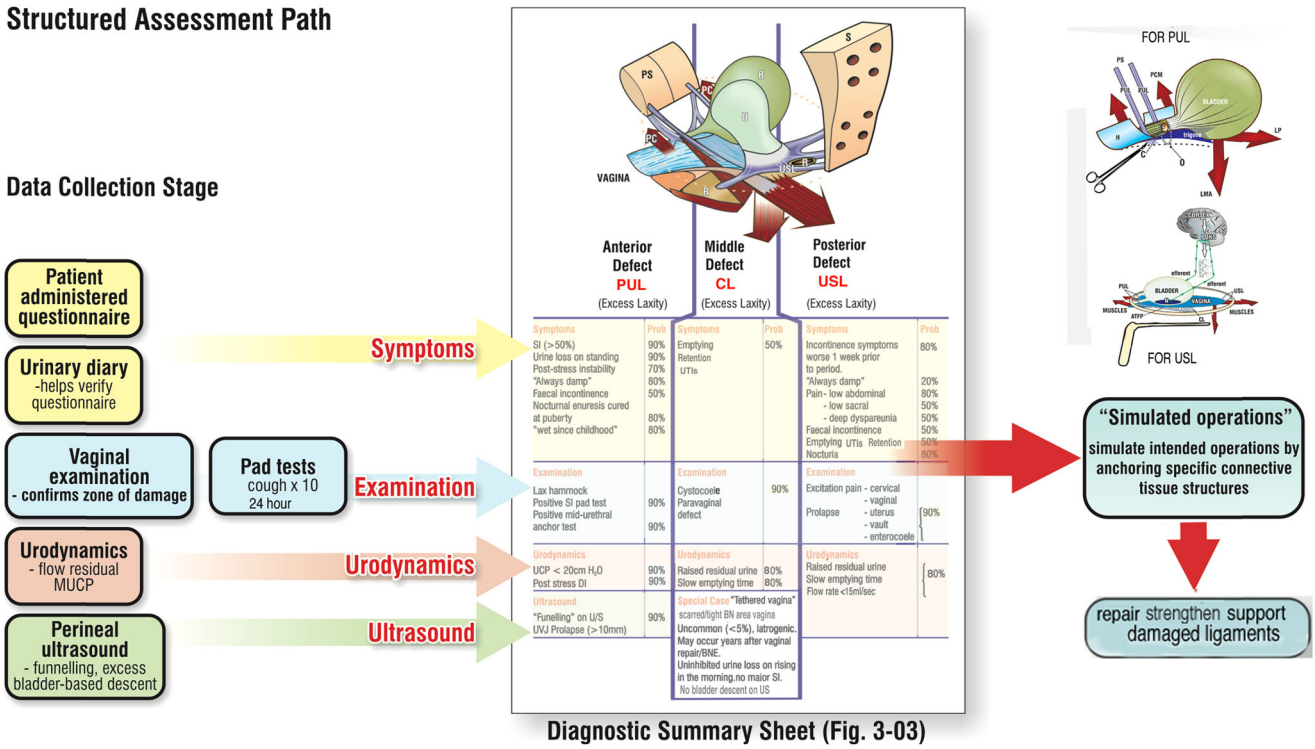

FIGURE 6 Extended diagnostic algorithm for ligament causation of lower urinary tract dysfunction

In part or in full, Figure 6 has been used before surgery by ITS followers on a regular basis since 1993. It gives approximate % probabilities for cure by repairing specific ligaments. Ligament damage is confirmed by vaginal examination and "simulated operations," e.g., as in Figures 3 and 4. Figure 6 has been computerized as a software program, the ITDS (Integral Theory Diagnostic System). The % probabilities for cure are estimates based on surgical results. An enormous potential exists for researchers to test every element of Figure 6 predictions against treatment results using more advanced objective testing methods now emerging.

7.2 | Mathematical modeling of the nonlinear binary feedback system

The binary system, Figure 1, was modeled with a nonlinear Chaos Theory feedback equation based on urodynamic testing data.[9,12,13] Figure 7 graphically represents the summation of all the modes of the bladder, retention, normal, low compliance, instability (UUI, OAB) iterated by the Chaos Theory feedback equation, Xnext = Xc(1-X), where "c" represents reflex cortical and peripheral suppression of afferent urothelial impulses "X" from urothelial stretch receptors "N", Figure 1; X = fraction of possible nerve impulses emanating from "N" in the micturition circuit of the model; Numeral "1" = maximum possible number of impulses in the circuit. How "c" and "X" were calculated: X was given a mean value of 0.5, being a sufficient number for input to the micturition center. "c" is inversely proportional to the quantum of inhibition. The clinical conditions were fitted into known "c" values from the Chaos Equation, inversely applied: Fowler's Syndrome (retention) has a very low "c", urge incontinence a high "c".

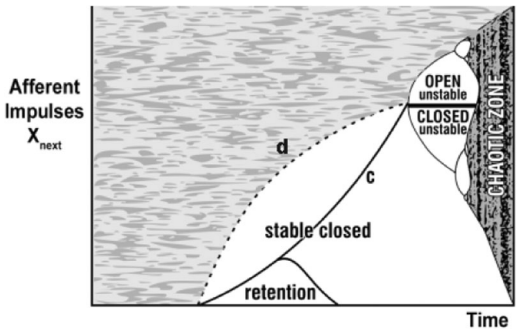

FIGURE 7 Modes of the bladder iterated by the Chaos Theory equation. Graph of an iterated Chaos Theory feedback equation $X_{NEXT} = cX(1 - X)$ applied to urodynamic experimental findings.[12,13] Vertical axis = afferent impulses Xnext; horizontal axis = Time. 'd'(broken lines) = iteration with one variable (central inhibition); 'c'(unbroken lines) is an inhibitory constant comprising the sum of two variables, central inhibition plus peripheral suppression as in Figure 1. X = fraction of possible nerve impulses in the micturition circuit. The whole spectrum of bladder conditions can be graphically expressed by iteration of the feedback equation varying the constant "c" which has an inverse value. If vaginal tension is excessive, e.g., in Fowler's Syndrome, or by excessive elevation by Burch colposuspension, peripheral inhibition of stretch receptors "N", Figure 1, is high, "c" is low. A nominal "c" value of 0.1 is assigned to the iteration and the system goes into retention. Stable closure (normal), micturition quiescent ("c" = 0.2); higher up the slope, c is low compliance, micturition activated but controlled ("c"= between 2 and 3); at the bifurcation, micturition overcomes closure ("c" > 3) and the system swings between open and closed

7.3 | FEM (finite element model) modeling of pressure transmission and micturition theories

Abdominal Pressure, the lynchpin for past theories of continence (Enhorning's Theory, "Hammock hypothesis), micturition, and fecal continence, was tested with an FEM based on known tissue characteristics of the urethra and bladder.[41–44,53] The objective was to achieve the geometric shape of Figure 2D. Using a starting abdominal pressure of 160 cmH2O, an abdominal pressure 2 orders of magnitude (×100) greater than 160 cm was required to achieve the shape of Figure 2D, forcible opening of the urethra as predicted by Enhoring's pressure transmission theory.

7.4 | Bayesian modeling

We compared the effectiveness of Bayesian networks versus Decision Tree (Figure 6). Bayesian networks and Decision Trees were developed and trained using data from 58 adult women presenting with urinary incontinence symptoms. In most cases, Bayesian networks were found to be at least as accurate as the Decision Tree approach.[54]

8 | MOVING FORWARDS

Added to its ligament-based concepts for bladder function and dysfunction, surgery based on the ITS is available now! Daycare native tissue USL/CL (cardinal ligament) plication is not difficult surgery. It has high cure rates for prolapse, urge and nocturia, at least in premenopausal women.[37] Collagenopoietic tapes are required for postmenopausal women.[37] USL: https://www.youtube.com/watch?v=MGLdYHtqxzg.

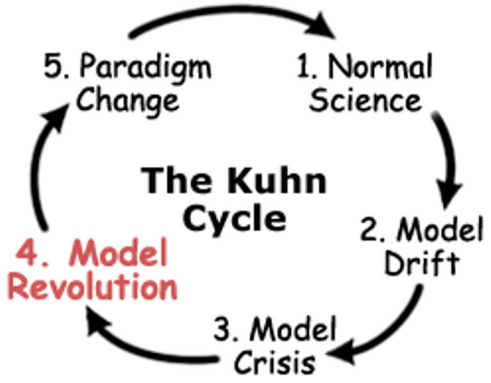

FIGURE 8 Kuhn's Cycle for paradigm change

CL: https://youtu.be/aJDPOELZZfc. These are transverse incision surgeries, easier to locate laterally displaced ligaments, but easily adaptable to longitudinal incisions. Probability of surgical success can be predicted by the hemostat test (PUL), Figure 3, and the speculum test (USL), Figure 4.

Kuhn famously stated that change happens, not because something is scientifically correct, but because there is a crisis.[49] The UUI crisis[1,2,6] affecting some one billion women, is worsening daily as the population ages. The NIDDK "crisis call" for UUI[1,2] would now be "3" on the Kuhn cycle, Figure 8. The discoveries of the 1990 Integral Theory, moved the cycle to "4" (Model Revolution) for SUI, and in 1997, for UUI also. It is inevitable, given the data[15–38,45] which proves OAB is curable by ligament support, that the whole ITS system will move to "5" (Paradigm Change). Whether this will be surgical or nonsurgical, sooner or later, won't matter. The ligament-based principle of OAB UUI pathogenesis has been proven.[15–38,45] The time has come for change.

ACKNOWLEDGEMENT

Open access publishing facilitated by The University of Western Australia, as part of the Wiley - The University of Western Australia agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST

The author declares no conflict of interest.

ORCID

Peter Petros https://orcid.org/0000-0002-9611-3258

REFERENCES

1. nau24875-sup-0001-NIDDK_Female_Urethral-Function_and_Failure_Ex_Summary-Key_Points.docx
2. nau24875-sup-0002-NIDDK_Female_Urethral-Function_and_Failure_Ex_Summary-Shorter_Version_Model.docx
3. Hokanson JA, DeLancey JOL. Urethral failure is a critical factor in female urinary incontinence. Now what? *Neurourol Urodyn*. 2022;41(2):532-538. Available from doi:10.1002/nau.24875
4. The logic of scientific debate: Epistemological quality control practices and Bayesian inference – a neoPopperian perspective John R. Skoyles CPNSS j.skoyles@lse.ac.uk; Available from www.human-existence.com
5. Popper KR. *Theories, falsifiability, the logic of scientific discovery*. Unwin, Hyman; 1980:27-146.
6. Petros PE, Quaghebeur J, Wyndaele J. Overactive bladder (OAB)—a failed concept needing revision to accommodate an external anatomical control system. *World J Urol*. 2022. Feb 22 Available from doi:10.1007/s00345-022-03938z. Online ahead of print
7. Peyronnet B, Mironska E, Chapple C, et al. A comprehensive review of overactive bladder pathophysiology: on the way to tailored treatment. *Eur Urol*. 2019;75:988-1000. Available from doi:10.1016/j.eururo.2019.02.038
8. Risacher SL, McDonald BC, Tallman EF, et al. Association between anticholinergic medication use and cognition, brain metabolism, and brain atrophy in cognitively normal older adults. *JAMA Neurol*. 2016;73:721-732. Available from doi:10.1001/jamaneurol.2016.0580
9. Petros PE, Ulmsten U. An integral theory of female urinary incontinence. *Acta Obstet Gynecol Scand*. 1990;Supp 153:1-79. Available from doi:10.1111/j.1600-0412.1990.tb08027.x
10. Toozs-Hobson P, Cardozo C, Hillard T. Managing pain after synthetic mesh implants in pelvic surgery. *Eur J Obstet Gynecol Reprod Biol*. 2019;234:49-52. Available from doi:10.1016/j.ejogrb.2018.12.037
11. Petros PE, Ulmsten U. An integral theory and its method, for the diagnosis and management of female urinary incontinence. *Scand J Urol Nephrol*. 1993;27(Suppl 153):1-93.
12. Petros PE, Ulmsten U. Bladder instability in women: a premature activation of the micturition reflex. *Neurourol Urodyn*. 1993;12:235-239.
13. Petros PE. Detrusor instability and low compliance may represent different levels of disturbance in peripheral feedback control of the micturition reflex. *Neurourol Urodyn*. 1999;18:81-91.
14. Liedl B, Inoue H, Sekiguchi Y, et al. Update of the integral theory and system for management of pelvic floor dysfunction in females. *Eur J Urol*. 2018;EURSUP-738:100-108. Available from doi:10.1016/j.eursup.2017.01.001
15. Petros PE. New ambulatory surgical methods using an anatomical classification of urinary dysfunction improve stress, urge and abnormal emptying. *Int Urogynecol J Pelvic Floor Dysfunct*. 1997;8:270-277. Available from doi:10.1007/bf02765483
16. Wagenlehner FM, Fröhlich O, Bschleipfer T, Weidner W, Perletti G. The integral theory system questionnaire: an anatomically directed questionnaire to determine pelvic floor dysfunctions in women. *World J Urol*. 2014;32:769-781. Available from doi:10.1007/s00345-013-1150-z
17. Scheffler K, Hakenberg OW, Petros P. Cure of interstitial cystitis and Non-Ulcerating Hunner's Ulcer by cardinal/

uterosacral ligament repair. *Urol Int*. 2021;105(9-10):920-923. Available from doi:10.1159/000515647

18. Rezapour M, Ulmsten U. Tension-Free vaginal tape (TVT) in women with mixed urinary incontinence—a long-term follow-up. *Int Urogynecol J Pelvic Floor Dysfunct*. 2001;12(Suppl 2): S15-S18. Available from doi:10.1007/s001920170006
19. Petros PE, Ulmsten U. The posterior fornix syndrome: a multiple symptom complex of pelvic pain and abnormal urinary symptoms deriving from laxity in the posterior fornix. *Scand J Urol Nephrol*. 1993;27:89-93.
20. Wagenlehner F, Muller-Funogea IA, Perletti G, et al. Vaginal apical prolapse repair using two different sling techniques improves chronic pelvic pain, urgency and nocturia: a multi-centre study of 1420 patients. *Pelviperineol*. 2016;35:99-104.
21. Liedl B, Goeschen K, Yassouridis A, et al. Cure of underactive and overactive bladder symptoms in women by 1,671 apical sling operations gives fresh insights into pathogenesis and need for definition change. *Urol Int*. 2019;103:228-234. Available from doi:10.1159/000500329
22. Goeschen K, Gold DM. Surgical cure of chronic pelvic pain, associated bladder %26 bowel symptoms by posterior sling in 198 patients validates the Pescatori Iceberg principle of pelvic symptom co-occurrence. *Pelviperineol*. 2017;36:84-88.
23. Liedl B, Inoue H, Sekiguchi Y, et al. Is overactive bladder in the female surgically curable by ligament repair? *Cent European J Urol*. 2017;70:53-59. Available from doi:10.5173/ceju.2017.938
24. Inoue H, Kohata Y, Fukuda T, et al. Repair of damaged ligaments with tissue fixation system minisling is sufficient to cure major prolapse in all three compartments: 5-year data. *J Obstet Gynaecol Res*. 2017;43:1570-1577. Available from doi:10.1111/jog.13413
25. Inoue H, Kohata Y, Sekiguchi Y, Kusaka T, Fukuda T, Monma M. The TFS minisling restores major pelvic organ prolapse and symptoms in aged Japanese women by repairing damaged suspensory ligaments 12-48 month data. *Pelviperineol*. 2015;34:79-83.
26. Abendstein B, Brugger C, Furtschegger A, Rieger M, Petros P. Study No.12: role of the uterosacral ligaments in the causation of rectal intussusception, abnormal bowel emptying, and fecal incontinence. A prospective study. *Pelviperineol*. 2008;27:118-121.
27. Petros PEP, Richardson PA. TFS posterior sling improves overactive bladder, pelvic pain and abnormal emptying, even with minor prolapse. A prospective urodynamic study. *Pelviperineol*. 2010;29:52-55.
28. Himmler M, Rakhimbayeva A, Sutherland SE, Roovers JP, Yassouridis A, Liedl B. The impact of sacrospinous ligament fixation on pre-existing nocturia and co-existing pelvic floor dysfunction symptoms. *Int Urogynecol J*. 2021;32:919-928. Available from doi:10.1007/s00192-020-04440-z
29. Richardson P. Surgical cure of nocturia using 4 different methods based on strengthening the structural supports of the vaginal apex—a short review. *Pelviperineol*. 2015;34:92-93.
30. Liedl B, Goeschen K, Sutherland SE, Roover JP, Yassouridis A. Can surgical reconstruction of vaginal and ligamentous laxity cure overactive bladder symptoms in women with pelvic organ prolapse? *BJU Int*. 2019;123:493-510. Available from doi:10.1111/bju.14453
31. Nakamura R, Yao M, Maeda Y, Fujisaki A, Sekiguchi Y. Outpatient mid-urethral tissue fixation system sling for urodynamic stress urinary incontinence: 3-year surgical and quality of life results. *Int Urogynecol J*. 2017;28:1733-1738. Available from doi:10.1007/s00192-017-3341-4
32. Sekiguchi Y, Kinjo M, Maeda Y, Kubota Y. Reinforcement of suspensory ligaments under local anesthesia cures pelvic organ prolapse:12-month results. *Int Urogynecol J*. 2014;25:783-789. Available from doi:10.1007/s00192-013-2281-x
33. Hocking IW. Experimental Study No. 9: Double incontinence, urinary and fecal,cured by surgical reinforcement of the pubourethral ligaments. *Pelviperineol*. 2008;27(No. 9):110.
34. Haverfield M. Tissue fixation system (TDS) neoligament pelvic organ repair procedures: 12 and 24 month results. *Pelviperineol*. 2015;34:70-74.
35. Scheffler KU, Petros PE, Hakenberg OW. A hypothesis for urinary stream divergence in the female: unilateral dislocation of the pubovisceral muscle. *Pelviperineol*. 2014;33: 10-13.
36. Petros P, Lynch W, Bush M. Surgical repair of uterosacral/cardinal ligaments in the older female using the tissue fixation system improves symptoms of obstructed micturition and residual urine. *Pelviperineol*. 2015;34:112-116.
37. Shkarupa D, Zaytseva A, Kubin N, Kovalev G, Shapovalova E. Native tissue repair of cardinal/uterosacral ligaments cures overactive bladder and prolapse, but only in pre- menopausal women. *Cent European J Urol*. 2021;74:372-378. Available from doi:10.5173/ceju.2021.285.3
38. Inoue H, Nakamura R, Sekiguchi Y, et al. Tissue fixation system ligament repair cures major pelvic organ prolapse in ageing women with minimal complications—a 10-year Japanese experience in 960 women. *Cent European J Urol*. 2021;74(4):552-562. doi:10.5173/ceju.2021.208
39. Petros PE, Ulmsten U. Role of the pelvic floor in bladder neck opening and closure: I muscle forces. *Int Urogynecol J Pel*. 1997;8:74-80.
40. Petros PE, Ulmsten U. Role of the pelvic floor in bladder neck opening and closure: II vagina. *Int Urogynecol J Pel*. 1997;8: 69-73.
41. Bush MB, Liedl B, Wagenlehner F, Petros P. A finite element model validates an external mechanism for opening the urethral tube prior to micturition in the female. *World J Urol*. 2015;33(8):1151-1157. doi:10.1007/s00345-014-1419-x
42. Bush MB, Petros PEP, Barrett- Lennard BR. On the flow through the human urethra. *Biomechanics*. 1997;30(9): 967-969.
43. Petros PE, Bush MB. A mathematical model of micturition gives new insights into pressure measurement and function. *Int Urogynecol J*. 1998;9:103-107.
44. Bush MB, Moron C, Messner-Pellenc L, Petros PE, Millard R. In: Adlassnig KP, Bracale M, editors. *A mechanical model for the opening of the human female urethra. Proceedings of Biomedical Engineering 2005, Austria*. Acta Press; 2005: 210-213.
45. Petros P, Abendstein B, Swash M. Uterosacral ligament repair improves urinary retention and other Fowler's syndrome descriptions. *Cent European J Urol*. 2018;71(4):436-443.

46. Petros PE, Von, Konsky B. Anchoring the midurethra restores bladder neck anatomy and continence. *Lancet*. 1999;354(9193): 997-998.
47. Petros PE, Ulmsten U, Papadimitriou J. The autogenic neoligament procedure: a technique for planned formation of an artificial neo-ligament. *Acta Obstet Gynecol Scand*. 1990;Suppl 15369:43-51.
48. Wu Q, Luo L, Petros PEP. Case report: mechanical support of the posterior fornix relieved urgency and suburethral tenderness. *Pelviperineology*. 2013;32:55-56.
49. Kuhn T. *The structure of scientific revolutions*. 3rd ed. University of Chicago Press; 1996.
50. Kapoor DS, Housami F, White P, Swithinbank L, Drake M. Maximum urethral closure pressure in women: normative data and evaluation as a diagnostic test. *Int Urogynecol J*. 2012;23:1613-1618.
51. Nakamura R, Yao M, Maeda Y, Fujisaki A, Sekiguchi Y. Retropubic tissue fixation system tensioned mini-sling carried out under local anesthesia cures stress urinary incontinence and intrinsic sphincter deficiency: 1-year data. *Int J Urol*. 2017;24(7): 532-537. Available from doi:10.1111/iju.13360. Epub 2017 May 14 PMID: 28503734.
52. Petros PE, Quaghebeur J, Wyndaele JJ. An anatomical pathogenesis of lower urinary tract definitions from the 2002 ICS report-symptoms, conditions, syndromes, urodynamics. *Neurourol Urodyn*. 2022;41:740-755.
53. Harrison SM, Bush MB, Petros PE. Towards a novel tensile elastometer for soft tissue. *Int J Mech Sci*. 2008;50:626-640.
54. Hunt M, von Konsky B, Venkatesh S, Petros P. Bayesian networks and decision trees in the diagnosis of female urinary incontinence. Engineering in Medicine and Biology Society, 2000. *Proceedings of the 22nd Annual International Conference of the IEEE*. 2000;1:551-554. doi:10.1109/IEMBS.2000.900799

How to cite this article: Petros P. THE CASE AGAINST urethral failure is not a critical factor in female urinary incontinence. Now what? The integral theory system. *Neurourol Urodyn*. 2022;41: 1270-1280. doi:10.1002/nau.24988