

# Pathophysiological Rationale for Surgical Treatments of Stress Urinary Incontinence



Urology Grand Rounds  
April 6, 2005  
Herman Christopher Kwan R4



## A familiar case?

- 62 year old female – initial presentation urinary incontinence 1999
- Cystoscopy, UDS
- Urologist diagnosed “SUI”
- After few months conservative therapy, a surgical procedure was performed successfully
- She returns w/ sx’s urinary incontinence 2005

## Surgical treatments of SUI

- 29.2% are re-operations  
(Olson, O&G 1997)



## Why did her incontinence recur?

- Patient factors
  - change in pt’s status
  - age, additional injury
- Procedural factors
  - Wrong material
  - Procedure prone to failure
- Surgeon factors
  - incorrect diagnosis
  - treatment did not address the pathophysiology of her SUI

## objectives

- We have a poor understanding of the pathophysiology of SUI...it is still evolving
- Introduce single factor theories for SUI
- Gain a more holistic view of SUI
  - Pathophysiology of SUI is multifactorial
  - Introduce concepts of **“shear force” & “continence threshold”**
- Introduce the “Trampoline Theory” of female continence

## “I think we’re tooting our own horn”

Dr. Christopher Payne NWUS meeting 2004

- High cure rates reported for SUI
- Considering only symptom of SUI
- Voiding dysfunction, post-op enteroceles or prolapse, detrusor instability
  - Reported in 10-25% of pts operated on for SUI

## “I think we’re tooting our own horn”

Dr. Christopher Payne NWUS meeting 2004

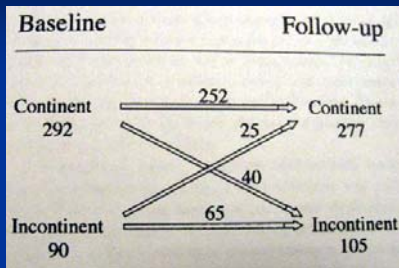
- therefore many pts classified as surgical success continue to have significant problems despite alleviation of their stress incontinence

## Current therapy for SUI is empiric!

One’s urologist’s ideal pt. for pubo-vaginal sling is another’s ideal TVT or another’s Burch

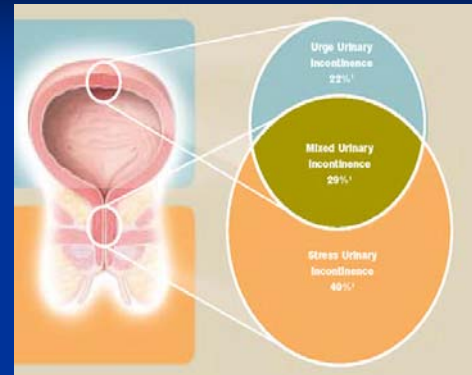


## UI prevalence/incidence

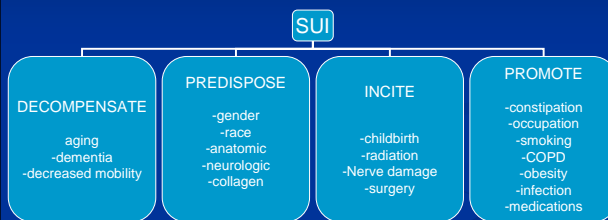


- Flow between continent and incontinent groups over time (n=382)  
-Samuelsson, Am J O & G '2000

## SUI is most common type in women



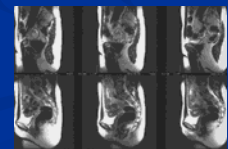
- Risk factors for SUI Bump '98



## Pathophysiology of SUI & Treatment Options

-existing treatment modalities based on existing understanding of pathophysiology of SUI

-Not well understood!!



## Pathophysiology of SUI & Treatment Options

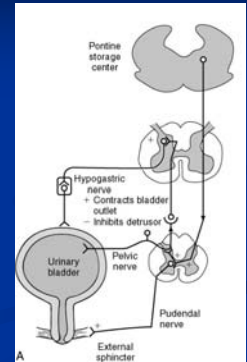
- Deficiencies in understanding of pathophysiology lead to failure of therapies
- “Can’t fix it if we don’t know where it is broken”

Omar Nazif P. Eng.



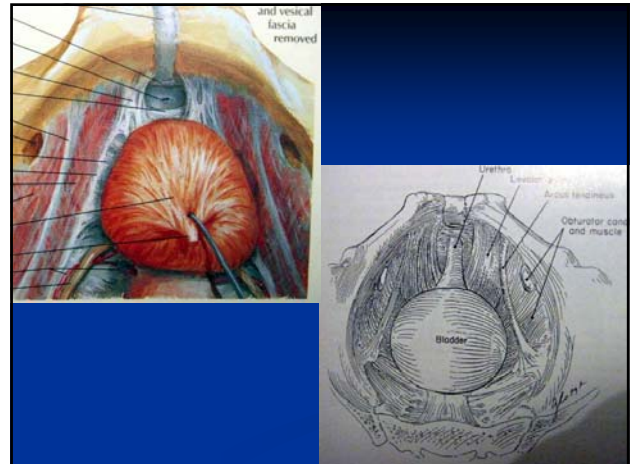
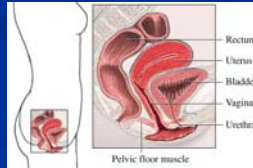
## Physiology of Continence

- Central control mechanisms
- Peripheral control mechanisms

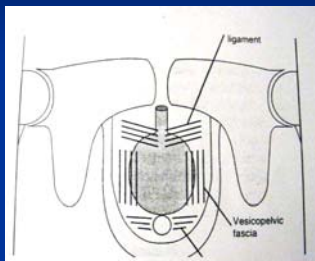


## Peripheral control mechanisms

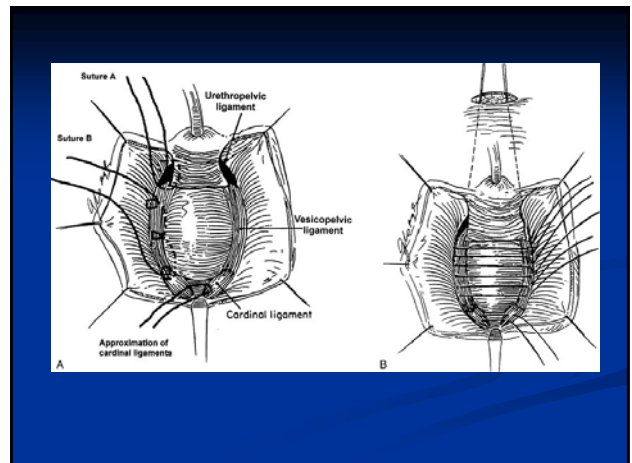
- Lower Urinary Tract Structures
  - Subject of most investigation
  - Basis of most treatment modalities of SUI in women (Delaney O&G '86)

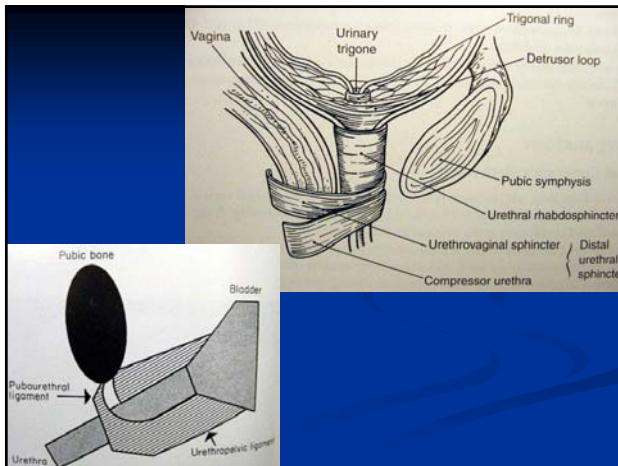
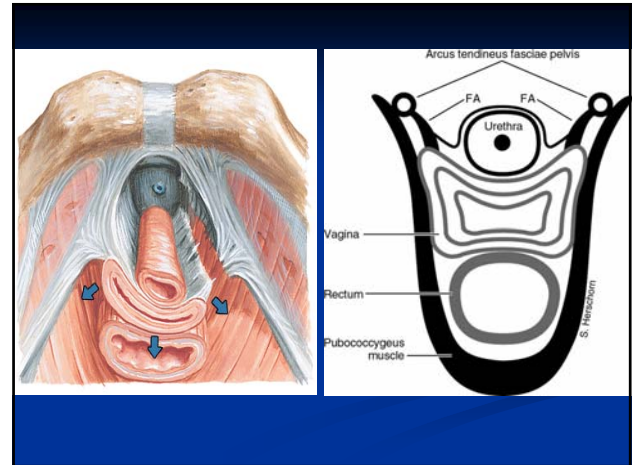
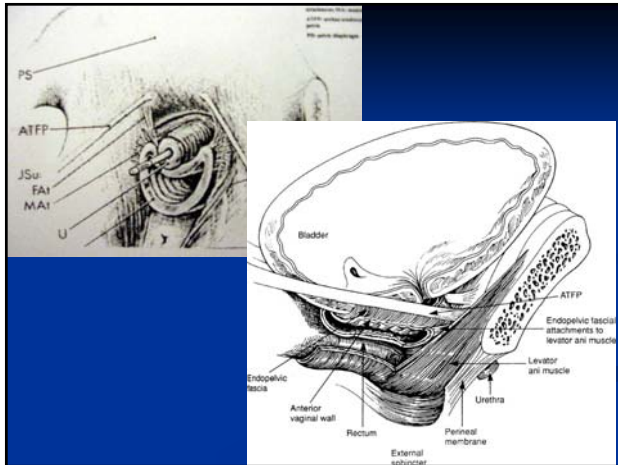


Ligaments and fascia of pelvis is actually one continuous sheet of levator fascia and not surgically distinct



- Endopelvic fascia
- Levators**
- Pubocervical fascia
  - periurethral fascia or urethropelvic ligament
  - perivesical fascia or vesicopelvic ligament
- sacrouterine/cardinal ligaments



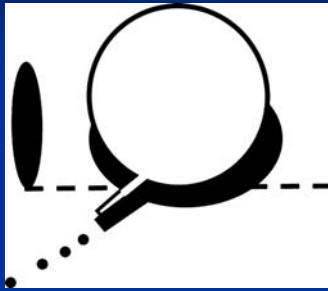


- ### Factors for SUI
- Bladder descensus
  - Hypermobility
  - ISD
  - Fixed, open bladder neck
  - Rotational descent
  - “pipestem” urethra
  - Hammock hypothesis
  - Mid-urethral continence zone

- ### Single factor theories on pathophysiology of SUI
- Position of proximal urethra<sup>1</sup>
  - Intrinsic sphincter deficiency<sup>2</sup>
  - Hammock hypothesis<sup>3</sup>
  - Integral theory<sup>4</sup>
1. Enhorning Urol Int. '76;
  2. McGuire '93
  3. Delaney Am J Obstet Gynecol '94
  4. Ulmsten U' Curr Opin Obstet Gynecol '92

- ### Urethral Position Theory
- Goran Enhorning 1961*
- Bladder, urethral pressure measurements in 250 women: normal, postpartum, and SUI
    - During stress, increase in urethral pressure was not as great in SUI compared to normal subjects
  - **Hypothesis:** absence of additional pressure during stress is due to extra-abdominal position of urethra

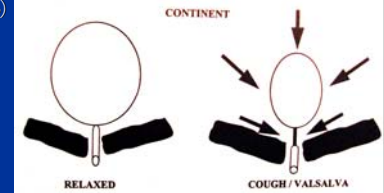
## Urethral position theory



- urethra needs to be above pelvic floor
- With stress, there would be = pressure transmission to bladder and proximal urethra

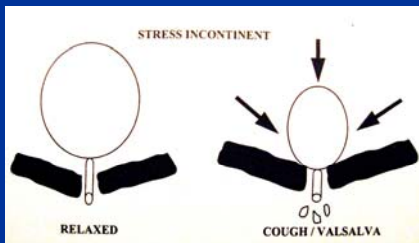
## Urethral position theory

- Normally continent women.
  - Well supported proximal urethra
  - Retropubic, intraabdominal position
  - Does not change position with stress (ie NOT HYPERMOBILE)



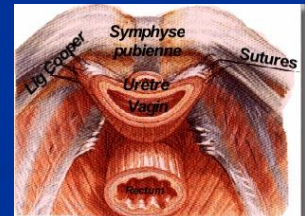
## Urethral position theory

- intrapelvic proximal urethra
- Inadequate transmission of intraabdominal pressure
- Leakage ensues



## Urethral position theory

- Forms basis for retropubic suspensions
- MMK 1<sup>st</sup> reported successful RP approach for SUI 1949
- Modified by Burch in 1961
  - Pereyra
  - Stamey
  - Gittes
  - Raz



## Why is the urethral position theory incorrect?

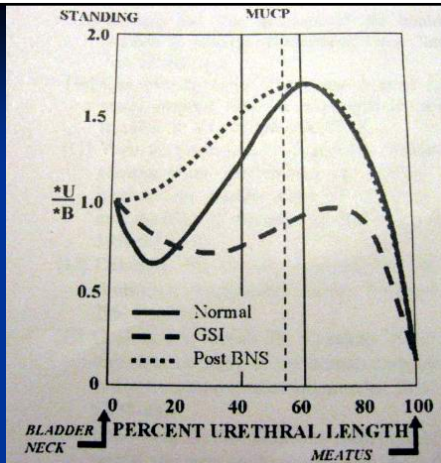
“No correlation b/t intraabdominal position of bladder neck and SUI” Greenwald et al '67

- Hypermobility is equally prevalent in continent and incontinent females
- Women w/ large cystourethroceles often continent

## Why is the urethral position theory incorrect?

- In 1981, Constantinou studied urodynamics of 20 stress incontinent women and compared w/ 13 normal women
  - Recorded urethral pressure profiles and transmission of abdominal pressures to urethra in:
    1. continent women,
    2. stress incontinent
    3. Stress incontinent after stamey needle suspension

- UPP demonstrating maximal pressure transmission at level of mid-urethra in normally continent women



Urol clinics N Am 2002

## Constantinou's conclusions

- 1. pt of maximal urethral pressure transmission is in mid urethra (almost always below pubis)
- 2. after needle suspension, mid urethral hump is re-established
- 3. a reflex muscular contraction augments the pressure transmission as % transmission is >100%
  - Rise in urethral pressure PRECEDED rise intravesical pressure during a cough
  - active contraction of midurethra through a neuromuscular reflex

## Invalidity of intra-abdominal pressure theory

“little advance in surgery of SUI over past 20yrs from uncritical acceptance of intra-abdominal pressure transmission theory”



Ulf Ulmsten '92 (inventor of TVT)

Current Opin Obs & Gyne 1992

## ISD/Open bladder neck

McGuire

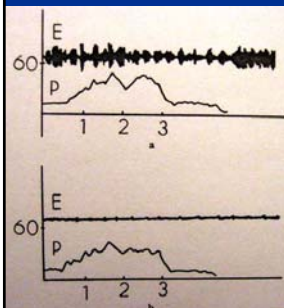
- 1980s, McGuire introduced concept of ISD
  - theory based on urodynamic observations of women who failed anti-incontinence surgery
  - intrinsic problem (anatomical or physiological) from multiple surgeries in urethral area
  - classically described as SUI w/ non-mobile retropublically fixed urethra Type III



## THE EFFECTS OF SACRAL DENERVATION ON BLADDER AND URETHRAL FUNCTION

Edward J. McGuire, M.D., and Franklin C. Wagner, Jr., M.D.,

J Surgery, Gyne, Obs 1977



- No activity of pudental nerve and still retain normal urethral pressure profile

- “urethral SM function alone provides satisfactory urinary continence”

## CLINICAL ASSESSMENT OF URETHRAL SPHINCTER FUNCTION

EDWARD J. MCGUIRE, CHRISTOPHER C. FITZPATRICK, JULIAN WAN, DAVID BLOOM, JILL SANVORDENKER, MICHAEL RITCHEY AND E. ANN GORMLEY  
From the Section of Urology, University of Michigan Hospitals, Ann Arbor, Michigan, and Division of Urology, University of Texas Health Science Center-Houston, Houston, Texas

JU 1993

TABLE 3. Abdominal pressures required to induce leakage

Pressure	No. Pts.	Maneuver Required for Leakage		Maximum Urethral Pressure (range)
		Valsalva	Cough	
5-60	37	30	7	29.5 (11-62)
61-89	46	32	14	34.2 (14-78)
90-119	20	16	13	32.4 (22-75)
120+	13	5	8	54.2 (30-92)

## Conclusions

*McGuire*

-Maximal Urethral Closing Pressure (MUCP) does NOT correlate w/ severity of incontinence and thus sphincter function

-Abdominal pressure required to induce leakage **DID** predict severity of incontinence (Low ALPP...larger amt of incontinence)

## ISD/Open bladder neck

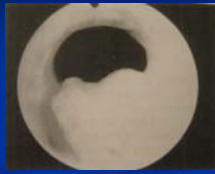
*McGuire*

- Valsalva Leak Point Pressure (VLPP)
  - Urodynamic tool to assess competence of urethra to resist increases in abdominal pressure
  - Definition:
    - High grade leakage +
    - Low VLPP+
    - Min bladder volume 150cc

## ISD/Open bladder neck

*McGuire*

- Urethra unable to generate enough outlet resistance to retain urine in bladder. Lack of “washer”
- He believed this problem of urethral coaptation could be improved with
  - Slings “McGuire Sling”
  - Collagen injection



## ISD/Open bladder neck

*McGuire*

- Important b/c it divided females w/ SUI into:
  - SUI from hypermobility: (↑ VLPP)
  - SUI from ISD: (↓ VLPP)

## ISD/Open bladder neck

*McGuire*

- ISD and hypermobility seem to coexist in many pts
  - Some women w/ open bladder necks are continent
  - A pt with hypermobility and leaks has ISD by definition b/c a normal urethra should be able to resist leakage regardless of its position

## ISD/Open bladder neck

*McGuire*

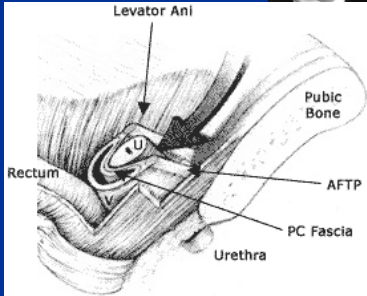
- VLPP today:
  - technique not standardized
  - “Still is a useful test and clinical utility is proven” Bump '97
  - Largely replaced UPP, which are falling out of favor

**Structural support of the urethra as it relates to stress urinary incontinence: The hammock hypothesis**  
 John O.L. DeLancy, MD  
 Ann Arbor, Michigan

■ Anatomical studies of fresh and embalmed cadavers

■ Urethra lies on supportive layer:  
 -endopelvic fascia  
 -anterior vaginal wall

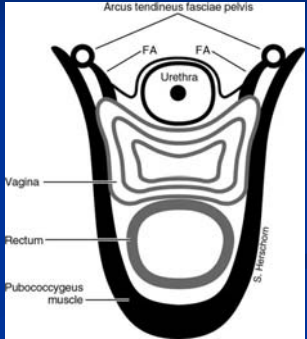

Am J Obstet Gynec 1994



**Hammock Hypothesis**  
 John DeLancy 1994


■ This layer gains structural stability through its lateral attachment to

- arcus tendineus fascia
- levator ani muscle

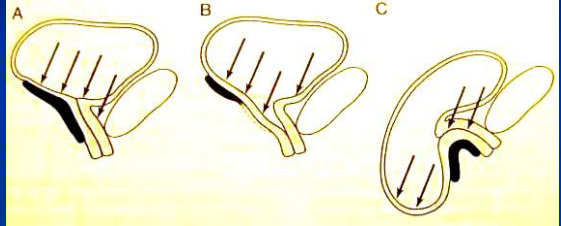



**Hammock Hypothesis**  
 John DeLancy 1994

■ Tissues below bladder neck and proximal urethra provide strong backboard to allow occlusion of urethra during increased abdominal pressure, thus preventing SUI



**Hammock Hypothesis**



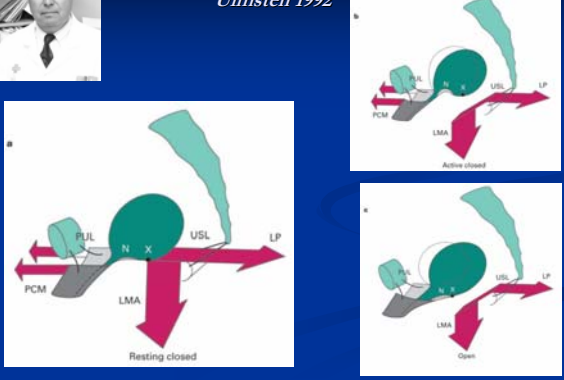

■ Explains why hypermobile urethras can still be continent

**Hammock Hypothesis**  
 John DeLancy 1994

■ Urethral support is not only factor involved in stress incontinence

- Acknowledged Constantinos observation of a possible NM reflex contributing to ↑ urethral pressure
- Greatest ↑ pressure in mid-urethra
  - Abdo pressure transmitted mostly to prox urethra

**Integral Theory**  
 Ulmsten 1992



## Integral Theory

Ulmsten 1992

- Integral theory
  - suggests pelvic muscles play a more active role in maintaining continence (vs suburethral hammock)
  - Tries to explain etiology of urge incontinence in SUI

## Integral Theory

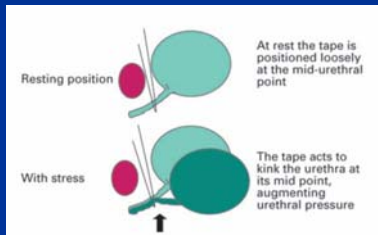
Ulmsten 1992

- “stress and urge symptoms arise from same anatomical defect...”
  - Lax anterior vaginal wall
    - Activation of stretch receptors in bladder neck and proximal urethra...triggers inappropriate micturition reflex...urgency, frequency
    - Does not allow efficient transmission closure pressure by 3 separate closure mechanism

## Integral Theory

Ulmsten 1992

- TVT re-establishes integrity of pubo-urethral ligaments



## Putting it all together...

- Hypermobility/Rotational descent
  - ISD
  - Suburethral support
  - Integrity of configuration
    - -introduce concept of
- “incontinence threshold” and “shear force”**

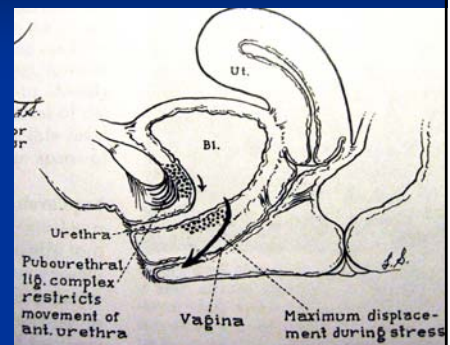
## Incontinence threshold



- Pubourethral ligaments tether anterior portion of urethra
- Kinetic energy of anterior vaginal wall pulls the posterior urethral wall away

- Shear forces pull's bladder neck open depending on...

- Configuration of urethra
- Intrinsic sphincter fxn
- Transmission of pressure
- Integrity of configuration



*Pathophysiology of SUI*  
**Conclusions**

- SUI is NOT a single factor disease but a spectrum of complex anatomical and physiological disorders based on central and peripheral control mechanisms
- Physiology of continence in women is MULTIFACTORIAL,  
-so is the pathophysiology of SUI

*Pathophysiology of SUI*  
**Conclusions**

- “Continence Threshold”
- -incontinence occurs when this “threshold” is overwhelmed



*Pathophysiology of SUI*  
**Conclusions**

- a **shearing effect** occurs at **continence threshold** when:
  - Urethral walls are separated (position/hammock)
  - Urethral washer is damaged (ISD)
  - Support structure is damaged (hammock, PUL)

*Pathophysiology of SUI*  
**Conclusions**

- We need to adapt a more holistic view of SUI
- The “Trampoline Theory”



**The  
Trampoline  
Theory of  
Female  
Continence**

- **Predispose** (gender, race, **anatomic**, neurologic, collagen)
- **Incite** (childbirth, radiation, nerve damage, surgery)
- **Promote** (constipation, occupation, smoking, COPD, obesity, infection, meds)
- **Decompensate** (aging, dementia, decreased mobility)

