Evidence of Common Pathophysiology Between Stress and Urgency Urinary Incontinence in Women

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Abstract. *Background/Aim:* Urinary incontinence in women is commonly categorized as stress urinary incontinence (SUI) and urgency urinary incontinence (UUI). SUI occurs due to an increased intra-abdominal pressure caused by an unstable anatomical outlet of the bladder and can be successfully treated surgically. UUI, a combination of a symptom (urgency to void) and urinary incontinence, is considered to be caused by a neurological dysfunction of the bladder. Current treatment options can reduce the feeling of urgency, but effects on restoration of continence are less impressive. However, surgery for pelvic organ prolapse reduction leads to cure UUI, indicating a critical role of pelvic anatomy in the etiology of UUI. We hypothesized that incontinence in patients with UUI is caused by an anatomical instability at the bladder outlet leading to incontinence even under minor physical stress exerted on the bladder base. *Patients and Methods:* Patients with UUI symptoms were asked to specify exactly when (in which body position) they involuntary lose urine after the feeling of urgency to void. *Results:* In total, 569 patients were evaluated between 2012 and 2020. Overall, 96% of the patients lost urine when they got up from a sitting position on their way to the toilet. Of the total study patients 3% lost urine already in the sitting position when they felt the urgency to void. *Conclusion:* The current treatment options for UUI are based on the hypothesis that UUI is a neurological disorder. This study demonstrated that urinary incontinence in patients with UUI is dependent on an intact

anatomical stability of the urethro-vesical junction under pressure. Therefore, treatment modalities should focus on the anatomical repair or support in that area.

Urinary incontinence (UI) in women is commonly divided into stress urinary incontinence (SUI) and urgency urinary incontinence (UUI) (1). SUI is the term for loss of urine during coughing or sneezing or any other respective activity which exerts pressure on the bladder. SUI occurs when the exerted pressure (stress) on the bladder neck is strong enough to open the outlet to the urethra, this is the urethro-vesical junction (UVJ). Tension-free vaginal tapes (TVT or TOT) or tightening of the upper vaginal wall (Burch operation) will exert a counter-pressure in these situations and thereby lead to urinary continence (2-4).

By contrast, UUI is the uncontrolled loss of urine after a short moment of urgency to void without clinically impressive pressure on the UVJ. The close association of a shortened time interval between the feeling of urgency and the subsequent involuntary loss of urine led to the hypothesis of a neurological disorder of bladder functioning and innervation (5).

Several treatment modalities have been developed for the treatment of UUI, ranging from various medications like anticholinergic agents to invasive treatment options like botulinum toxin A injections or sacral neuromodulation (SNS), resulting in a 'chemical denervation' of the bladder affecting the sensory processing in the spinal cord, respectively (6, 7). The results of these treatments, however, are ambiguous. These treatment options rather reduced the feeling of urgency than result in a permanent restoration of urinary continence (8). In most patients only a reduction of "incontinence episodes" was reported, but the effects on urinary incontinence were less impressive (6-11).

The fact that these UUI treatment options cannot affect urinary incontinence in the majority of patients challenges the hypothesis that UUI is a purely neurological disorder. We, therefore, focused our interest on the involuntary loss of urine in these patients. Two observations led us to hypothesize that changes in the anatomical outlet of the bladder (in the region of the UVJ) are important for urinary continence in these

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Key Words: Urgency urinary incontinence, stress urinary incontinence, OAB wet, involuntary loss of urine.

Figure 1. Flowchart of the 569 evaluated patients in the study. Distribution of urinary incontinence symptom “involuntary loss of urine” according to different body positions. TOT, Transobturator tape; TVT, tension-free vaginal tape; ITT, intention to treat; PP, per protocol.

patients. First, there is a ‘co-existence’ of UUI and the presence of pelvic organ prolapse (POP) (12). Studies have shown that surgical correction of POP also restored urinary continence (13, 14). Nevertheless, the applied surgical techniques for prolapse reduction were strongly dependent on the surgeon’s own discretion and therefore comparison of clinical outcomes with respect to UUI is difficult. Consequently, it cannot be determined which step was important in becoming continent again. However, these operations have one thing in common: the elevation (tensioning) of the upper vagina. We interpreted this effect on urinary incontinence as a stabilization of the UVJ.

The second observation was the fact that quadrupeds are usually not incontinent. There is a striking difference in the physiological anatomical position of urethra and bladder in humans and animals. In quadrupeds the bladder lies below the urethra and the UVJ. Up to a certain point, filling of the bladder probably exerts no pressure on the UVJ. However, in humans it is the other way around. The bladder lies above the urethra and the UVJ. Therefore, filling of the bladder will cause increasing pressure on the UVJ. Thus, urinary continence must be dependent on an effective closing mechanism of the bladder outlet.

In this study, we focused on the hypothesis, that urinary incontinence in women with UUI is caused by the pressure (stress) exerted on the UVJ. We, therefore, decided to survey patients with UUI not only about the symptoms of urgency to void, but also when and under what circumstances they involuntary lost urine.

Patients and Methods

Women with urinary incontinence who presented at the University Hospital of Cologne, Department of Obstetrics and Gynecology, between April 2012 and December 2020 were surveyed for urinary incontinence symptoms. The diagnosis of urinary incontinence was established according to the recommendations of the International Continence Society (ICS) using established and validated urinary incontinence questionnaires (15, 16). Urodynamic measurements were not performed in all patients.

Further, all patients were additionally advised to perform a micturition protocol and a specially-designed bladder diary for 12 days, existing of questions highlighting UUI symptoms. All patients were then asked to show up at a follow-up appointment two weeks after, for clinical examination and personal interview. In order to avoid misinterpretation or misunderstanding, the questions used in

these bladder-diaries were described clearly and described everyday situations.

The following questions were asked and the situation was elucidated to the patients as following:

“Imagine you are watching the news on TV. Suddenly you feel the need to void urine. What do you do?”

a) I can watch the news until the end. Then I go to the toilet without any loss of urine.

b) I need to go immediately. However, most of the time, I can reach the toilet without loss of urine.

c) Even when I go immediately, I lose urine on my way to the toilet.

When patients answered that they lost urine on the way to the toilet, they were further asked to specify when they lose urine after the first feeling of urgency to void:

1) ..when still sitting on the chair?

2) ..when sitting up from the chair?

3) ..when walking to the toilet?

4) ..when sitting down on the toilet?

5) ..any other occasion?

The corresponding answers were documented in a documentation sheet and electronically. The interviews were conducted by the first and second author and documented accordingly.

This study was approved by the Ethical Committee of the Medical Faculty of the University of Cologne, Germany (Approval No.: 20-1080). Data analysis was done using Microsoft Excel.

Results

Of a total of 645 women with UI who presented at our tertiary Center for treatment of their urinary incontinence, 569 could be evaluated (Figure 1). Pertinent data of all included patients are given in Table I, mean age of the patients was 62 years (range=34-92), most of the patients (85%) were between 50 and 75 years of age at the time of their survey.

Out of the 569 patients included in the analysis, 20 patients (4%) reported urine loss while still lying in bed or when sitting up to get out of bed. The majority of patients (549 patients, 96%) reported involuntary urinary loss during various physical activities. Divided further, 134 (24%) reported urinary loss when standing up from a sitting position in order to walk to the toilet. Involuntary loss of urine while walking to the toilet was reported by 415 (73%) patients. Sixty-eight of these 415 patients stated to lose already a small amount of urine as soon as they stood up from a sitting position. None of the patients stated to lose urine in the sitting position.

Discussion

Thus far, UI is defined as the involuntary loss of urine associated with a sudden and compelling desire to pass urine (1). A causal relationship is believed to exist between the symptom of urgency and the immediate loss of urine, where the feeling of urgency to void is the cause and urinary loss

Table I. *Clinical characteristics of 569 patients with urgency urinary incontinence and involuntary loss of urine.*

Characteristic	Value
Age, years (range)	62 (34-92)
Body mass index, BMI (range)	29 (18-41)
Parity (range)	2 (0-11)

the effect. Therefore, UI is considered a neurological disorder and treated accordingly (5).

The results of this study challenge that hypothesis. A total of 96% of the patients with UI lost urine involuntarily only during physical activities (stress-related) when getting up from their sitting position or when walking to the toilet, only 3% of the patients in the supine position and none of the patients when remaining in the sitting position.

Considering what happens with changing body positions (*e.g.* from lying in bed to sitting, standing up and walking), the anatomy and the vertical vector of a full bladder and the pressure exerted along this vector have to be taken into account. The urgency to void is induced by stretch receptors at the bladder base at the UVJ. When the bladder fills to a critical point, these receptors are stimulated and induce a feeling of urgency to void. Until then, the patient does not lose urine. However, when bending forward, getting up from the chair, or walking to the toilet the patient loses involuntarily urine and becomes incontinent.

In a recent study, urodynamic studies were performed in patients with UI in changing body positions [in sitting position, getting up (from sitting) and walking]. When changing body position from sitting to standing the urethral closure pressure diminishes significantly, leading to urinary incontinence. The authors arrived at the conclusion that the urethral closure mechanism is impaired in patients with UI (17).

Considering the urinary incontinence in these situations (different body positions) as a consequence of increased pressure on the UVJ seems reasonable (“vector-pressure hypothesis”). In the lying position the central vertical vector is directed towards the sacral vertebrae. When sitting up, the vector of the full bladder moves towards the UVJ. In the sitting position, a counterpressure (*via* the perineum and its connective tissue and muscles) to the bladder-outlet is exerted, like when the patient “tightens her buttocks”, which prevented the loss of urine (18). When getting up from a sitting position, the pressure of a full bladder exceeds the counterpressure from the pelvic tissues or muscles, resulting in involuntary urinary loss. In the standing body position and when walking, the vertical vector is directed towards the UVJ. Urinary incontinence results due to a diminished closing mechanism of the bladder (pressure-counterpressure) (Figure 2).

Figure 2. Schematic drawing of the pressure-counterpressure exerted on the urethro-vesical junction (UVJ) at different body positions and different urinary continence and incontinence forms. This figure was inspired by the drawings of J.O. DeLancey (24).

Already in the early 1990s, Ulmsten and Petros described the reason for urinary incontinence as a defect of the holding apparatus, especially the pubourethral and uterosacral ligaments (19-23). In 1994, DeLancey described the anatomical changes in the area of the UVJ as “funneling” and interpreted that as the reason for urinary incontinence (24).

The timeline of development of urinary incontinence in women suggests a chronological progression (“pathophysiological continuum”). Urinary incontinence starts with urinary loss under heavy pressure exerted on the UVJ. The pathophysiology continues as loss of urine under continually diminishing pressure on that area. Urinary continence or incontinence is then a balance of pressure and counterpressure in the region of the UVJ. Therefore, medical treatment can affect urgency but urinary continence should be achieved by an anatomical support of the UVJ (25-29).

Conclusion

The current treatment options for UUI are based on the hypothesis that UUI is a neurological disorder. This study demonstrated that urinary incontinence in patients with UUI is caused by stress exerted on the UVJ. If the pressure exerted on the UVJ exceeds the counterpressure of an intact UVJ the patients loses urine. Treatment of urinary incontinence must therefore focus on the anatomical repair or support in that area.

Conflicts of Interest

W. Jäger and S. Ludwig received travel bursaries from FEG Textiltechnik mbH Company (Aachen, Germany). E. Neumann and P. Mallmann declare that they have no conflicts of interest in regard to this study. There was no funding of this study.

Authors' Contributions

WJ: Manuscript writing, project development, and data collection, statistical analysis. SL: Manuscript editing, data collection. EN: Data collection. PM: Project development.

Acknowledgements

The Authors would like to thank Mrs. Elke Neumann for her support. Without her continuous and meticulous documentation, such an analysis would not have been possible.

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Received June 8, 2020

Revised June 30, 2020

Accepted July 1, 2020