An analysis of rapid pad testing and the history for the diagnosis of stress incontinence

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Two rapid exercise pad tests, the vitamin B test, and the methylene blue test, are introduced for the diagnosis of urinary stress incontinence. The vitamin B test is entirely non-invasive, takes only a few minutes to perform, and is especially useful as an office test. The methylene blue test has fewer variables, and fits easily into a urodynamic routine. With the methylene blue test, a direct correlation was noted between amount of urine lost and pressure generated by the tests. This conforms to the definition of stress incontinence as a passive process. The sensitivity of the test in a group with mainly mixed symptoms was 89.5%, and the specificity 100%. The test is useful where objective diagnosis of stress incontinence is important.

A group of 38 patients with a history (questionnaire) of stress incontinence exhibited a total of 105 positive individual symptoms out of a possible 228 symptoms (6 x 38), comprising a history of leaking at sneezing, coughing, exercise, laughing, walking, or bending. The individual symptoms were analyzed for accuracy and predictability by comparing them with six graded provocative exercises comprising a trampoline test, star jumps, coughing, stepping, bending and hand washing. The symptoms were graded into a hierarchy from the results. A history of stress incontinence was found to be an accurate determinant of stress incontinence, even in patients with mixed symptoms. This allows the questionnaire as presented to be used as a semiquantitative index for assessment purposes.

Key words: rapid pad test; stress incontinence; history

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Pad tests potentially offer a cheap, simple, and accurate method of diagnosing urinary incontinence. The most accepted 'short' pad test, ICS (1), lasts 1 hour. This test is non-invasive, comprising a 30 minute elapsed schedule. It consists of the following: standing up from sitting x 10, coughing vigorously x 10, running on the spot for 1 minute, bending to pick up an object from the floor x 10, washing hands in running water for 1 minute. Jorgensen et al. (2) noted a good correlation with the patient's historical assessment with the ICS test during pre and postoperative assessment of 18 patients undergoing the Burch colposuspension operation for stress incontinence. The reproducibility of pad tests was reviewed by Kromann-Andersen et al. (3). They found that the ICS test was not consistently reproducible by all authors. Jorgensen et al. (2), showed that more...
P. E. Papa Petros and U. Ulmsten

Table I. 38 patients with 105 stress incontinence symptoms

<table>
<thead>
<tr>
<th>Individual symptom and incidence of urine loss within the 38 pts</th>
<th>No. of pos. pad tests per symptom (exercise test abbreviations as in Fig. 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T</td>
</tr>
<tr>
<td>Sneeze</td>
<td>35</td>
</tr>
<tr>
<td>Aer/sport</td>
<td>19*</td>
</tr>
<tr>
<td>Cough</td>
<td>28</td>
</tr>
<tr>
<td>Laugh</td>
<td>10</td>
</tr>
<tr>
<td>Walk</td>
<td>9</td>
</tr>
<tr>
<td>Bend</td>
<td>4</td>
</tr>
</tbody>
</table>

* Only 21 patients played sport/acrobics.
+ Urge symptom provoked, pad loss in 2.

LEGEND

T = trampoline jump
C = coughing
SJ = star jumps
S = stepping × 20
FL = picking object from floor (bending)
HW = hand washing

Table I is a clinical reference table useful in assessing preoperative disability, and post-operative improvement using 1. the severity of the symptom; and 2. the pressure generated by the activity. If the patient's symptoms disappear on moving from the bottom (low pressure symptom), to the top (high pressure) left-hand vertical column, then the SI has improved. Similarly, if the patient can perform the graded activities from low pressure, (right hand side to left of the top horizontal column) without wetting, then also the SI has improved.

Interpretation of this table Correlation of pad tests (horizontal axis) to symptoms (vertical axis), was made as follows: the files of all 10 patients who gave a history of wetting with laughter, for example, were set aside. The number of individual positive exercise tests in these patients was now able to determine. e.g., nine patients leaked during the trampoline test, four on coughing, five on doing star jumps, three on stepping on a step 20 times etc.

urine leakage could be demonstrated by pad test than by videocystourethography (VCU), though others including Versi (4) have reached different conclusions. Such comparisons are difficult, as the ICS test does not specify that it specifically diagnoses stress incontinence. Comparisons with other pad tests may also be misleading. Short pad tests and 24 hour pad tests measure different things, the 24 hour test more accurately reflecting the severity of a patient's incontinence symptoms, Victor (5). Krommann-Andersen et al. (3) address some of these problems in their 'future recommendations'. They recommend analysis of the different types of incontinence separately. We identify another problem with existing pad tests: they are tedious and time-consuming, taking a full hour to perform. Even with an average age of 55 years, 10% could not complete the test, Jorgensen (2).

The value of the history in the diagnosis of stress incontinence (SI) has been disputed. Sand, Hill & Ostergard (6) found that a patient's history was a poor predictor of the underlying cause of incontinence. Farrar (7) showed that the history was accurate as a diagnostic parameter, though not in patients with mixed symptoms.

This paper sets out to assess 1. The validity of a 'rapid' pad test in the diagnosis of stress incontinence. 2. The validity of the patient's history.

Materials and methods

The population studied consisted of 46 patients with symptoms of urinary incontinence. The mean age was 43 years, (24 to 67). Mean parity was 3 (1 to 7). Mixed symptoms of stress and urge incontinence were present in 26 patients, pure SI symptoms in 12 patients, whereas 8 patients had symptoms only of urge incontinence. Two control groups were used. The matched group comprised 32 multiparous continent women (mean age 41, parity 2.4) presenting with other minor gynecological disorders not affecting the lower urinary tract. This group was used in the statistical analysis. The unmatched group com-

38 patients with SI symptoms.

### Methyline blue pad test

The protocol for the methylene pad test was that the patient emptied her bladder, was catheterised and residual urine measured. Three-hundred ml of normal saline containing half an ampoule of 1% methylene blue was then run into the bladder at a rate of 100 ml/minute. The patient’s vulva was wiped, a pre-weighed pad was applied with a plastic liner and the following exercises were performed over a space of 3–4 minutes.

1. Coughing ten times.
2. Picking up a pen off the floor 10 times.
3. Handwashing for 30 seconds.
4. Stepping up and down on a simple step 20 times.
5. 10 star jumps (scissor jumps).
6. 10 Minitrampoline Jump. The patient was supported under each elbow and instructed to jump as high as possible. If there was no leakage with 10 jumps, the test was repeated with 20 jumps. This was needed on 3 occasions in patients who had only occasional symptoms of SI.

At the end of each test, the pads were weighed on a Munakumi beam scale with 100 gm capacity and sensitivity of 1 in 1000 (0.1 mg). If urine loss was felt during a test schedule, the exercise was stopped and the pad examined and weighed. Any pad staining was considered to be a positive result. If urine loss continued on cessation of the exercise, the patient was excluded from the sample on the basis that the urine loss could not be caused by stress incontinence, as it was not coincident with the increase in intraabdominal pressure. The vulva was carefully dried before proceeding.
Table I. Sensitivity, specificity, and predictive values of 105 individual incontinence symptoms in 38 patients

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Sensitivity (a/a + c)</th>
<th>Specificity (d/b + d)</th>
<th>pos. pred. value</th>
<th>neg. pred. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sneeze</td>
<td>88.6%</td>
<td>90.6%</td>
<td>74.9%</td>
<td>96.2%</td>
</tr>
<tr>
<td>Ac/Sport</td>
<td>100%</td>
<td>90.6%</td>
<td>76.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Cough</td>
<td>96.4%</td>
<td>90.6%</td>
<td>70.7%</td>
<td>99.1%</td>
</tr>
<tr>
<td>Laugh</td>
<td>90%</td>
<td>90.6%</td>
<td>41.2%</td>
<td>99.2%</td>
</tr>
<tr>
<td>Walk</td>
<td>88%</td>
<td>90.6%</td>
<td>38.5%</td>
<td>99.2%</td>
</tr>
</tbody>
</table>

a = true positive. b = false positive. c = false negative. d = true negative.

* The positive and negative predictive values were calculated using Baye's Rule, and the estimated frequency of symptoms 26%, Osborne (9).

The sensitivity of the ‘sneeze’ symptom was determined by objective testing is lower than coughing, in spite of the fact that historically, sneezing was associated with urine loss in 34/38 patients, more than any other symptom. We explain this as being due to insufficient pressure generated by the pad tests for the production of urine loss i.e., the gold standard used was likely to be inadequate.

**Vitamin B (riboflavine) pad test**

This was used in the 2 control groups as follows: Each patient took 50 mg riboflavine tablet on the morning of the test, drank 6 to 8 glasses of water, and presented with a comfortably full bladder. The pad was examined after each exercise for any dark yellow staining. The women were rejected as controls if the volume of urine passed at the end of the procedure was less than 300 ml.

With all tests, any pad staining signified a positive test. The number of positive pad tests as well as the actual weight of urine lost was recorded. So as to understand what pressures were generated with each exercise, and what was happening at the moment of leakage, pressure recording was performed simultaneously with a further pad test in 14 symptomatic and 5 asymptomatic patients using a thin 60 cm Camino fibre optic pressure cable, inserted to 6 cm from the external urethral orifice, and connected to a 420 digital recorder (Camino Laboratory, San Diego).

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**Results**

**Stress incontinence symptoms**

Out of a possible 288 individual SI symptoms (6 × 38), 105 symptoms were present, Table I. Out of a possible 288 possible individual positive exercise pad tests for SI (6 × 38), a total of 116 positive tests were recorded, Table I. The trend of pressure increase and therefore urine loss within each patient was consistent, Figs 1 & 2, Tables I & II. This permits the symptoms and exercises to be graded. The accuracy of the test for stress incontinence symptoms is statistically analyzed in Table III. Three of the matched continent patients lost urine with the trampoline test. On repeat questioning, all three admitted to a very occasional urine loss with a full bladder on sneezing. Thus the history as initially taken was inadequate in these patients. There was no urine loss in the nulliparous control group. Simple examination of Fig. 1 reveals that the number of positive pad tests correlates very well with the indicative pressures and urine loss recorded by the various exercises, Fig. 2.

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Table III. Sensitivity, specificity, and predictive values of the pad test, taking the collective symptoms as the gold standard

<table>
<thead>
<tr>
<th></th>
<th>Collective symptoms of SI (38 cases)</th>
<th>50% Filter applied to symptoms (now 21 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad Test Sensitivity</td>
<td>89.5%</td>
<td>95.2%</td>
</tr>
<tr>
<td>Pad Test Specificity</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Positive Predictive value</td>
<td>100%*</td>
<td>100%*</td>
</tr>
<tr>
<td>Negative Predictive value</td>
<td>96.1%*</td>
<td>98.2%*</td>
</tr>
</tbody>
</table>

* Calculated according to Baye's Rule and symptom frequency of 26%.

Urgency
Twenty of the patients with stress incontinence symptoms (54%) felt an urge within a few seconds of commencement of the handwashing test. In two patients it was uncontrollable, resulting in urine loss (average loss 38 gms). All patients, without exception, knew the moment any urine was lost and informed us so. None of the 8 patients with pure urge incontinence lost urine with the handwashing test.

Reproducibility
The first 18 patients with positive pad tests had their pad tests repeated on another day so as to check for reproducibility. The trampoline test was positive in 18/18, star jump test: 9/11, cough test: 6/11, step test: 2/2, floor test: 1/5 and handwashing: 0/2.

50% filtering of symptoms. (Appendix A)
The last column in Appendix A (does a symptom occur more than 50% of the time?) was aimed as a tool for filtering, and therefore semiquantifying of the symptoms, so that some estimate of the severity of the stress incontinence could be determined. For example, using Appendix A, 38 patients were diagnosed as having SI, and of these, 21 patients needed to wear a pad at least occasionally on going out. If the symptoms as listed in Appendix A were ignored if they did not occur more than 50% of the time, then the diagnosis of SI could now only be made in 21 patients, and not 38 as previously determined. Of these, 19 needed to wear a pad on going out.

Gold standards. (Table III)
As concerns the reliability of the pad test, all the 105 individual SI symptoms within the 38 patients were used as a gold standard for the pad test, Tables I & II, i.e. each symptom was considered to be absolutely reliable. The 5 exercise pad tests were compared individually against the individual symptoms Table I. It was reasoned that any false positive symptoms would reflect against the test.

As concerns the reliability of the history, Table III, the methylene blue pad test as described was taken as the gold standard against which the symptoms were compared.

Statistical calculations: These were based on the raw data in Table I using the matched control group.

Discussion
The validity of the history in the diagnosis of stress incontinence
The results of the six exercises within each patient were consistent with their history, Tables I, II & III. This suggests that the pad test as used was able to validate the various historical symptoms, even in patients with mixed symptoms. It is possible from these results to introduce the following hierarchy of symptoms, in descending order of pressure generated: sneezing, sport, coughing, laughing, walking, bending. This allows symptomatic semiquantification. With surgery, improvement (partial cure) may be deduced symptomatically when urine loss occurs only with a higher pressure symptom than occurred preoperatively. Table I may be used as a ready reference table for this.

Requiring symptoms to be present more than 50% of the time, Appendix A, improved the diagnostic sensitivity considerably, as can be seen by reference to Table II. It also brought a much higher correlation between the history of SI, and whether or not a pad was worn. We introduce this concept of filtering symptoms, i.e. ignoring them if they do not occur 50% of the time as a further means of semiquantifying the history.

Reproducibility
Our results agree with those of Fantl (10), that there is not adequate reproducibility within the individual patient. We do not entirely agree that the results cannot be used to give an objective index of improvement after operation. There is a maximum variation in urine loss possible for a given exercise within a given patient. If the patient is entirely cured, then there is no urine loss and no variation. If there is only partial improvement, the upper and lower limits of variation will still be decreased, so that a rough objective estimate of improvement is still possible. We believe that the major variables causing this poor reproducibility between tests are: 1. The potential for differing pressures generated, and 2. The variable effectiveness of the urethral and bladder neck closure mechanisms.

Rationale for two control groups
The pad test was able to unmask an apparent latent sphincter weakness in three out of 32 apparently asymptomatic matched control patients. The test was therefore either very sensitive, or inaccurate (not entirely specific), giving false positive results. The aim of the second control group was to be
was absolutely certain of the pad tests specificity, i.e. it was the integrity of the sphincteric mechanism which was being tested, not the patient.

Validity of the test

According to the ICS (1) a valid test for SI requires that the amount of urine lost should be due entirely to the intraabdominal pressure generated in the absence of a detrusor contraction. Thus any urine lost must be due to a passive process. It follows that the urine lost will be proportional to the pressure generated. In the present study, there was an almost precise relationship between urine loss and the strenuousness of the exercise, Figs 1 & 2, indicating that the test as performed was likely to be valid for the diagnosis of SI. Even though urine loss continuing after cessation of the test was excluded, there could, at least theoretically, have been a minor detrusor contraction component contributing to the urine loss during the tests. We address this question as follows: 1. The six individual pad tests were performed within the same patient, almost within the same time span. Any significant contribution by bladder contraction in each test would have skewed the results away from the linear relationship found, between urine loss and pressure generated, Figs 1 & 2. 2. Even the handwashing test, a provocative test for the micturition reflex, only provoked two cases of urine loss, though 20 instances of urgency were induced in the 38 patients, Table I. We interpret this urgency as an indicator that the micturition reflex was stimulated, but maintained in a suppressed state in 18 of the 20 patients. Thus urine loss associated with urgency in this test needs to overcome a threshold, and continues until suppressed, being identical with the micturition process. We believe that this threshold is induced by contraction of the pelvic floor. It is known that voluntary urethral contraction suppresses bladder contraction, Abrams (8). This is explained as the voluntary mechanism for 'holding on' 3rd closure mechanism, Petros & Ulmsten (9). We suggest that this is how the micturition reflex was suppressed and therefore no urine loss occurred. During exercise, the contraction of the abdominal and diaphragmatic muscles induce a reciprocal contraction of the pelvic floor muscles, Sturmdorf (11). This would provide continual support of the bladder base nerve endings from below, similarly suppressing the micturition reflex (9). Any urine lost during an exercise test would, therefore, be a purely passive process, needing to overcome the patient’s voluntary or involuntary closure mechanisms constricting the outflow channel. The results show that the amount of urine lost was dependent on the intraabdominal force applied, consistent with the definition of SI. This suggests that the test as performed was likely to be valid.

Explanation of urine loss continuing after cessation of the exercise tests

In some patients, the actual exercise induced a bladder contraction. According to a previously introduced theory, Petros & Ulmsten (9), during bladder neck closure, exactly the same events take place as in bladder neck opening, except that in the latter, the antesor portion of pubococcygeus reflexly relaxes, enabling levator plate contraction to open the proximal urethra. We hypothesize that the above patients had a deficient tethering mechanism for the proximal urethra; activation of the bladder neck closure mechanism pulled the bladder neck downwards and backwards opening the bladder and causing stress incontinence; at the same time it also stimulated the nerve endings at bladder base activating the micturition reflex, decreasing urethral resistance, and contracting the detrusor. In this way, urine loss continued after cessation of the exercise.

Comparison with the ICS test

When applying our results to the ICS pad test, we believe that the two principal reasons for the questions raised by Kromann-Andersen (3) as to ‘insufficient reliability’ of the ICS test, are that: 1. The ICS test does not precisely define what it is attempting to objectively measure; we believe that it primarily measures SI. 2. The majority of the ICS test activities generate low pressures, easily seen by comparing the ICS exercises coincident with ours (e.g. stepping, bending, coughing) with the more stressful exercises such as the trampoline test, Figs 1 & 2. We suggest that it is important to perform tests which generate a high intraabdominal pressure if objective diagnosis of SI is required, as the body’s voluntary and involuntary closure mechanisms (9) need to be overcome. We believe that performing the low pressure exercises is not useful for the diagnosis of SI, and only tires the patient unnecessarily. The results indicate that our test principally measures SI.

Significance of the ‘gold standard’ used for symptom assessment

Of the 38 patients with SI symptoms, 34 had a positive ‘rapid’ pad test. The poor correlation of history to objective findings found by other authors may be partly explained by the low diagnostic value of the gold standard used, the cough stress test, usually performed in an artificial situation with transducers in the anal and urethral orifices. Such circumstances
are usually not conducive to generating a high intraabdominal pressure, an essential factor in diagnosing SI. This point is well demonstrated in Table I. Among the 28 patients who reported SI with the cough symptom, only 12/28 demonstrated urine loss with the cough exercise test, 14 with the star jump test (SJ), and 27 with the trampoline test (T). Only 31/35 patients who reported wetting with the sneeze symptom lost urine during the trampoline pad test. This suggests that even the trampoline test could not generate sufficient pressure to provoke urine loss in all patients reporting wetness with the sneeze symptom.

Conclusions and recommendations

We suggest that the history as presented in Appendix A may be an accurate diagnostic parameter of stress incontinence, even in patients with mixed symptoms. An important aspect of Appendix A is its capacity for semiquantification, e.g. by grading the SI symptoms in descending order of pressure generated, recording whether a symptom occurs more than 50% of the time, and whether a pad is worn occasionally, sometimes or never.

If urine loss continuing after cessation of the exercise is excluded, then the pad tests as presented may also objectively accurately diagnose stress incontinence, even in the presence of mixed symptoms. The two pad tests can be simplified for most patients to just the cough and star jump tests. This reduces the time taken for these tests to literally 1 or 2 minutes. The trampoline test is useful where a strict objective diagnosis is required in doubtful cases. The methylene blue test allows assessment of residual urine and slots easily into a urodynamic routine. The vitamin B pad test is presented as a simple, objective, non invasive office screening test. Its major defect is that the bladder volume is variable.

Acknowledgments

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References


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Appendix A

PATIENT QUESTIONNAIRE

NAME:  
DATE:  
ADDRESS:  
DATE OF BIRTH:  
WEIGHT:  
NO. OF VAGINAL DELIVERIES:  
TELEPHONE:  
NO. OF CESAREAN SECTIONS:  

Describe in your own words your main urinary symptoms and duration:

All sections: Tick appropriate square ( ). Write extra details if you wish.

S. I. SYMPTOMS
Do you lose urine during: Yes No 50% or more
Sneezing ( ) ( ) ( )
Coughing ( ) ( ) ( )
Exercise ( ) ( ) ( )
Laughing ( ) ( ) ( )
Picking up objects off the floor ( ) ( ) ( )

STREAM:
Do you ever have difficulty starting off your stream? ( ) ( ) ( )
Is it a slow stream? ( ) ( ) ( )
Does it stop and start involuntarily? ( ) ( ) ( )
Can you interrupt your stream? ( ) ( ) ( )

URGE SYMPTOMS:
Do you ever have an uncontrollable desire to pass urine? ( ) ( ) ( )
If so, do you ever wet before reaching a toilet? ( ) ( ) ( )

Do you feel urgency while washing your hands or showering? ( ) ( ) ( )
Do you have pain while passing urine? ( ) ( ) ( )
In the morning do you wet before reaching the toilet? ( ) ( ) ( )
Do you pass urine or feel urgency during intercourse? ( ) ( ) ( )
How many times during the night do you get up to pass urine?—write number ( ) ( ) ( )
How many times do you pass urine during the day?—write number ( ) ( ) ( )

BOWEL SYMPTOMS:
Do you have problems emptying your bowels? ( ) ( ) ( )
Do you ever soil yourself (faeces)? ( ) ( ) ( )
Do you pass urine or feel urgency during intercourse? ( ) ( ) ( )

STREAM:
Do you ever have difficulty starting off your stream? ( ) ( ) ( )
Is it a slow stream? ( ) ( ) ( )
Does it stop and start involuntarily? ( ) ( ) ( )
Can you interrupt your stream? ( ) ( ) ( )

URGE SYMPTOMS:
Do you ever have an uncontrollable desire to pass urine? ( ) ( ) ( )
If so, do you ever wet before reaching a toilet? ( ) ( ) ( )

Do you feel urgency while washing your hands or showering? ( ) ( ) ( )
Do you have pain while passing urine? ( ) ( ) ( )
In the morning do you wet before reaching the toilet? ( ) ( ) ( )
Do you pass urine or feel urgency during intercourse? ( ) ( ) ( )
How many times during the night do you get up to pass urine?—write number ( ) ( ) ( )
How many times do you pass urine during the day?—write number ( ) ( ) ( )

SOCIAL INCONVENIENCE:
Are you 'moist' all the time? ( ) ( ) ( )
Do you leave puddles on the floor? ( ) ( ) ( )
Do you lose urine in bed at night? ( ) ( ) ( )
Do you have to wear a pad on going out? ( ) ( ) ( )

PREVIOUS OPERATIONS:
Have you had a hysterectomy, or vaginal repair (circle which)? when? __________ / NO
Have you had previous surgery for your incontinence? when? __________ / NO
Are you better or worse, (circle which) since? __________