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Clarification and Confirmation of the Effect of Volitional Pelvic Floor Muscle Contraction to Preempt Urine Loss (The Knack Maneuver) in Stress Incontinent Women

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Abstract

The aim of the study was to determine the immediate effect of timing a pelvic muscle contraction with the moment of expected leakage (the Knack maneuver) to preempt cough-related stress incontinence. Women performed a standing stress test using three hard coughs without and then with the Knack maneuver. Volume of urine loss under both conditions was quantified with paper-towel test. Two groups of women were tested: nonpregnant women (n=64) and pregnant women (n=29). In nonpregnant women, wetted area decreased from a median (range) of 43.2 (0.2–183.7) cm² without the Knack maneuver to 6.9 (range of 0 to 183.7 cm²) with it (p<0.0001); while in pregnant women it decreased from 14.8 (0–169.7) cm² to 0 (0–96.5) cm², respectively (p=0.001). This study confirms the effect from the Knack maneuver as immediate and provides a partial explanation for early response to widely applied pelvic muscle training regimens in women with stress incontinence.

Keywords

Urinary incontinence; Pelvic muscle training; Stress incontinence; Pelvic muscle education;
Kegel; Pregnancy

Introduction

We learned from an early pilot study¹ that selected older incontinent women can significantly reduce urine loss with coughing by volitionally contracting the pelvic floor muscles before and during a cough (see Figure 1a, re-graphed from the original data). The effect was apparent at an initial evaluation conducted at 1-week follow-up, far earlier than would be expected if the underlying improvement mechanism involved pelvic muscle hypertrophy. We distinguish the intervention of teaching women to tighten their pelvic floor muscles in preparation for a known leakage-provoking event from the intervention of teaching women to set aside time to contract the pelvic floor muscles as a repetitive exercise for strength development and enhancement of reflex response. We call the former the Knack maneuver and the latter Kegel's exercises. The term "Knack" was coined by Ashton-Miller in the original study¹ because the simple English word "knack" implies an adroit way of doing something, a trick or skill; in this case an adroit way of stopping anticipated leakage, but without attempting to permanently change actual physiology. Although the term "Knack" is now commonly used, this same maneuver is also known by many other names, for example: bracing, perineal lock², pelvic clutch, Kegel when you cough, squeeze when you sneeze, quick Kegel, muscle clenching, or voluntary pelvic floor muscle contraction in response to a specific situation³. Women who use the Knack maneuver often refer to it simply as "holding back" which is perhaps the most adept description. Terminology aside, the point is to distinguish momentary, volitional "holding back" (Knack) from that of exercising the same complex of muscles (Kegel's exercises). While both are arguably important, the goals are different, as are the underlying theories as to why these distinct training components might each assist women to overcome incontinence⁴.

Complicating our understanding about how and why pelvic muscle training reduces urine leakage is the fact that many research studies that report an emphasis on strength training also imply (or directly state) that the Knack maneuver was taught at the same time^{2, 5-9}. Thus, it is important to distinguish each component of training and document its contribution separately⁴. The purpose of this study was to validate the Knack maneuver as a specific component of pelvic muscle training and to determine its unique effect as a minimalist intervention.

Materials and methods

We approached the research question through two experiments: (1) testing response in women with long-standing incontinence under conditions of simple verbal instruction to "contract when you cough," as might occur during a brief routine visit to a primary care provider and, (2) under similar conditions, testing response in pregnant women when the weight of the gravid uterus is imposed on the bladder, creating a physiologically stressed continence mechanism. Both experiments used a pre-and post-test design, with the precondition being without the Knack maneuver and the immediately post-condition being with the Knack maneuver.

The Institutional Review Board (IRBMED) approved all procedures. Women were recruited in southeast Michigan through newspaper advertisements, fliers, radio advertisements, referrals from the local urogynecology community, letters to primigravid women identified by chart review, and networking. All participants gave written informed consent to participate. Experimental procedures followed the ethical standards for human experimentation established by the Declaration of Helsinki of 1975, revised in 1983.

In experiment 1, 65 women with either stress or stress-predominant mixed-incontinence symptoms participated as part of an ongoing parent study investigating the long-term effect

of the Knack maneuver (P50 HD044406). Women were excluded from the analysis reported in this paper if leakage was not found on any of the cough paper towel standing stress tests used in the clinic on first day of examination. Additional exclusion criteria included male gender, any vaginal or bladder-related surgery, currently pregnant or less than 1 year beyond the birth of a child, and any of the following conditions: spinal cord injury, multiple sclerosis, muscular dystrophy, cerebral palsy, chronic urinary tract infections, Alzheimers or other dementia, stroke, or uncontrolled diabetes. Demographics of the 64 women with valid data on the full testing procedures are shown in Table 1.

In experiment 2, 29 women (22 primigravid and 7 multigravid) were sub-sampled from a parent study on pregnancy and incontinence prevention (NR 04007, “Urinary Incontinence Prevention: Reducing Birthing Risk”). This randomized controlled trial focused on self-management practices to reduce the incidence of birth-related incontinence. Criteria for selection in this sub-analysis included the parent study criteria of a dry standing stress test at 20 weeks gestation, participation in a standing stress test at home at about 35 weeks gestation, and demonstrable urine leakage during a cough at 35 weeks gestation (de novo stress urinary incontinence). Additional exclusion criteria included prior surgery on the bladder or lower urinary tract or vaginal surgery, incontinence before becoming pregnant, problem controlling the bowels, prior miscarriage after 12 weeks of pregnancy, pregnant with twins, and any of the following conditions: spinal cord injury, multiple sclerosis, muscular dystrophy, cerebral palsy, more than three urinary tract infections per year. Demographics of the 29 women with de novo incontinence in pregnancy are shown in Table 1.

A quantified standing stress test known as the “papertowel test”¹⁰ was conducted by asking the woman to hold a tri-fold brown paper towel lightly against her perineum without applying pressure while coughing. Any resulting urine loss was quantified by circling the wetted area on the paper towel within 10 to 15 seconds for later calculation of area (see Fig. 2). A small drop resulted in an area of 0.5 cm width and 0.5 cm length (0.20 cm² when modeled as an ellipse). The towel saturated at a volume of 6 ml. A saturated towel was coded as the entire paper towel, which measured 9 cm width and 26 cm length (183 cm² when modeled as an ellipse). For convenience, and because it is easier to conceptualize urine loss as volume rather than area, the actual wetted areas were converted to milliliters of leakage according to a calibration chart ad modum Miller et al.¹⁰. The paper towels’ absorptive capacity was recalibrated for this study to check for any product manufacturing changes with consequent effect on the calibration curve; absorptive capacity was consistent with that reported previously¹⁰. A conversion chart to volume in milliliters is offered in Appendix A along with detailed instruction in conducting the paper-towel test. Suggested improvements on the paper-towel test have been reported¹¹ but were not available at the outset of this study. Hence, the original protocols were followed using the same brand of tri-fold paper towel (item #219–24 Handifold Towels; Fort Howard, Green Bay, WI, USA) as previously reported¹⁰. Original testing of the paper-towel test included four bench tests to calibrate and validate the paper-towel test for quantifying urine volume. In addition, test–retest was performed in eight women with proven stress incontinence on coughing. In the eight women tested, 85% of within-and across-visit comparisons of urine loss quantified by paper-towel test were within 1 ml¹⁰.

Intervention Procedures

In Experiment 1, women were prepared for the paper towel test by filling the bladder to 250 cc through a 10 Fr catheter. The 10 Fr catheter was removed and a standard dual-tip microtransducer catheter (either a GaeltekTM, Medical Measurement Incorporated, Hackensack, NJ or a MillarTM Model=Supc-7805 (ref 804–7129), size 8, <http://www.millarinstrument.com/products/uro/uro-uro.html>) was inserted in the upper

fornix of the vagina to measure the pressure produced by coughing. Because Experiment 2 involved pregnant women, filling was achieved by asking each woman to drink 2 glasses of water an hour prior to her paper towel test to avoid the infection risk of filling the bladder through a catheter.

In Experiment 1, women were provided with the verbal instruction to “perform your usual hardest cough three times,” and on the second paper towel test, to “now cough with the same intensity again three times but this time while attempting to contract your pelvic floor muscles at the same time.” No other preliminary instruction or training was provided.

In experiment 2, women were provided with brief training in the Knack maneuver in conjunction with a pelvic examination at their earlier 20-week gestation visit. The approximately 5 minutes of Knack training included teaching women how to contract the pelvic floor muscles and conducting a standing stress test with and without the Knack maneuver to document no incontinence at 20 weeks per parent study inclusion criteria. Cough pressures were measured using the same procedures as in experiment 1. The pregnant women were told the Knack maneuver may be useful in controlling urine leakage, should that symptom develop later in pregnancy. The training also encouraged women to routinely perform Kegel's exercises as well as develop the Knack habit of contracting the muscles during a cough or sneeze as preventive measures. We notified the women that a questionnaire about their practice of Kegel's and the Knack maneuver would be mailed to their home at 30 weeks with return envelop. Likewise, a self-administered paper-towel test kit would be mailed to their home at 35 weeks gestation with instruction for them to test for leakage just as we did in the clinic at 20 weeks gestation. The home paper-towel test included written instructions; pre-labeled paper towels, with paper towel #1 labeled “without muscles contracted” and paper towel #2 labeled “with muscles contracted”; a pen for circling any wetted area resulting or marking an X on a dry paper towel; a Ziploc bag for depositing the towels; and a mail-back envelope. Measurements of the circled area were made later by research staff. Details of the home paper-towel test are reported in Appendix B of this article.

Data Analysis

The data from the paper towel test were analyzed by reporting central tendency as median and range due to the skewed distributions of the measures as observed on histograms. Nonparametric statistical tests, Wilcoxon Signed Rank Test (for within group comparisons), and Spearman's rho (for correlation analysis) were used. $P < 0.05$ was considered statistically significant. The statistical software package SPSS 12.0 (SPSS Inc., Chicago, IL) was used for data analysis.

Mean difference and limits of agreement of cough pressures under the two conditions (without and with the Knack maneuver) were calculated using methods outlined by Bland and Altman¹² to investigate if cough pressure differed under the two conditions. The limits of agreement are equal to the mean difference $\pm$ twice the standard deviation of the difference; this makes it easy to interpret in the original units of measurement as 95% of the sample falling within these limits. A priori, we judged that ideally 95% of the sample should demonstrate cough pressure measures within 20 cm H₂O or less in order to conclude that differences in cough pressures performed without and with the Knack were at a variance level below that expected to influence leakage in any systematic way. The groups' mean difference in cough pressures was expected to hover near zero. In Experiment 1, cough pressures were estimated simultaneously with the testing scenario. In Experiment 2, we estimated cough pressures by analyzing the measures obtained in clinic at 20-weeks gestation.

Results

Experiment 1 (nonpregnant stress-incontinent women)

Of the 65 women with demonstrable incontinence, 1 had incomplete data on the paper-towel test and was thus excluded from the remaining analysis for this study. Approximately 49 (76.6%) of the women were able to reduce leakage during coughing by using the Knack maneuver; of these, 12 (18.8%) were able to eliminate leakage (Figure 3). Wetted area on the paper-towel test was reduced from a median (range) of 43.2 (0.2–183.7) cm² prior to verbal instruction in the Knack maneuver to a median of 6.9 (range of 0 to 183.7 cm²) immediately after instruction ($p<0.0001$) (Table 2). According to a calibration curve for this particular paper towel product¹⁰, 42.2 cm² wetted area is equivalent to 1.5 ml, and 6.9 cm² is equivalent to three drops. The scatter plot in Figure 1b shows the relationship between percent reduction and amount leaked on both cough sets for each patient. There was no correlation demonstrated between percent reduction and volume leaked on the cough sets performed without the Knack maneuver (Spearman rho = -0.032 , $p=0.802$).

Experiment 2 (pregnant women)

Twenty-three (79.3%) of the pregnant women with de novo stress incontinence at 35 weeks gestation were able to reduce leakage during coughing by using the Knack maneuver with 16 (55.1%) eliminating leakage completely (Figure 3). The wetted area was reduced from a median (range) of 14.8 (0–169.7) cm² without the Knack maneuver to a median of 0.0 (0–96.5) cm² when the Knack maneuver was used ($p=0.001$) (Table 2 and Figure 1c).

For the pregnant women, percent reduction did not correlate with amount leaked on the no-Knack coughs (Spearman rho = 0.207 , $p=0.281$). By questionnaire distributed at 30 weeks gestation, 21 (72%) of the women checked “yes” to the question, “Since your 20-week visit, have you ever intentionally contracted the pelvic floor muscles during a cough or sneeze to prevent urine loss?” Of the remaining eight women, five checked “no,” one skipped the question, and two had missing questionnaires. Similarly, in response to the question, “Since your 20-week visit, have you practiced pelvic floor muscle contractions?” Twenty six (90%) checked “yes,” 1 checked “no,” and 2 had missing questionnaires.

We also analyzed the amount of leakage and response to Knack by parity. Twenty-two of the 29 women in the sample who leaked were primigravid. Of these primigravid women, the median (range) wetted area was reduced from 11.6 (0–169.7) to 0 (0–68.9). Of these women, 63.6% were able to eliminate leakage entirely with the Knack maneuver. For the remaining seven women who were multigravid, median (range) wetted area was reduced from 20.4 (0–24.4) to 3.1 (0–35.8); 28.6% were able to eliminate leakage entirely. Statistical testing was deferred in these seven women as a distinct group due to small sample size.

Equivalency of coughs produced under no-Knack and Knack conditions

To determine if differences in cough pressures between the two cough series (without and with Knack) might explain the reduced leakage, we analyzed agreement between pressures produced on both sets of coughs. We used a sub-sample of the women in experiment 1 due to equipment failure ($n=10$), catheter slippage ($n=12$), and incomplete ($n=3$) or unknown reasons for missing data ($n=3$) interfering with data collection for 28 women. For the remaining 36 women in Experiment 1, the mean (SD) pressure for coughs without the Knack maneuver was 178.0 (55.6) cm H₂O, compared to mean (SD) cough pressures with the Knack maneuver, 176.4 (60.2) cm H₂O. This group's mean (SD) difference of 1.6 (15.9) cm H₂O was not significant ($p=0.541$). The lower and upper limits of agreement were -30.2 and 33.4 cm H₂O respectively, calculated as the group mean difference of 1.6 cm H₂O $\pm$

twice the standard deviation of the mean difference (2×15.9 cm H₂O). That is, while the group's mean difference was essentially zero, certain individuals differed in their cough sets by as much as 30 cm H₂O in either direction. Although this size difference was a bit beyond our a priori expectations of less than 20 cm H₂O, there was no bias in direction as to which cough was harder across the sample.

We could not measure the cough pressures at 35 weeks gestation because the data were obtained in the home setting using the self-employed paper-towel test. However, to provide a rough estimate in this sample of an individual woman's consistency in coughs with and without the Knack, we used the cough pressures obtained from the parent study at the 20-weeks gestation clinic visit as a proxy (Experiment 2). The mean (SD) difference in pressures between the cough sets without and with the Knack maneuver was -2.6 (21.7) cm H₂O, indicating slightly lower but nonsignificant mean (SD) pressures for coughs without the Knack maneuver, 144.8 (45.8) cm H₂O, compared to cough pressures with the Knack maneuver, 147.4 (47.5) cm H₂O ($p=0.27$). The lower and upper limits of agreement were -46.0 and 40.8 cm H₂O, respectively.

Discussion

Although extensive investigation on repetitive Kegel's exercises has been conducted over the past 60 years¹⁸, to our knowledge, this is only the second published report on the Knack maneuver as an isolated component of behavioral therapy. The leakage reduction demonstrates that this learned maneuver may provide at least partial explanation of response when it is embedded within other more comprehensive interventions. The results of significant leakage reduction under controlled conditions were demonstrated in two samples of women, those with long-standing incontinence and those with de novo incontinence.

Theoretical explanation of findings

The immediacy of the leakage reduction and its implications of the Knack maneuver as a contributor to leakage suppression are at least partially explained by prior findings from both anatomic and biomechanical work. Anatomically, the urethral support structures (the levator ani) and the urethra itself (external urethral sphincter component) are both made up of or include striated muscles: a type of muscle under volitional control. Active contraction of these muscles momentarily increases both stiffness in the underlying support of the urethra¹³ and pressure within the urethra to resist urine outflow^{14, 15}. The latter was demonstrated even amongst selected women with known loss of the pubococcygeal portion of the levator ani, suggesting that an effective Knack effort recruits the striated muscles of the urethra as well as the striated "lifting portion" of the levator ani (the traditionally targeted muscle of Kegel's exercises). Because of these mechanistic underpinnings, it is logical to also assume that resulting improvement in urethral closure pressure would yield an immediate reduction in leakage when women are told to contract the pelvic floor muscles at the moment of expected leakage. An as yet undocumented but potentially important additional mechanism may include suppression of detrusor activation¹⁶. Further investigation is needed.

Nonresponders

It is important to remember that about 20% of the women showed no reduction in leakage volume with use of the Knack maneuver. These women deserve particular attention; we speculate three possible explanations. First, it is possible that the underlying muscular structures for these women (urethral striated muscle and/or levator ani muscle) were underdeveloped, injured, or atrophied to such an extent that it was either not possible to perform an effective contraction, or contraction was possible but of insufficient strength.

Second, these women may have needed additional training or time to develop the skill and coordination necessary to produce an effective Knack maneuver during coughing. Ability to coordinate two muscle groups at one time (e.g., diaphragmatic excursion with pelvic muscle hold) may require supervised practice for some women; it is not particularly intuitive. Third, it is possible that a portion of the women already employed the Knack maneuver or experienced a maximal reflex contraction, such that when asked to “cough hard three times,” they were unable to refrain from contracting their muscles. If so, then no change would be expected on the next set of coughs when asked to employ the Knack maneuver concurrently, since both sets of coughs would have been performed with muscles maximally contracted. Indeed, the data collectors report that on certain rare occasions women did ask: “Should I try to hold back?” when instructed to perform their “usual cough.” When asked, the data collector responded: “Please perform this first set of coughs without trying to hold back,” but some women still indicated difficulty in doing so. That is, they had quite effectively instilled the Knack maneuver as a habit, or physiologically had a reflex response prior to entering the study, and yet still leaked. Unfortunately, these anecdotal reports were not systematically recorded in this study, so a precise percentage cannot be reported. These speculations deserve further investigation but were beyond the scope of this study. Larger studies are also needed to explore if there are particular patient characteristics, such as age, body mass index, parity, etc that might predict successful response to the Knack maneuver, but again this was beyond the scope of our current data.

Limitations

Limitations of this study include the following: (1) We did not evaluate prior knowledge of the Knack maneuver before initiating data collection. Although we discussed this possibility, we felt that asking the question, with an accompanying explanation of what we meant by “the Knack maneuver” might unduly influence the physiological testing, particularly for those women who were initially naïve about its potential effect. (2) We did not randomize order of performing the no-Knack and Knack-supported coughs. This was intentional, based on similar reasoning. (3) It could also be argued that women who leaked on the first coughs had lost enough urine that they would be expected to leak less on the second coughs simply due to decreased bladder volume. However, the appearance of high-volume leakage is typically unsubstantiated when actually measured on a singular event, such as during a standing stress test. For instance, it only requires about 3 ml of urine to leak through a standard pair of cotton underwear and only about 6 ml to saturate the paper towel that we used on standing stress test¹⁰. Leakage of the amount that would decrease a bladder volume by 20% (for instance losing 50 ml on a bladder filled to 250 ml) is an atypical occurrence and, even if it should occur, is not likely to be enough volume reduction to affect potential for high-volume urine loss on the next stressor event. By contrast, our study participants have often expressed worry about potential increased leakage on the second set of coughs, explaining that it often takes several coughs to elicit leakage. This suggests that our finding of less leakage with the Knack maneuver used on the second cough set may actually be a conservative finding. Some women (n=4) in the nonpregnant group of women (n=0 in the pregnant group of women) saturated the paper towel (greater than 6 ml leakage) on both cough series, without and with the Knack maneuver. Thus, some may have actually reduced leakage, but the paper-towel test was not sufficiently sensitive at high volumes to quantify this reduction. This again suggests that our reported findings of positive response to the Knack maneuver could be conservative. However, a therapy that still allows leakage of an amount that saturates a paper towel reflects incomplete treatment at best.

In our sample of pregnant women, multigravid women were less successful than primigravid women at eliminating leakage. We can speculate that multigravid women may have reduced physiological capacity compared to primigravid women due to residual pelvic muscle injury

from prior deliveries¹⁷, but the sample is too small to draw definitive conclusions. Thus, the Knack maneuver results obtained in this study may not be fully generalizable to multigravid women. Other limitations to the generalizability of the study are that the convenience sampling resulted in primarily highly educated and higher-income women in the study and low representation from minority groups. Additionally, there might be some question as to the equality of cough pressures between those performed without and with the Knack maneuver, since the difference for some individuals was as much as 35 cm H₂O (vs our a priori criteria of 20 cm H₂O). However, the difference was equally distributed with some individuals coughing harder on no-Knack coughs and others coughing harder on Knack coughs. Group mean differences were essentially zero.

Conclusions

Despite these limitations, the data suggest that an effective Knack maneuver is simpler to learn than previously realized. In fact, it seems it should be common sense: if one contracts the urethral and levator ani striated muscles just before and during the moment of a stressor event, one can prevent urine loss. Unfortunately, many women have not discovered this “hidden” self-care mechanism on their own. Thus, part of the mechanism by which Kegel's exercises may be effective for stress urinary incontinence could plausibly be the increased awareness and skill development of timing the contraction with the event that elicits leakage. The “timing” component has not been evaluated in any studies on pelvic muscle training, to these authors' knowledge.

This study does not address the potential for additive effects from more intensive therapies targeting strength and reflex response, especially for women with poor initial response to the Knack maneuver⁴. However, the decrease in urine loss volume immediately occurring on use of the Knack maneuver does support the hypothesis that this learned body mechanics skill provides at least partial explanation for improved continence status observed in many other studies following pelvic muscle training. This study on simple verbal instruction was meant to mimic what might be offered by a primary care provider within a brief clinical exam on a busy day, or within a group teaching or public health context. In the real world setting, we hope for follow-up with more complete teaching, which typically involves a different level of intervention and cost. In this study, we think of the Knack maneuver as almost a “public health” approach: simple instruction available to all.

Acknowledgments

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Appendix A

Look-Up Table for the University of Michigan Paper Towel Test

(please see Miller JM, Ashton-Miller JA, DeLancey JO. “Quantification of Cough-Related Urine Loss Using the Paper Towel Test” *Obstet. Gynecol.* 91:705–9, 1998.

(please direct questions to janismmm@umich.edu or jaam@umich.edu)

This Look-up Table was obtained from our data collated from tests using the brown paper towel, Item #219–24 supplied by Handifold Towel, Fort Howard Corp., Green Bay, Wisconsin, U.S.A.. Note: If you use a different paper towel, then you must calibrate it in the way described in the above article.)

Usage Instructions:

1. Ask woman to perform the test with a symptomatically full bladder. To achieve this ask her not to void for 2 hrs before visit, and drink 0.5 liters of water 1 hour before arrival. She should be able to void at least 100 mL after the test is complete.
2. First, have the patient dry her perineum thoroughly in the standing position.
3. Ask her to hold the a new towel lightly against her perineum.
4. Ask her to take a deep breath and cough “as hard as she can”. Repeat two more times
5. Take the towel and trace the wetted area with a ballpoint pen 10–15 s after conducting the test.
6. Using a metric ruler, measure in cm the length (a) and width (b) of the wetted area, and note the results on data sheet. You should measure these lengths to the nearest tenth of a centimeter, i.e, 3.1 cm).
7. To find the wetted area you will use the formula for the area of an ellipse. (As you will recall the area of an ellipse in Pi times half the length times half the width.) Hence you multiply the length (in cm) by the width (in cm), multiply that result by 3.14, and then divide the result by 4 to obtain the wetted area in units of square centimeters.
8. Now use the table below to look up the volume of urine corresponding to the closest value of area to that which you measured. If you wish you may interpolate between adjacent area values.
9. As an example, suppose you calculated the wetted area as 19.5 sq. cms. Then you use the table to find that the leakage volume was approximately 0.55 mls (equivalent to 11 drops from an eye drop pipette). If, for more accuracy, you wanted to interpolate the volume, then the volume would be = $0.55 + (0.60 - 0.55) * (19.5 - 19.2) / (21.2 - 19.2) = 0.5575$ which should be rounded to two decimal places, i.e. 0.56 mls)

Converting Wetted Area to Milliliters from the Paper Towel Test

Volume (mls)	Volume (Drops of Water)	Ellipse-Modeled Area * pi X radius lgth X width (units: square cms)
0.05	1	2.7
0.10	2	4.0
0.15	3	6.7
0.20	4	7.3
0.25	5	8.7
0.30	6	12.0
0.35	7	12.9
0.40	8	15.3
0.45	9	16.8
0.50	10	17.9
0.55	11	19.2
0.60	12	21.2

Volume (mls)	Volume (Drops of Water)	Ellipse-Modeled Area * pi X radius lgth X width (units: square cms)
0.65	13	21.7
0.70	14	25.0
0.75	15	26.6
0.80	16	27.9
0.85	17	29.3
0.90	18	32.5
0.95	19	33.8
1.00	20	33.6
1.25	25	39.9
1.50		
2.00		
2.50	50	68.2
3.00		
3.50		
3.75	75	84.3
4.00		
4.50		
5.00	100	95.7
5.50		
6.00		
6.25	125	108.5
6.50		
7.00		
7.50	150	171.2
8.00		
8.50		
8.75	175	165.8
9.00		
9.50		
10.00	200	170.7
11.25	225	168.4

**Provides a reasonable estimate

Appendix B: Home Paper Towel Test

Instructions

Home Paper Towel Test Kit

Contents:

Instructions

Two paper towels

A lined pad on which to lay the paper towels

An ink pen

A plastic bag to place the paper towels into

A return envelope

One hour before performing the paper towel test, empty your bladder and drink 16 ounces of water. After the hour has passed perform the test. Alternatively, perform the test first thing in the morning after sleeping at least 5 hours without emptying your bladder.

1. Lay the paper towels out on the white pad in numbered order.
2. The paper towels are labeled with your ID and the activity. Please add the date.
3. Use toilet paper or tissue to wipe away any vaginal secretions.
4. Starting with paper towel #1, hold the paper towel instruction side toward you lightly against your vagina. Be sure not to double the paper towel over onto itself, just hold it flat in your palm. Cough hard three times, really hard coughs please. (Without consciously contracting your pelvic muscles).
5. Lay the paper towel onto the white pad, (see picture on back) and right away outline any wetted area with the pen. If the paper towel is dry, just mark a large X on it.
6. Pat yourself dry with toilet paper again.
7. Using paper towel #2, repeat the test but this time try to contract and hold your pelvic floor muscles just before and throughout coughing.
8. Lay the paper towel onto the pad, and outline any wetted area, or mark with a large X if dry.
9. Put each towel into the ziplock plastic bag.
10. Mail the ziplock bag back to us in the envelope provided.

Many Thanks!

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Figure 1.

Degree of leakage volume reduction with use of the Knack maneuver in three different groups of women all with demonstrable stress incontinence: 1a) women over age 59 (data abstracted from Miller, 1998), 1b) nonpregnant women across the age spectrum, and 1c) pregnant women.

Figure 2.

Photo of paper towel test showing wetted area corresponding to 3 mL, 1 mL, and 3 drops of water when diameter of the wetted area is circled according to the protocol of 10 seconds after exposure to the liquid. The area outside the line represents absorption occurring after 10 seconds.

Figure 3.
Flow chart of leakage reduction with the Knack maneuver in Experiment 1 and Experiment 2

Table 1

Descriptive demographics for samples in Experiment 1 (Nonpregnant women) and Experiment 2 (pregnant women).

		Nonpregnant Women (N=64)	Pregnant Women (N=29)
Age: mean (SD)		57.9 (13.3)	31.5 (5.0)
Race			
	European American	81.2%	89.7%
	Asian American	9.4%	3.4%
	African American	7.8%	0%
	Other	1.6%	6.8%
Annual Income			
	< \$41,000 per year	39.3%	13.8%
	≥ \$41,000 per year	60.7%	86.2%
Education			
	< 13 years	11.3%	0%
	13–16 years	48.4%	42.9%
	>16 years	40.3%	57.1%
Parity			
	No births	5.0%	75.9%
	1 birth	20.0%	24.1%
	2 births	38.2%	0
	>2 births	36.8%	0
BMI: mean (SD) prepregnancy		28.1 (6.6)	22.6 (3.2)

Table 2

Median (range) of wetted paper towel before and after Knack maneuver instruction in nonpregnant (Experiment 1) and pregnant (Experiment 2) women

	<i>n</i>	Prior to Instruction (cm ²)	After Instructions (cm ²)	<i>p</i> Value
Experiment 1	64	43.2 (0.2–183.7)	6.9 (0–183.7)	0.0001
Experiment 2	29	14.8 (0–96.5)	0.0 (0–96.5)	0.0001