Physical Therapy
Journal of the American Physical Therapy Association

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PHYS THER. 2008; 88:1208-1217.
Originally published online September 4, 2008
doi: 10.2522/ptj.20070330

Case Report

Use of Transabdominal Ultrasound Imaging in Retraining the Pelvic-Floor Muscles of a Woman Postpartum

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[Ariail A, Sears T, Hampton E. Use of transabdominal ultrasound imaging in retraining the pelvic-floor muscles of a woman postpartum. *Phys Ther*. 2008;88:1208–1217.]

Background and Purpose. Postpartum stress urinary incontinence (SUI) often compromises a woman's ability to participate in normal daily routines or physical activities. Pelvic-floor muscle (PFM) training has been shown to be effective in improving urinary incontinence. Transabdominal ultrasound (TAUS) imaging is a new, noninvasive method for assessing the function of the PFMs. This case report describes the use of TAUS imaging in the strengthening of a patient's PFMs.

Case Description. The patient was a 29-year-old woman experiencing SUI with high-impact activities following a history of 2 vaginal deliveries, 1 resulting in a grade III perineal laceration. Intervention included PFM training with the use of TAUS imaging. A 1-year follow-up examination was performed to assess the long-term functional outcomes experienced by the patient. The patient's ability to maintain a PFM contraction during motor tasks was documented throughout the course of treatment to demonstrate her gain in PFM control.

Outcomes. The patient gained strength in her PFMs, enabling her to maintain a PFM contraction during various motor tasks. She was able to return to a running program with no SUI symptoms. Her satisfaction level was high at 1 year.

Discussion. The use of TAUS imaging was a helpful assessment and biofeedback tool for re-education and rehabilitation of the PFMs for this patient.

Incontinence that begins during pregnancy and persists following delivery negatively affects a woman's functional activity and quality of life. Some studies[1–3] have demonstrated a higher prevalence of stress urinary incontinence (SUI) in women who deliver vaginally compared with those who undergo cesarean section. Pelvic-floor muscle (PFM) weakness due to pudendal nerve or levator ani nerve injury sustained during vaginal delivery is thought to be a primary contributor to SUI in the postpartum population. Factors that may lead to pudendal nerve damage include multiparity, forceps delivery, an extended second stage of labor, high fetal birth weight, and third-degree perineal lacerations.[4] Vaginal delivery itself can result in injury to the pudendal nerve. Lien et al[5] demonstrated that during the second stage of labor, the pudendal nerve is stretched beyond the 15% strain threshold that is known to cause permanent damage. Fewer studies have examined the relationship between vaginal delivery and injury to the levator ani nerve. Wallner et al[6] argued that due to the anatomical position and the protection of the pudendal nerve by the levator ani muscle belly, the levator ani nerve is more prone than the pudendal nerve to damage during vaginal delivery. Either neuropathy can lead to a weakening of the PFMs.

The integrity and function of the PFMs also are affected by perineal trauma during labor and delivery. Third- and fourth-degree perineal lacerations have been associated with decreased strength (force-generating capacity) of the PFMs.[7] Fenner et al[8] demonstrated that women who sustain a third- or fourth-degree laceration in the PFMs and rectal sphincter during childbirth are more likely to have urinary and fecal incontinence. For these women, an incidence rate of 56% has been observed for either urinary or fecal incontinence.[9]

Several clinical trials have demonstrated that strengthening the PFMs can decrease SUI symptoms.[10–15] A study examining the effects of a 6-month PFM training protocol on the strength of the PFMs concluded that there was a positive relationship among overall strength increase, maximal strength of the PFMs, and improvement of SUI symptoms.[10] Another study[14] showed that women who completed a 3-month program of pelvic-floor exercises had at least a 50% reduction in the number of incontinence episodes experienced.

Pelvic-floor muscle exercise prescriptions applied across published studies vary with regard to frequency, intensity, and type of muscle contraction. A recent meta-analysis[16] reported that almost every published clinical trial addressing PFM training lacked some description of treatment parameters such as the number, frequency, or velocity of contractions, the length of training period, or the type of instruction provided. This lack of information creates difficulty for the clinician to follow a proven protocol. The meta-analysis concluded that future studies should include detailed reports of treatment parameters and should test these parameters in order to devise an ideal protocol that can be used for evidence-based interventions.[16]

In a Cochrane review, Hay-Smith and Dumoulin[17] discussed treatment parameters in greater depth, differentiating between strength training and endurance training of the PFMs. Characteristic parameters of strength training include a low repetition count with increased voluntary effort, while characteristic parameters for endurance training include a high repetition count or a prolonged contraction, with low to moderate voluntary effort.[17] Of the studies included in the review, treatment protocols were highly variable. The total number of PFM contractions performed per day ranged from 30 to 200, and the number of sets performed ranged from 3 per day to 1 per every waking hour. Contraction duration ranged from a few seconds to 12 seconds. Treatment protocols in most of the studies incorporated both strength training and endurance training within the parameters stated.[17] Due to the variance of treatment protocols in the literature, exercise progressions prescribed by the clinician currently are based on experience rather than on evidence.

Assessment and training of PFM strength can be performed by several methods, including verbal instruction alone, manual palpation, pressure perineometry, surface electromyography (EMG), and the newer technique of transabdominal ultrasound (TAUS) imaging. Verbal instruction alone has been shown to be less than 50% effective in the ability to learn a correct PFM contraction.[18] Surface EMG has the risk of cross talk from surrounding muscles, thus decreasing the reliability of the data. Reliability is further diminished due to variability in vaginal placement of the EMG electrode.[19] Pressure perineometry has a similar reliability issue with variability of vaginal placement of the device. Standardized comparisons also are difficult due to the number of different vaginal pressure measuring devices available.[19] Additionally, any change in intra-abdominal pressure (IAP) affects the measured pressure in the vagina.[19] This change in IAP poses an inherent problem for the use of pressure perineometry because Valsalva maneuvers increase IAP. Palpation is widely used to assess the PFMs clinically. However, there are more than 25 different palpation methods, along with several different grading systems.[19] Studies of the intrarater and interrater reliability of vaginal palpation strength measurements have shown conflict-

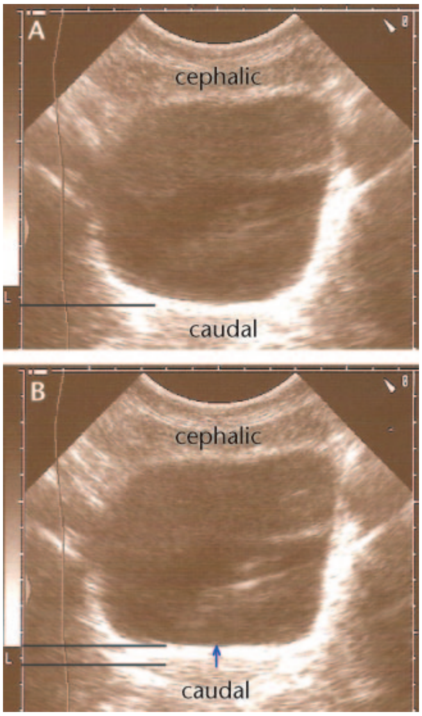

Figure 1.
Ultrasound image of a healthy bladder before (A) and after (B) a pelvic-floor muscle (PFM) contraction. The "L" indicates the left side of the patient's body. The vertical line seen in the ultrasound image is optionally used for alignment purposes and is not needed when visualizing the bladder. The horizontal lines were added at the level of the bladder base to emphasize the excursion of the bladder base upon contraction of the PFMs. Note the cephalic lift of the base of the bladder in Fig. 1B, as indicated by change in horizontal lines before contraction (bottom line) and during contraction (top line).

ing results.[19] Bø and Finckenhagen[20] found that the widely used Laycock modified Oxford grading system confirms contraction, but cannot reliably differentiate among weak, moderate, good, and strong contractions compared with vaginal squeeze pressures.

Transabdominal ultrasound imaging is a noninvasive procedure that images the base of the bladder, allowing a visual assessment of the excursion and function of the PFMs.[21,22] The TAUS image of a PFM contraction results in a vertical displacement of the base of the bladder, representing a cephalic movement of the PFMs[23] (Figs. 1A and 1B). Both interrater and intrarater reliability of TAUS imaging have been shown to be high.[23]

When imaging the PFMs with the use of TAUS, the anatomical data are presented in images of varying radiodensity. These images are based on the characteristics of tissue absorption of sound waves. The transducer head produces sound waves that enter the body through an aqueous coupling medium. The waves reflect off tissues, forming an image that is captured by the transducer and displayed on a digital screen. Mediums that lack density, such as urine, create a minimal reflection and, therefore, appear black on the screen. Denser tissues produce more of a reflection and generate images that vary in shades of gray and white, with the densest tissues appearing whiter.[24,25] The muscular wall of the bladder appears white, allowing the clinician to use the image to assess the excursion of the bladder base and, consequently, the function of the PFMs.

The imaging obtained by TAUS does not provide the clinician with a muscle strength grade, but rather visualization of a patient's ability to activate the PFMs enough to elevate the base of the bladder. Thompson et al[22] defined a "correct pelvic-floor contraction" as one that resulted in bladder base elevation as shown on an ultrasound screen, whereas a Valsalva maneuver resulted in bladder base depression. Sherburn et al[23] observed a consistent cephalic movement of the bladder base on the ultrasound screen when a correct PFM contraction was confirmed with digital palpation. However, they also found that the manual muscle test strength grade found with digital palpation did not correlate with the measurement of excursion of the bladder (in millimeters) on the ultrasound screen.[23] In light of these findings, in this case report, we operationally define a correct pelvic floor contraction as visible elevation of the base of the bladder in a cephalic direction, with movement that is symmetrical without the depression of the lateral aspects of the bladder base. A Valsalva maneuver is defined as visible depression of the base of the bladder, or caudal migration of the entire bladder. The purpose of this case report is to document the use of TAUS imaging in the assessment of PFM function, as well as its use as a biofeedback tool when training the PFMs of a postpartum woman with a history of multiple vaginal deliveries and subsequent SUI.

This report chronicles the examination, intervention, and short- and long-term outcomes of a woman who had a grade III perineal tear during vaginal delivery. The training activities were approved by the institutional review boards of Sargent College of Health and Rehabilitation Sciences, Boston University, Boston, Massachusetts, and United General Hospital, Sedro-Woolley, Washington. The patient gave written informed consent. This case report met the institutions' requirements of the Health Insurance and Portability and Accountability Act for the disclosure of protected health information.

Patient History

The patient was a 29-year-old, postpartum mother of 2 children with no major medical problems, no surgical history, no medications, normal menstrual cycles, and good physical fitness (body mass index=20.8 kg/m^2).[26] The patient's obstetrician/gynecologist noted she did not have any pelvic organ prolapse greater than grade 1. The patient reported having no pain in her back, pelvis, or lower extremities and that she had never used any type of pelvic-floor strengthening or retraining devices. Additionally, she was unfamiliar with Kegel exercises. She had a history of 2 pregnancies, each resulting in an unmedicated vaginal delivery. Both labors lasted approximately 24 hours, with 3 to 4 hours in the second stage of labor. Her first delivery of an 8-lb, 4-oz (3.74-kg) child resulted in a grade III perineal laceration. Her second child, weighing more than 10 lb (4.5 kg), was delivered with no perineal trauma 2½ years later. Following each delivery and throughout her second pregnancy, the patient experienced daily urinary leakage of a few drops, occurring during child care and household activities. Within 6 months of each delivery, the frequency of the leakage decreased to a few drops of urine leaked exclusively during high-impact activities such as jogging or during a cough with a full bladder. The patient reported increased urge with triggers of running water and cold. However, she never experienced incontinence as a result.

Due to the episodes of SUI, the patient felt significantly restricted in her ability to participate in an exercise program. After 44 total months of experiencing SUI symptoms, the patient sought treatment for her condition and was referred for physical therapy by her primary care provider. She was 11 months postpartum at the time of the initial examination and was not working outside the home.

Figure 2.
Position of the transabdominal ultrasound imaging transducer during the examination and intervention.

Examination

The examination included a medical history and review of the patient's symptoms using a 3-day bladder diary and a clinic-developed questionnaire (Tab. 1). This questionnaire was sent to the patient prior to the examination to allow her time to log her urinary habits. A comprehensive lower-quadrant examination, as described by Lee and Lee,[27] was performed to rule out other musculoskeletal impairments that might affect PFM function, including sacroiliac or pubic symphysis dysfunction. The patient's lower-quadrant, lumbar, and thoracic range of motion and strength were pain-free and within functional limits. No abnormalities in pelvic alignment were noted. There was no tenderness to palpation throughout the pelvis or low back. No shearing or positional shifts were felt at her pubic symphysis during an active straight leg raise or in a static lying position.

Transabdominal ultrasound imaging was used to evaluate the patient's PFMs. The patient was asked to follow a bladder-filling protocol modified from the World Health Organization guidelines[28] in an attempt to standardize the bladder size during TAUS imaging. She was instructed to void 1 hour before her appointment time and to drink 16 to 20 ounces of water 30 minutes before her appointment time without voiding again. The Siemens Sonoline Adara imaging system* was used during the examination with a 3.5C40S curved array, 40-mm transducer set at 3.5 MHz, per manufacturer's recommendations, to view the bladder. A transverse view of the patient's bladder base was used to allow for the assessment of any asymmetries in PFM excursion. To obtain this transverse view, the patient was positioned supine with the transducer placed transversely across the abdomen 5.08 cm (2 in) above the pubic bone, angled 10 degrees from the abdomen, and facing the perineal area (Fig. 2).

The patient's ability to contract her PFMs then was assessed. When she was instructed to think about drawing her vagina inward, no PFM contraction was visible. Instead, the patient's entire bladder was pulled caudally in a Valsalva maneuver. She then was instructed to repeat the contraction at a slower rate and at 50% effort in order to eradicate the Valsalva strategy. When the patient attempted a contraction again, she continued to perform a Valsalva maneuver. She then attempted various positions with an assortment of ver-

* Siemens Medical Solutions USA, 51 Valley Stream Pkwy, Malvern, PA 19355.

bal cueing by the therapist in attempts to attain a correct PFM contraction (Tab. 2). However, she continued to perform Valsalva maneuvers throughout the examination. Intravaginal assessment of the PFMs was not performed on this patient, but her primary care provider reported she did not have any spasm or point tenderness in the PFMs upon internal examination.

Intervention

The patient was seen in the clinic for 30-minute sessions, twice a week for 3 weeks, followed by once a week for 8 weeks. The frequency of treatment was determined by the patient's progress, notably an improved ability to isolate a PFM contraction with no Valsalva maneuver present. In all intervention visits, TAUS imaging was used to confirm activation of the PFMs and proper strategy for contractions. The ultrasound imaging also doubled as visual biofeedback for the patient until her kinesthetic awareness improved such that she could identify when she was correctly performing a PFM contraction.

Because of the lack of a specific evidence-based treatment protocol for strengthening the PFMs, the clinician chose the progression of exercises based on experience. A progression of exercises based on the principles of exercise progression recommended by Sahrmann[29] was incorporated into the treatment protocol. Sahrmann's general exercise principles were used due to the fact that the PFMs not only play a significant role in urinary continence but are critical to pelvic stabilization.[30] Incorporating the exercises described by Sahrmann into the treatment protocol provided successively more difficult challenges for the patient to address throughout the intervention. Additionally, the treatment protocol included both power training and endurance training of the PFMs by including both short contractions and longer-duration contractions. The inclusion of both types of training into the treatment protocol was intended to create a more thorough exercise routine and has been supported by recent a Cochrane review.[17]

Patient success was determined throughout the course of treatment by the ability to correctly perform each type of contraction 90% of the time without visual biofeedback provided by TAUS imaging. During the intervention, the patient initially learned to isolate a PFM contraction using various verbal cueing provided by the clinician. The patient initially used a synergistic contraction of the hip adductors to enhance a PFM contraction and periodically provided tactile perineal cueing to improve proprioceptive awareness. With continued treatment, the patient further strengthened her PFMs by increasing the number of repetitions she was performing as well as increasing the length of time each contraction was held. A stopwatch was used to time the length of contractions for consistency purposes. She further advanced the strength and endurance of her PFMs by progressing toward gravity-resisted positions for the PFMs and performing motor tasks while maintaining a PFM contraction. Additionally, the patient continued to challenge her PFMs by attempting to maintain a contraction with increases in IAP such as clearing her throat or coughing. In each successive treatment, the patient learned new exercises that were a progression from the previous treatment. Her home exercise program was based on the success of exercises performed during the clinic visit. To ensure patient adherence to the home exercise program, she was asked to maintain a log of home exercises completed. All exercises performed in the intervention and prescribed for the home exercise program are outlined in the Appendix.

Outcomes

At discharge, the patient no longer experienced SUI symptoms. She increased the time she was able to hold urine before voiding and decreased voiding frequency during the day and night. She was able to maintain a PFM contraction for 10 seconds continuously, as well as during motor tasks and high-impact activities. The patient was able to withstand increases in IAP without SUI symptoms. In addition, she met her personal goal of returning to a running program with no SUI symptoms. At discharge, the patient reported her satisfaction level with therapy on a visual analog scale as 10/10, with 0 being "no satisfaction" and 10 being "absolute satisfaction."

The patient was re-examined 1 year following her discharge to verify the long-term carryover in PFM strength. She completed a 3-day bladder diary and the identical questionnaire form used at her previous admission. She also completed a "functional continence with physical activity" questionnaire. This questionnaire compared the current status of her SUI symptoms during physical activities with her status at discharge 1 year previously. She experienced no medical changes over the year.

The patient reported that she experienced no SUI with normal daily activities. She admitted that she did rarely experience anxiety about the possibility of leaking if her bladder was full while jogging on a hard surface. When this occurred, she would perform PFM contractions while running in order to prevent leakage. She reported not having any wetness on her undergarments with these occurrences. The patient reported that running water was an urge trigger. However, she never experienced incontinence as a result.

An examination with TAUS imaging similar to that performed at the initial examination was completed. The patient was not permitted to view the ultrasound imaging, thus ensuring her performance was not influenced by visual feedback. She was able to contract her PFMs so that the base of her bladder was lifted in a symmetrical manner. She was able to hold this contraction for 10 seconds in various positions as well as during motor tasks and high-impact activities. The patient then attempted to hold a PFM contraction with increases in IAP while clearing her throat or coughing. She was able to maintain a PFM contraction while clearing her throat. However, when she coughed, the TAUS imaging verified a PFM deactivation through an involuntary drop in the base of the bladder. This inability to maintain a PFM contraction during a cough was a loss in ability since the time of discharge. A summary contrasting the results at the initial examination, at discharge, and at the 1-year follow-up is shown in Table 1.

Discussion

This case report demonstrates the clinical application of TAUS imaging to train the strength and endurance of the PFMs. We believe that using TAUS imaging as a biofeedback tool helped this patient attain her goal of participation in high-impact activities without urinary leakage. One year following discharge, the patient remained satisfied with her results and reported an 85% improvement compared with her status at the initial examination. She maintained her ability to activate and sustain PFM contractions during motor tasks. However, she lost the ability to maintain a PFM contraction with increases in IAP during a cough. Bø and Talseth[13] found that 5 years following the cessation of a 6-month pelvic-floor exercise program, there was a slight decrease in the strength of the PFMs and a slight increase in the rate of incontinence compared with immediately following the cessation of the PFM strengthening program. Despite this, 70% of the women remained satisfied with the state of their condition and did not desire further treatment.[13] This case report corroborates those findings.

Limitations of this case report include the use of a nonvalidated bladder questionnaire and the lack of manual assessment of the patient's PFMs. The patient did not desire to undergo an internal assessment of her PFMs and specifically sought treatment at our clinic to avoid this. The use of TAUS imaging allowed us the option to treat this patient and address PFM strengthening without internal examination. Prior to treatment, the patient's medical provider confirmed no problems with increased PFM tone, defined as velocity-dependent resistance to stretch exhibited by a muscle.

The rigorous strengthening program prescribed to this patient included many functional training activities. We believe that the majority of this patient's gains were due to her participation in the previously described exercise protocol. However, we maintain that using TAUS imaging was an integral part of this program. The biofeedback provided by TAUS imaging allowed the patient to learn to isolate a PFM contraction and allowed the clinician to assess and verify PFM activity in multiple positions throughout the intervention.

Transabdominal ultrasound imaging is relatively easy for a clinician to learn to use effectively. However, the clinical reliability and validity of images obtained by a self-taught clinician may not be comparable to those achieved in studies establishing the reliability and validity of using TAUS imaging in assessing PFM activity. In one of the studies examining the reliability and validity of TAUS imaging in assessing PFM activity, the data were gathered by a qualified sonographer rather than a physical therapist.[22] Other studies[21,23] used physical therapists to perform the TAUS assessments and demonstrated similar reliability and validity. Nonetheless, if TAUS imaging is to be an accepted tool for pelvic-floor assessment and training, there need to be a standardized educational curriculum and means to ensure clinician competence in TAUS imaging techniques. This training would decrease the number of operator errors and improve reliability of the data collection.

One advantage of TAUS imaging is that it allows for concurrent movement of the lower extremities, which is important when functionally training a woman's PFMs. Another advantage is that TAUS imaging offers a noninvasive option for physical therapists to use with patients for whom an internal PFM assessment is contraindicated or refused by the patients. However, internal PFM assessments provide different clinical data compared with TAUS imaging. Therefore, it is important to use TAUS imaging as part of a complete assessment including use of additional clinical assessment techniques as appropriate.

In some TAUS units, the degree of lift of the bladder base is measurable, in millimeters, by using electronic markers on the ultrasound screen.[21] This measurement ability allows the clinician to track progress made during a PFM strengthening program. Obtaining measurements through this method provides specific measurable progress of the individual patient's strength. However, Sherburn et al[23] found no correlation between the excursion of the bladder base measured in millimeters and the manual muscle test strength grade. Additionally, in order to provide a comprehensive functional training program for a woman's PFMs, muscle re-education should take place in various positions as well as during

Table 1.
Patient Characteristics, Symptoms, and Abilities at Initial Examination Compared With at Discharge and 1 Year Following Her Discharge Date

Characteristic	Initial Examination	Discharge	1-Year Follow-up From Discharge Date
Body mass index (kg/m^2)	20.8	20.8	20.8
Information gathered via 3-day bladder diary			
No. of times voiding during the day	6	4	4
No. of times voiding after going to bed	1 (2 out of 3 nights recorded)	0	0
Average amount voided (each void was measured in a collection container for 1 day, and the amount was averaged)	12–16 oz	16+ oz	16+ oz
Stress urinary incontinence	3 times total, once each day when jogging	No episodes recorded	No episodes recorded
Bowel movements	Daily, pain-free	Daily, pain-free	Daily, pain-free
Stress fecal incontinence	None	None	None
Information gathered via urinary incontinence symptom questionnaire			
Estimated average time between first sensation to void and need to empty bladder	15–30 min	31–45 min	31–45 min
Urinary stream	Strong, no difficulty initiating	Strong, no difficulty initiating	Strong, no difficulty initiating
Ability to stop urine stream	Unable to stop or slow the urine stream	Able to stop the urine stream	Able to stop the urine stream
Urge triggers	Running water and walking through the freezer section in a grocery store increase urge	Running water increases urge	Running water increases urge
Estimated frequency of urine leakage	3–5 times a week while lifting or playing with her children Consistently with high-impact activities, particularly running or jogging	None	Once every 3 mo with a full bladder; she becomes anxious about the possibility that she might have leakage while running on a concrete surface
Severity of urine leakage	Few drops, wets undergarments	None	Unsure if leakage actually occurs; no spots or wetness in undergarments
Protection worn	Panty liner	None	None
Limited activities due to stress urinary incontinence	Running, jogging, snow skiing, jumping with children, aerobics	None	None
Measurements gathered via patient questionnaire			
Severity (0–10)	8/10	0/10	0/10
"My bladder is controlling my life" (0–10, with 0 being "not true at all" and 10 being "completely true")	6/10	0/10	0/10
Information gathered via examination using transabdominal ultrasound imaging			
Pelvic-floor muscle (PFM) strength and endurance	Not able to contract her PFMs; Valsalva maneuvers performed	Able to contract her PFMs in an isolated manner and hold for 10 s with normal breathing, no abdominal or gluteal bracing, and no Valsalva maneuvers in supine and standing positions Able to maintain PFM contraction with motor tasks in supine and standing positions Able to hold a PFM contraction with jumps and stomps Able to hold a PFM contraction with increases in intra-abdominal pressure	Able to contract her PFMs in an isolated manner and hold for 10 s with normal breathing, no abdominal or gluteal bracing, and no Valsalva maneuvers in supine and standing positions Able to maintain PFM contraction with motor tasks in supine and standing positions Able to hold a PFM contraction with jumps and stomps Not able to consistently hold a PFM contraction with increases in intra-abdominal pressure
Improvement at discharge and at 1-yr follow-up via the Functional Continence With Physical Activity Questionnaire			
Patient was asked to rate her improvement, with 0% being her status at initial examination and 100% having no problem at all	0%	95%	85%

Table 2.
Visualizations, Assistance, and Positions Used in Attempts to Attain a Correct Pelvic-Floor Muscle (PFM) Contraction During the Examination

Variable	Instruction/Description
Verbal cueing provided by therapist in order to promote muscle contraction	Imagine lifting a tampon Think about cutting off the flow of urine Imagine pressure moving up the inside of your thighs into your perineum Tighten the inside of your vagina Lift your perineum Think about cutting off gas
Assistance provided in order to promote muscle contraction	Slower speed of contraction. This often helps to eradicate a Valsalva maneuver. Tactile cueing at her perineum to improve the proprioceptive awareness Use of synergistic muscles by activating hip adductors through a gentle ball squeeze
Exercise positions used in order to promote muscle contraction	Supine Unsupported hook-lying position with back in neutral and hips flexed to 60°. Hook-lying position allows some patients to achieve a more neutral spine position, which can help in performing a PFM contraction. Supported hook-lying position with legs propped on bolster, back in neutral, and hips flexed to 60°. Allowing the patient to rest the legs on a bolster can remove any activity in the gluteal muscles. This occasionally enables a woman to have an easier time activating her PFMs. The above position with buttocks propped on pillows in order to allow gravity to assist the PFMs

dynamic functional activities rather than solely focusing on the degree of lift measured.

Transabdominal ultrasound imaging is an emerging tool for the 21st century clinician who treats women with pelvic-floor dysfunction. To date, most studies using TAUS imaging have examined the reliability and validity of TAUS imaging as a PFM assessment tool. There have been no randomized controlled trials examining the efficacy of using TAUS imaging as a biofeedback tool in PFM re-education. This case report demonstrates the use of TAUS imaging as a biofeedback tool for PFM re-education and strengthening in a postpartum woman experiencing SUI. Randomized controlled trials should be designed to investigate the use of TAUS imaging in the rehabilitation of the PFMs in the postpartum and postmenopausal populations. The degree of recovery and level of satisfaction when utilizing TAUS imaging in treatment versus methods currently used to retrain the PFMs should be explored. Further research using TAUS imaging has the potential to advance clinical understanding of pelvic fascial competence, PFM integrity, and competence of PFM contraction during increases in IAP or dynamic activity. This new understanding would significantly increase the understanding of urinary and fecal incontinence.

Dr Ariail provided concept/idea/project design, data collection and analysis, project management, the patient, facilities/equipment, institutional liaisons, and clerical support. All authors provided writing and consultation (including review of manuscript before submission).

This article was received November 6, 2007, and was accepted July 23, 2008.

DOI: 10.2522/ptj.20070330

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Appendix.

Progression of Pelvic-Floor Muscle (PFM) Exercises Performed During Intervention[a]

Position and Exercise Prescribed to the Patient, Including Number of Repetitions and Number of Sessions per Day						
Weeks 1 and 2	**Weeks 3 and 4**	**Week 5**	**Week 6**	**Weeks 7 and 8**	**Weeks 9 and 10**	**Week 11 (Discharge)**
Hook-lying position with buttocks propped on pillows: • 1-s PFM contraction with slight hip adduction by squeezing her knees on a ball: 5 repetitions Five sessions a day	Hook-lying position with buttocks propped on pillows: • 1-s PFM contraction: 8–10 repetitions • PFM contraction with 3-s hold: 8 repetitions Both exercises performed 5 sessions a day	Hook-lying position: • 1-s PFM contraction: 3 repetitions as a warm-up • PFM contraction with 7-s hold: 8 repetitions • Coordinating PFM contraction with breath cycle: 5 repetitions The warm-up was to be performed with only one of the other exercises (due to fatigue), 5 sessions a day. Patient was to alternate exercises for each session.	Hook-lying position: • 1-s PFM contraction: 3 repetitions as a warm-up • PFM contraction with 10-s hold: 8 repetitions Hook-lying position with dynamic movement: • Hold PFM contraction with bent-leg fall-outs: 10 repetitions alternating legs Hook-lying position with legs supported on bolster: • Hold PFM contraction with hip flexion (keeping leg supported on bolster): 10 repetitions alternating legs All exercises performed 5 sessions a day. The patient was allowed a 3- to 5-s rest between repetitions of lower-extremity movement.	Hook-lying position: • 1-s PFM contraction: 3 repetitions as a warm-up Hook-lying position with dynamic movement: • Hold PFM contraction with active bent leg raise: 14 repetitions alternating legs Supine position with challenges: • Hold PFM contraction with active straight leg raise: 14 repetitions alternating legs • Hold PFM contraction with cough: 10 repetitions Standing position with dynamic movement: • Hold PFM contraction with 10 steps: 5 repetitions • Hold PFM contraction with ½ squats: 5 repetitions • Hold PFM contraction with light stomp: 5 repetitions The warm-up was to be performed with only 3 of the other exercises, 5 sessions a day. The patient was to alternate exercises for each session. The patient was allowed a 3- to 5-s rest between repetitions of lower-extremity movement	Hook-lying position: • 1-s PFM contraction: 3 repetitions as a warm-up Supine position with challenges: • Hold PFM contraction with active straight leg raise with no rest between lower extremities: 10 repetitions alternating legs Standing position with dynamic movement: • Hold PFM contraction with ½ squats: 10 repetitions • Hold PFM contraction with stomping feet: 10 repetitions • Hold PFM contraction while coughing: 10 repetitions • Hold PFM contraction while jumping: 10 repetitions • Hold PFM contraction while conversing or not thinking about the PFMs: 10 repetitions The warm-up was to be performed with only 3 of the other exercises, 3 sessions a day. The patient was to alternate exercises for each session.	Patient was instructed to continue to perform 2 to 3 of all PFM exercises she had accomplished throughout the intervention, 2 times a day. She also was advised to continue performing PFM contractions during daily activities.

[a] Exercises and repetitions prescribed for the home exercise program were determined by patient success during clinic visit.

Physical Therapy
Journal of the American Physical Therapy Association

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PHYS THER. 2008; 88:1208-1217.
Originally published online September 4, 2008
doi: 10.2522/ptj.20070330