GYNECOLOGY

Development of a standardized, reproducible screening examination for assessment of pelvic floor myofascial pain

Melanie R. Meister, MD, MSCI; Siobhan Sutcliffe, PhD, ScM, MHS; Chiara Ghetti, MD, MSc; Christine M. Chu, MD; Theresa Spitznagle, PT, DPT, WCS; David K. Warren, MD, MPH; Jerry L. Lowder, MD, MSc

BACKGROUND: Pelvic floor myofascial pain is common, but physical examination methods to assess pelvic floor muscles are defined poorly. We hypothesized that a simple, transvaginal pelvic floor examination could be developed that would be highly reproducible among providers and would adequately screen for the presence of pelvic floor myofascial pain.

OBJECTIVE: The purpose of this study was to develop a simple, reproducible pelvic floor examination to screen for pelvic floor myofascial pain.

STUDY DESIGN: A screening examination was developed by Female Pelvic Medicine & Reconstructive Surgery subspecialists and women's health physical therapists at our institution and tested in a simulated patient. We recruited 35 new patients who underwent examinations by blinded, paired, independent examiners. Agreement was calculated with the use of percent agreement and Spearman's rank correlation coefficient.

RESULTS: The final examination protocol begins with examination of the following external sites: bilateral sacroiliac joints, medial edge of the anterior superior iliac spine, and cephalad edge of the pubic symphysis (self-reported pain: yes/no). The internal examination follows with palpation of each muscle group in the center of the muscle belly, then along the length of the muscle proceeding counter-clockwise: right obturator internus, right levator ani, left levator ani, left obturator internus (pain on a scale of 0—10). Thirty-five patients were enrolled. Correlation was high at each external (0.80—0.89) and internal point (0.63—0.87; $P<.0001$).

CONCLUSION: Our newly developed, standardized, reproducible examination incorporates assessment of internal and external points to screen for pelvic floor myofascial pain. The examination is straightforward and reproducible and allows for easy use in clinical practice.

Key words: myofascial pain, pelvic pain, trigger point

Myofascial pain is a chronic pain disorder characterized by the presence of tenderness to palpation of muscles and connective tissue that causes both local and referred pain.[1] In men and women with chronic pelvic pain and other pelvic floor disorders, myofascial pain has been identified within the muscles of the pelvic floor (levator ani [LA], comprised of the iliococcygeus, pubococcygeus, and puborectalis muscles) and internal hip (obturator internus [OI]), and throughout the body.[1–8] Pelvic floor myofascial pain may occur in conjunction with or as sequelae of disease of the urinary, genital, colorectal, or musculoskeletal systems, or it may arise independently.[3] Prevalence estimates of pelvic floor myofascial pain vary widely from 14% to as high as 78%[3] and are highest in studies in which universal assessment is performed.

EDITORS' CHOICE

Trigger points, tender nodules, or bands within the muscle are the hallmark finding in myofascial pain and can be active or latent.[3,9] Latent trigger points may be activated at any point, often as a result of physical or emotional stress;[10] because trigger points may remain dormant for many years, seemingly insignificant stressors can lead to trigger-point reactivation and recurrence of pain.[11] Unfortunately, physical examination methods to assess the internal hip and pelvic floor muscles for the presence of trigger points or tenderness characteristic of myofascial pain are defined poorly.[12–18] As a result, few physicians are trained to examine these muscles in the evaluation of patients with pelvic floor complaints or to consider pelvic floor myofascial pain among the differential diagnoses for patients with pelvic floor symptoms.[19]

Examination of pelvic floor muscles is important for several reasons. In addition to its role in chronic pelvic pain, pelvic floor myofascial pain identified on palpation has been proposed to contribute to lower urinary tract symptoms and symptoms of pelvic organ prolapse.[2,3] Retrospective data from our institution show a correlation between the severity of pelvic floor myofascial pain and degree of pelvic floor symptoms bother.[20,21] Clinically, we see an improvement in the presence and bother of symptoms after treatment of the underlying pelvic floor myofascial pain through pelvic floor physical therapy. If these associations ultimately are found to be causal, providers may be able to better identify patients with pelvic floor symptoms who may benefit from rehabilitative musculoskeletal treatment modalities (ie, physical therapy, cryotherapy) rather than treatment options that have significant side-effects or are more invasive or costly. However, without provider knowledge and awareness of pelvic floor myofascial pain/dysfunction through a standardized screening pelvic floor examination, further investigation into these questions is

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AJOG at a Glance

Why was this study conducted?

Pelvic floor myofascial pain is common, but physical examination methods to assess pelvic floor muscles are defined poorly. We aimed to develop a simple, reproducible examination to screen for pelvic floor myofascial pain.

Key findings

A complete pelvic floor myofascial examination includes assessment of external sites (bilateral sacroiliac joints, medial edge of the anterior superior iliac spine, and cephalad edge of the pubic symphysis) and internal muscle groups (right obturator internus, right levator ani, left levator ani, left obturator internus). Correlation was high at each external (0.80−0.89) and internal point (0.63−0.87; $P<.0001$).

What does this add to what is known?

Physical examination methods to screen for the presence of pelvic floor myofascial pain are highly variable and often defined poorly. Here we present a concise examination strategy that is reproducible among providers.

difficult. Therefore, to address the lack of a standardized screening examination for the presence of pelvic floor myofascial pain, we aimed to develop a simple and reproducible examination. We chose a screening examination for internal hip and pelvic floor myofascial pain/dysfunction instead of a diagnostic examination because of the difficulty of identifying individual pelvic floor muscles and the complexity of the interactions between the low back, hip, abdominal wall, pelvic floor, and visceral organs. The goal of developing this screening examination was to help bring awareness to the presence of pelvic floor myofascial pain on palpation and to facilitate further study of its possible association with pelvic floor symptoms. In addition, a diagnostic examination to determine the musculoskeletal origin of the pain (ie, a labral tear of the hip) or a movement impairment (ie, a femoral glide) would likely be beyond the practice scope of primary care physicians, gynecologists, or urologists. We liken this musculoskeletal screening process to that used for scoliosis, whereby a simple physical examination is used to screen for signs of a spine abnormality and advanced testing is used for a definitive diagnosis.[22]

Materials and Methods

Examination development

The protocol for the pelvic floor myofascial screening examination was developed through collaboration between Female Pelvic Medicine and Reconstructive Surgeons (FPMRS) and women's health physical therapists at our institution. Before protocol development, a systematic review of the literature was performed by 4 study authors (M.R.M., S.S., T.S., J.L.L.) to assimilate the evidence that supported each component of the examination and current evaluation strategies. This systematic review was completed in 2017 and included 55 manuscripts. Overall, published examination strategies were highly variable and had little supporting evidence.[12] Key examination components that were identified through this systematic review were incorporated into the examination protocol. Additional components based on FPMRS surgeon and women's health physical therapy experience were incorporated. The protocol was circulated among the FPMRS physicians, and revisions were made until consensus was reached.

Once the protocol was developed, the examination was tested in 1 simulated patient (SP) from the Washington University Simulated Patient program. An SP was selected for this step because they are accustomed to undergoing multiple pelvic examinations in a single setting by providers who are learning pelvic examination techniques. These women are able to provide real-time, specific feedback. The protocol was revised based on SP feedback and repeated on the same SP at a separate encounter at which time consensus was confirmed among the participating providers. All FPMRS physicians then implemented the revised and final examination protocol in the clinic.

Pressure standardization

To standardize the amount of pressure applied to the muscles on internal examination, a force-sensing resistor (FlexiForce; Tekscan Inc, Boston, MA) was used. This small, thin device was applied to the index finger of the examiner and worn under the glove during the examination (Supplemental Figure 1). This device records the pressure applied from the examining finger onto the muscles and is displayed both as a waveform with the use of FlexiForce software (Supplemental Figure 2) and quantitatively as pounds of force in Excel (Microsoft Corporation, Redmond, WA). The device has not been Food and Drug Administration−approved for this indication but functioned well when tested in the SP. From the outset, we did not intend to use the device as part of the final proposed screening examination, because the device set-up is cumbersome and would not be a necessary part of a screening examination outside of a research setting. Therefore, we planned an interim analysis after the first 16 patients were enrolled to measure and compare the pressure used on internal examination. At that time, the pressure applied on internal (OI, LA) examination was found to be consistent among examiners, and the use of the force-sensing resistor was discontinued for the remainder of the study. Pressure was also standardized on all examinations by single-digit palpation of an area of the mid thigh, which was found to be consistent with applied internal pressure when measured with the force-sensing resistor during examination development on the SP.

Patient recruitment and examination

New patients at the Women's Center for Bladder and Pelvic Health at Washington University in St. Louis from November

TABLE 1
Screening examination protocol

Initial protocol	Rationale	Revision and rationale	Final protocol
Counsel the patient on the examination; explain the steps of the examination; obtain consent to begin	Counseling/consent documented before examination in 6/55 studies[12]		Counsel the patient on the examination; explain the steps of the examination; obtain consent to begin
Examination begins with patient seated on examination table	Allows orientation to examination	Confirm feet resting on the floor, which stabilizes the SI joint and prevents excessive stretch or mobility that may influence the finding of pain	Examination begins with patient seated on examination table and both feet resting on the floor
Palpation of the SI joint	Musculoskeletal pain and dysfunction at sites external to the pelvis often co-exist with pelvic floor myofascial pain	No changes	Palpation of the SI joint
Reposition to lithotomy with feet in footrests	Position patient for examination of internal sites; lithotomy position used in 14/55 studies[12]	Avoid excessive hip flexion, abduction, or external rotation; abduction and external rotation effectively shorten the obturator internus muscle and may influence the examination findings	Reposition to lithotomy position with feet in stirrups; ensure hips are neutral without excessive flexion, abduction, or external rotation
Palpation of medial edge of ASIS (origin of iliacus muscle)	Musculoskeletal pain and dysfunction at sites external to pelvis often coexist with pelvic floor myofascial pain	No changes	Palpation of medial edge of ASIS (origin of iliacus muscle)
Palpation of cephalad edge of pubic symphysis (insertion of rectus abdominis)	Musculoskeletal pain and dysfunction at sites external to pelvis often coexist with pelvic floor myofascial pain	No changes	Palpation of cephalad edge of pubic symphysis (insertion of rectus abdominis)
Orientation to internal examination with demonstration of pressure by palpation of mid thigh	Introduces patient to steps of examination and provides scale for reporting pain; patient-reported scores used in 28/55 studies[12]	No changes	Orientation to internal examination with demonstration of pressure by palpation of mid thigh
Palpation of the internal muscles once, in the center of the muscle belly, proceeding counter-clockwise starting with right OI and finishing with left OI[a]	Palpation of muscle belly elicits pain in patients with pelvic floor myofascial pain; palpation with single digit occurred in 34/55 studies;[12] clock-face orientation was used to identify muscles of the pelvic floor in 16/55 studies;[12] palpation of the OI in addition to the LA occurred in 25/55 studies[12]	Palpation once in the center of the muscle belly may miss trigger points present in the muscle; palpation along the length of the muscle increases the opportunity to identify additional trigger points missed with palpation at a single site	Palpation of the internal muscles once, in the center of the muscle belly and then along the length of the muscle in the orientation of the muscle fibers; examination proceeds counter-clockwise starting with right OI and finishing with left OI

ASIS, anterior superior iliac spine; *LA*, levator ani; *OI*, obturator internus; *SI*, sacroiliac.

[a] Practitioners learning this examination may find it beneficial to locate the obturator internus by (1) placing the hand not being used for palpation of the pelvic floor muscles on the lateral surface of the woman's knee on the side being examined, (2) vaginal palpation with the other hand between 9 o'clock to 12 o'clock (to assess the patient's right obturator internus) or 12 o'clock to 3 o'clock (to assess the patient's left obturator internus), and (3) asking her to abduct her thigh against the hand on her knee. Patient-initiated contraction and movement of the muscle can help the examiner more confidently identify the appropriate muscle.

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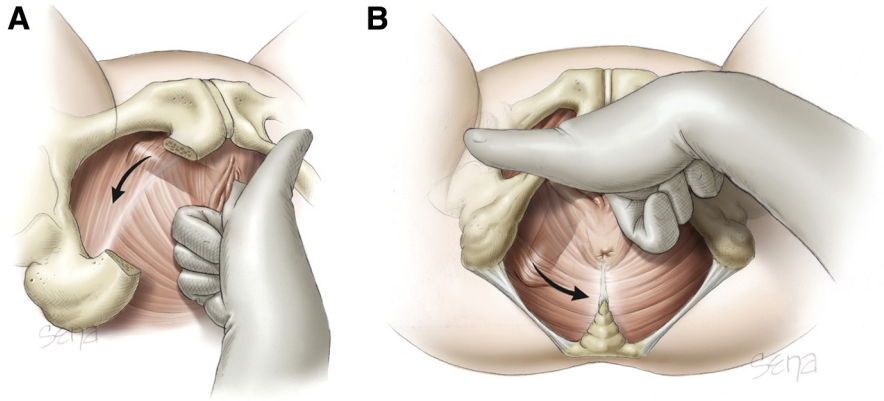
2017 to March 2018 were recruited. Eligible patients included adult women (age ≥18 years) who were willing to undergo 2 sequential pelvic floor myofascial examinations. Patients were excluded if they had physical immobility that would limit their ability to be positioned comfortably in dorsal lithotomy for the examination or a previously diagnosed cognitive impairment that would interfere with their ability to understand and participate in the examination process. Examinations were performed in enrolled patients by paired independent examiners (M.R.M., J.L.L., C.G., C.M.C.) who were blinded to the results of the other examination. The presence of pain at external sites was reported as a binary (yes/no) score. Pain scores on palpation of the internal sites were reported on an 11-point (0–10) verbal pain rating scale. A research assistant, who was present for both examinations, recorded scores. The

FIGURE
Method of internal palpation



Internal palpation is performed with the index finger of the dominant hand, once in the center of the muscle belly, then in a sweeping motion along the length of the muscle in the direction of the orientation of that muscle and proceeds counter-clockwise: right obturator internus (**A**), right levator ani (**B**), left levator ani, and then left obturator internus. Illustration used with permission of Ms Marie Sena.

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agreement between scores from each examiner was calculated with the use of percent agreement at external sites and Spearman's rank correlation coefficient at internal sites.

To explore the possibility of the use of pain at external sites as a proxy for internal examination by providers who were unfamiliar with a pelvic examination, we analyzed the association between pain reported at external and internal sites. For this analysis, a summary score was created for external pain: 1 point was assigned to each tender site (right sacroiliac, left sacroiliac, right anterior superior iliac spine (ASIS), left ASIS, rectus insertion; possible range 0–5). Additionally, pain on internal palpation of the LA and OI muscle groups was categorized into 2 groups based on severity: <4 of 10 vs ≥4 of 10. This threshold was chosen because we use it clinically to prompt referral to pelvic floor physical therapy for treatment of pelvic floor myofascial pain; a similar threshold has been used by other investigators to distinguish clinically significant myofascial pain.[23] The number of painful sites on external examination was compared with internal pain scores with the use of the Cochrane-Armitage trend test and Fisher's exact test.

Patient demographics that included age, race, body mass index, obstetric history, menopausal status, and pelvic floor symptoms based on chief complaint were collected and managed by research electronic data capture that is hosted at Washington University in St. Louis.[24] This study was approved by the Institutional Review Board at Washington University in St Louis (no. 201609115).

TABLE 2
Demographic characteristics of examination cohort

Variable	Measure
Median age, y (range)	55 (29–83)
Median body mass index, kg/m^2 (range)	29.8 (21.0–45.2)
Median gravidity, n (range)	2 (0–6)
Median parity, n (range)	2 (0–4)
Race, %	
White/Caucasian	60.0
Black/African American	22.9
Not reported	17.1
Prolapse symptoms, %	25.7
Urinary symptoms, %	100
Dyspareunia, %	31.4
Menopausal status, %	
Postmenopausal	57.1
Premenopausal	34.3
Perimenopausal	5.7
Unknown	2.9

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Results

Examination protocol: results of an iterative process

The final examination protocol begins with the patient seated on the examination table with both feet resting on the floor (Table 1). The sacroiliac joints are identified and palpated bilaterally, and the patient is asked whether this elicits pain (yes/no). The patient is then asked to recline to dorsal lithotomy with her feet in footrests. The point just medial to the ASIS, which corresponds to the insertion of the iliacus muscle, is then identified and palpated bilaterally. The patient is asked whether this elicits pain (yes/no). Additionally, the insertion points of the rectus abdominis muscles at the superior aspect of the pubic symphysis are palpated, and the patient is asked whether this elicits pain (yes/no).

TABLE 3
Force applied on internal examination

Force[a]	Examiner 1	2	3	4	Depth of mid-thigh palpation, cm
Maximum, lb	1.37	1.32	1.04	1.32	1
Average, lb	0.55	0.52	0.46	0.47	0.55

[a] Force applied resembles a bell-shaped curve (Supplemental Figure 2) and is reported as maximum and average (in pounds); maximum and average force applied corresponds to an approximate depth of palpation of 1 cm and 0.55 cm, respectively, on mid-thigh palpation; force used on internal examination did not differ among examiners (P=.168).

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The patient is then oriented to the internal examination. The examiner uses a single digit of the nondominant hand to depress the mid thigh, which corresponds to the mid muscle belly of the rectus femoris. This provides a reference for the pressure of palpation that the patient should expect internally and demonstrates that palpation of a skeletal muscle is typically sensed as "pressure, not pain." At this time, she is also oriented to the verbal pain rating scale that is used to score the degree of discomfort at each site. The sensation of pressure, analogous to that sensed with palpation of the mid thigh, is scored 0. Any discomfort beyond the sensation of pressure is given a score from 1−10: 1

TABLE 4
Frequency and distribution of pain scores at each examination site

Examination site	Examiner 1 (n=35)	2 (n=35)	*P* value	Agreement[a]
External sites, % (with tenderness)[b]				
Sacroiliac joint				
Right	34.3	37.1	.71	0.80
Left	28.6	31.4	.65	0.86
Anterior superior iliac spine				
Right	45.7	54.3	.18	0.86
Left	42.9	42.9	1.00	0.89
Rectus insertion	37.1	34.3	.80	0.83
Internal site scores, median (range)				
Right obturator internus score				
Muscle belly	4 (0−10)	4 (0−10)	.81	0.87
Length	6 (0−10)	6 (0−10)	.36	0.80
Right levator ani score				
Muscle belly	3 (0−10)	2 (0−10)	.45	0.71
Length	3 (0−10)	4 (0−10)	.55	0.76
Left levator ani score				
Muscle belly	2 (0−10)	3 (0−10)	.08	0.63
Length	4 (0−10)	4 (0−10)	.13	0.63
Left obturator internus score				
Muscle belly	4 (0−10)	4 (0−10)	.55	0.83
Length	5 (0−10)	5 (0−10)	.48	0.83

[a] Agreement is presented as percent agreement for external sites and Spearman's rank correlation coefficient results for internal sites and is high between examiners at all sites (P<.0001); [b] Tenderness reported as yes/no (frequency of "yes" is presented); at the remaining sites, tenderness on palpation reported on 0−10 verbal pain rating scale, where 0=no pain and 10=worst pain imaginable.

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TABLE 5
Association between pain at external sites and pelvic floor myofascial pain score

	No. of external sites with pain						
Internal pain score[a]	0	1	2	3	4	5	≥1[b]
Levator ani	27.3	57.1	75.0	80.0	50.0	50.0	83.3
Obturator internus	45.5	100.0	75.0	100.0	100.0	75.0	81.5
Total	31.4	20.0	11.4	14.3	11.4	11.4	68.6

Internal pain score categorized by maximum score on palpation of levator ani and obturator internus muscles. Summary score for external sites (right sacroiliac joint, left sacroiliac joint, right and left anterior superior iliac spine, rectus insertion) created by the assignment of 1 point for each reported as tender to palpation (yes/no) on external examination: *P*-trend for levator ani=.24, for obturator internus=.06.

[a] Score ≥4; [b] Pain present at ≥1 external sites was associated significantly with pain of ≥4 of 10 on internal palpation (levator ani, *P*=.048; obturator internus, *P*=.005).

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corresponds to mild discomfort and 10 to severe pain. If the patient reports pain with palpation of the mid thigh, another skeletal muscle site that does not elicit pain is selected.

The index finger of the dominant hand is used to palpate the internal muscles: once in the center of the muscle belly, then in a sweeping motion along the length of the muscle in the direction of the orientation of that muscle (Figure). The examination proceeds counter-clockwise: right OI, right LA, left LA, and then left OI. After completion of the pelvic floor myofascial examination, the remainder of the pelvic examination, which includes speculum examination, bimanual examination, and urethral catheterization, is performed if indicated.

Demographics and clinical characteristics of the study sample

Thirty-five patients were enrolled and underwent pelvic floor myofascial examination by 2 providers according to the developed protocol. The majority of enrolled patients were white, postmenopausal with a median age of 55 years (range, 29−83 years) and overweight (Table 2). All patients reported some degree of bothersome urinary symptoms, and 25.7% of the patients had symptoms of pelvic organ prolapse, according to their chief complaint. No patients who were included in this sample were seen specifically for evaluation of pelvic pain; however, 31.4% of the patients did report dyspareunia when asked as part of the comprehensive history.

Pressure standardization

Force on internal examination, which was measured on the first one-half of participants with the use of the force-sensing resistor, was similar between the 4 examiners (Table 3). A maximal force of 1.04−1.37 lbs was used by all examiners, with an average of 0.46−0.55 lbs. At the mid thigh, palpation with 1−1.3 lbs (ie, maximal force) resulted in a depression in the tissue to a depth of 1 cm; palpation with 0.5 lbs (average force) resulted in tissue depression to 5.5 mm. This was found to be consistent among examiners and patients.

Pain scores

One-third to one-half of patients had tenderness to palpation at each external site (Table 4); this was similar among examiners. Agreement was high at each external site: right sacroiliac joint, 80.0%; left sacroiliac joint, 85.7%; right ASIS, 85.7%; left ASIS, 88.6%; and rectus insertion, 83.3%; all were $P<.0001$. Reported pain scores on internal sites spanned the entire range of possible scores at each site examined (Table 4). Median pain scores were slightly higher in the OI muscles compared with the LA muscles bilaterally. For each site, the median pain score with palpation along the length of the muscle was equivalent or slightly higher than the median score on palpation of the muscle belly. Correlation was high between examiners at each internal point examined: right OI muscle belly, 0.87; right OI length, 0.80; right LA muscle belly, 0.71; right LA length, 0.76; left LA muscle belly, 0.63; left LA length, 0.63; left OI muscle belly, 0.83; and left OI length 0.83; all were $P<.0001$. The presence of pain at ≥1 of the external sites was associated with a myofascial pain score of ≥4 of 10 in severity in the OI ($P=.005$) and LA muscles ($P=.048$; Table 5).

Comment

We developed a simple and reliable screening examination for pelvic floor myofascial pain with palpation and demonstrated its reproducibility among examiners. Because there is no "gold standard" examination strategy for the assessment of pelvic floor myofascial pain to date, we developed our protocol using expert opinion and a systematic review of the literature[12] to ensure inclusion of all critical examination components; we standardized it by several procedures to control for anticipated difficulties in both locating and palpating internal examination sites accurately and with uniform force.

To locate internal sites accurately and identify pain with palpation, our protocol explicitly describes the site of palpation with the use of standard anatomic landmarks and incorporates 2 distinct palpation strategies: palpation once in the center of the muscle belly then along the length of the muscle in the orientation of the muscle fibers. We have found that patients tend to report tender points near muscle origin or insertion, and palpation in the center of the muscle

belly may miss these points. In our sample, pain scores were consistently higher on palpation along the length of the muscle, which suggests that additional trigger points were identified with the use of this strategy. We recognize that pelvic floor myofascial pain has been associated with trigger points in muscles outside of the OI and LA complex, which include within the coccygeus and piriformis muscles, and that some investigators advocate isolation of these components during the examination.[12] We specified examination of the LA as a muscle group rather than the individual component muscles because of documented difficulties in accurately distinguishing between the individual muscle components on transvaginal examination.[7,25,26] Because our examination was designed as a screening tool, not a comprehensive examination to map all possible muscles associated with pelvic pain, we believed that identification of trigger points within these muscles was sufficient to screen for pelvic floor myofascial pain and representative of the examination that a general gynecologist or urologist may perform to screen the pelvic floor musculature. Furthermore, accurate identification of the coccygeus and piriformis muscles requires a deeper internal pelvic examination than many women may tolerate as part of a routine examination. Although more experienced providers may be comfortable palpating the coccygeus and piriformis muscles, our goal was to develop a screening examination that could be used by providers with less experience with the internal pelvic examination.

Practitioners who are learning this examination may find it beneficial to locate the OI by (1) placing the hand not being used for palpation of the pelvic floor muscles on the lateral surface of the woman's knee on the side being examined, (2) vaginal palpation with the other hand between 9 o'clock to 12 o'clock (to assess the patient's right OI) or 12 o'clock to 3 o'clock (to assess the patient's left OI), and (3) asking her to abduct her thigh against the hand on her knee. Patient-initiated contraction and movement of the muscle can help the examiner more confidently to identify the appropriate muscle. To control for variation in applied force, we used a combination of strategies: a force-sensing resistor to quantify force applied in pounds and a "real world" technique whereby the examiner applied pressure to the patient's mid thigh to simulate the amount of force that would be applied to the muscles internally. Using a force-sensing resistor, we demonstrated equivalent pressure application between examiners. Although the force-sensing resistor or other devices that are like pressure algometers do provide a quantitative reading for the amount of force applied, we do not believe this is a realistic examination strategy for most busy clinicians, particularly as part of a screening examination. We found that pressure standardization through palpation of the mid thigh was sufficient for pressure standardization based on the high agreement noted between pain scores that were obtained by blinded examiners. We did not incorporate a superficial vaginal examination into the standardized examination presented here. It is possible that the presence of superficial vaginal tenderness could lead to a report of pain with transvaginal muscle palpation and should be considered as a possible cause in patients who report significant pain with only light palpation.

To gauge reproducibility of the examination technique and avoid the influence of changes in other factors over time, we performed the examinations in succession at the same visit. Because latent trigger points can be reactivated through physical or emotional stressors, examinations that are performed on different days could result in different examination scores because of reactivation or quiescence of trigger points. However, because the examinations were performed in succession, patients' experience with the first examination may have influenced their responses on the second examination. Despite this, we did not identify any patterns of responses between the first and second examiners and thus conclude that any bias introduced through successive examinations was minimal.

We identified an association between tenderness at $\geq$1 external sites and pelvic floor myofascial pain score of $\geq$4 of 10 on the internal sites. We routinely refer patients to pelvic floor physical therapy when they have pelvic floor symptoms (urinary urgency, frequency, pelvic pressure) and are found to have pelvic floor myofascial pain with palpation score of at least 4 of 10 in severity on internal examination. Based on this finding, providers with less experience who perform internal pelvic examinations may still be able to screen for possible pelvic floor myofascial pain using the external examination only and refer appropriate patients to pelvic floor physical therapy. If tenderness is not identified at any of these external points, pelvic floor myofascial pain is unlikely to be a significant driver of patients' pelvic floor symptoms.

As described earlier, we developed our examination protocol based on a systematic review of the literature through June 2017 and expert opinion. Since this review and the development of our protocol, the Multidisciplinary Approach to the Study of Chronic Pelvic Pain Research Network has published the results of a standardized genitourinary examination that incorporates assessment of many of the same points as our examination, in particular, the LA and OI muscle groups, for use in both men and women with urologic chronic pelvic pain syndrome.[27] In contrast to our examination protocol, pain on internal examination in that protocol was recorded as present/absent rather than on an 11-point scale, and the depth of palpation was not standardized. To our knowledge, the reproducibility of this new protocol has not yet been evaluated.

We have shown that our screening examination is simple and reproducible within a subspecialty practice. Further investigation is needed to demonstrate reproducibility among providers of various backgrounds and in patient populations with various symptoms. Nevertheless, given the ease with which it can be incorporated and the consistency among providers that was demonstrated in this study, we advocate for its use by providers who routinely evaluate patients with chronic pelvic pain. Given emerging evidence for a role of pelvic floor myofascial pain in other pelvic

floor symptoms[1–3] and the efficacy of pelvic floor physical therapy as a noninvasive treatment option for pelvic floor myofascial pain,[3] further investigation into the influence of myofascial pain on pelvic floor symptoms is needed. If an association is confirmed, incorporation of this myofascial pain screening examination should be considered as part of the evaluation for all patients with new pelvic floor complaints. ■

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References

1. Bo K, Frawley HC, Haylen BT, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for the conservative and nonpharmacological management of female pelvic floor dysfunction. Neurourol Urodynam 2017;36:221–44.

2. Adams K, Gregory WT, Osmundsen B, Clark A. Levator myalgia: why bother? Int Urogynecol J 2013;24:1687–93.

3. Pastore EA, Katzman WB. Recognizing myofascial pelvic pain in the female patient with chronic pelvic pain. J Obstet Gynecol Neonatal Nurs 2012;41:680–91.

4. Moldwin RM, Fariello JY. Myofascial trigger points of the pelvic floor: associations with urological pain syndromes and treatment strategies including injection therapy. Curr Urol Rep 2013;14:409–17.

5. Peters KM, Carrico DJ, Kalinowski SE, Ibrahim IA, Diokno AC. Prevalence of pelvic floor dysfunction in patients with interstitial cystitis. Urology 2007;70:16–8.

6. Sanses TV, Chelimsky G, McCabe NP, et al. The pelvis and beyond: musculoskeletal tender points in women with chronic pelvic pain. Clin J Pain 2016;32:659–65.

7. Giraudet G, Patrouix L, Fontaine C, Demondion X, Cosson M, Rubod C. Three dimensional model of the female perineum and pelvic floor muscles. Eur J Obstet Gynecol Reprod Biol 2018;226:1–6.

8. Hull M, Corton MM. Evaluation of the levator ani and pelvic wall muscles in levator ani syndrome. Urol Nurs 2009;29:225–31.

9. Spitznagle TM, Robinson CM. Myofascial pelvic pain. Obstet Gynecol Clin N Am 2014;41:409–32.

10. Dommerholt J. Persistent myalgia following whiplash. Curr Pain Headache Rep 2005;9:326–30.

11. Doggweiler-Wiygul R, Wiygul JP. Interstitial cystitis, pelvic pain, and the relationship to myofascial pain and dysfunction: a report on four patients. World J Urol 2002;20:310–4.

12. Meister MR, Shivakumar N, Sutcliffe S, Spitznagle T, Lowder J. Physical examination techniques for the assessment of pelvic floor myofascial pain: a systematic review. Am J Obstet Gynecol 2018;219:497.e1–13.

13. Carrico DJ, Peters DM, Diokno AC. Guided imagery for women with interstitial cystitis: results of a prospective, randomized controlled pilot study. J Altern Complement Med 2008;14:53–60.

14. FitzGerald MP, Anderson RU, Potts J, et al. Randomized multicenter feasibility trial of myofascial physical therapy for treatment of urologic chronic pelvic pain syndrome. J Urol 2009;182:570–80.

15. Montenegro ML, Mateus-Vasconcelos EC, Rosa e Silva JC, Nogueira AA, Dos Reis FJ, Poli Neto OB. Importance of pelvic muscle tenderness evaluation in women with chronic pelvic pain. Pain Med 2010;11:224–8.

16. Lamvu G, Nguyen R, Burrows JL, et al. The evidence-based vulvodynia assessment project. J Reprod Med 2015;60:223–35.

17. Langford CF, Nagy SU, Ghoniem GM. Levator ani trigger point injections: an underutilized treatment for chronic pelvic pain. Neurourol Urodynam 2007;26:59–62.

18. Morrissey D, El-Khawand D, Ginzburg N, Wehbe S, O'Hare P, Whitmore K. Botulinum toxin A injections into pelvic floor muscles under electromyographic guidance for women with refractory high-tone pelvic floor dysfunction: a 6-month prospective pilot study. Female Pelvic Med Reconstr Surg 2015;21:277–82.

19. Kavvadias T, Baessler K, Schuessler B. Pelvic pain in urogynecology: part I: evaluation, definitions and diagnoses. Int Urogynecol J 2011;22:385–93.

20. Meister M, Sutcliffe S, Badu A, Ghetti C, Lowder JL. Pelvic floor and obturator internus myofascial pain is common in patients with pelvic floor symptoms. Female Pelvic Med Reconstr Surg 2017;23:S33.

21. Meister M, Sutcliffe S, Badu A, Ghetti C, Lowder JL. Pelvic floor and obturator internus myofascial pain is correlated with lower urinary tract symptom severity. Female Pelvic Med Reconstr Surg 2017;23:S34.

22. Horne JP, Flannery R, Usman S. Adolescent idiopathic scoliosis: diagnosis and management. Am Fam Physician 2014;89:193–8.

23. Chelimsky T, Chelimsky G, McCabe NP, Louttit M, Hijaz A, Mahajan S. Interstitial cystitis: elucidation of psychophysiologic and autonomic characteristics (the ICEPAC Study): design and methods. J Pain Res 2014;7:243–53.

24. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377–81.

25. Van Delft KW, Sultan AH, Thakar R, Shobeiri SA, Kluvers KB. Agreement between palpation and transperineal and endovaginal ultrasound in the diagnosis of levator ani avulsion. Int Urogyenecol J 2015;26:33–9.

26. Gupta P, Ehlert M, Sirls LT, Peters K. Transvaginal pelvic floor muscle injection technique: a cadaver study. Female Pelvic Med Reconst Surg 2017;23:61–3.

27. Yang CC, Miller JL, Omidpanah A, Krieger JN. Physical examination for men and women with urologic chronic pelvic pain syndrome: a MAPP (Multidisciplinary Approach to the Study of Chronic Pelvic Pain) Network Study. J Urol 2018;116:23–9.

Author and article information

From the Department of Obstetrics & Gynecology, Division of Female Pelvic Medicine and Reconstructive Surgery (Drs Meister, Ghetti, Chu, and Lowder), the Department of Surgery, Division of Public Health Sciences (Dr Sutcliffe), the Department of Physical Therapy (Dr Spitznagle), and the Department of Internal Medicine, Division of Infectious Diseases (Dr Warren), Washington University in St. Louis, MO.

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Corresponding author: Melanie Meister, MD, MSCI. meisterm@wustl.edu

SUPPLEMENTAL FIGURE 1
Force-sensing resistor

The 9.7-mm round disc (FlexiForce; Tekscan Inc, Boston, MA) is applied to the index finger of the examiner's dominant hand and worn under examination gloves during the internal examination.

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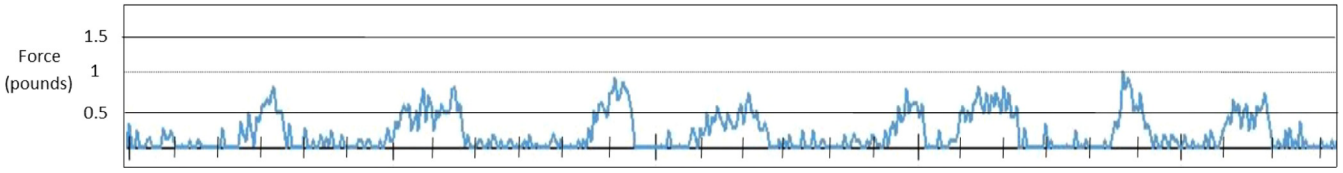
SUPPLEMENTAL FIGURE 2
Sample tracing taken during internal examination



Force is displayed in pounds on the y-axis with time (in seconds) on the x-axis. Each curve corresponds to a site on the internal examination (right obturator internus muscle belly, right obturator internus muscle length, right levator ani muscle belly, right levator ani muscle length, left levator ani muscle belly, left levator ani muscle length, left obturator internus muscle belly, left obturator internus muscle length). The quantitative data are exported and presented in Excel (Microsoft Corporation, Redmond, WA) for analysis.

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