Pelvic Floor Muscle Re-education
Treatment of the Overactive Bladder and Painful Bladder Syndrome

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Normal function of the pelvic floor musculature is essential in maintaining appropriate function of the pelvic viscera. Low-tone pelvic floor dysfunction, as may be seen in patients with pelvic floor musculature denervation, can contribute to pelvic organ prolapse, transurethral urinary incontinence, vaginal laxity, or transrectal fecal incontinence. High-tone pelvic floor dysfunction, as may occur in patients with overactive bladder or painful bladder syndrome (interstitial cystitis), can manifest as voiding dysfunction, sexual dysfunction with dyspareunia, or fecal retention. Pelvic floor rehabilitation for patients with pelvic floor dysfunction is performed in an effort to restore normal tone and function to the muscles of the pelvic floor, and in patients with overactive bladder may provide an additional element of reflex bladder inhibition. Muscle re-education techniques, typically preceded by a trial of behavioral therapy, include pelvic floor musculature exercises, pelvic floor musculature exercises with biofeedback, and electrical stimulation. The purpose of this chapter is to discuss the use of pelvic floor musculature rehabilitation to treat overactive bladder and to correct high-tone pelvic floor dysfunction.

Anatomy of the Pelvic Floor
The pelvic floor contains layers of connective tissue and muscle that provide support to the pelvic viscera. The urethra, vagina, and rectum are attached to the pelvic sidewalls by the endopelvic fascia, penetrating the pelvic floor at the urogenital hiatus. Im-
Immediately beneath the endopelvic fascia is the pelvic floor musculature. It is composed of the puborectalis, levator ani (pubococygeus and iliococcygeus), and coccygeus muscles. The puborectalis originates from the pubis and runs posteriorly to join its contralateral muscle behind the anorectal junction, forming a U-shaped sling. The pubococygeus muscle emanates from the pubis, traveling posteromedially to insert on the superior surface of the coccyx and the anococcygeal raphe. The iliococcygeus arises from the arcus tendineus levator ani, running posteromedially to insert on the coccyx and anococcygeal raphe. The coccygeus muscle originates from the ischial spine and sacrospinous ligament, inserting onto the lateral coccyx and lower sacrum. Beneath the pelvic floor musculature is the perineal membrane, which together with the pelvic floor musculature defines the pelvic floor. The perineal membrane is a triangular sheet of dense fibromuscular tissue spanning the anterior half of the pelvic outlet. Its attachments include the urethra, vagina, and perineal body medially and the inferior ischiopubic rami laterally.1

**Innervation of the Pelvic Floor**

The nerve supply to the pelvic floor includes both somatic and autonomic innervation. Somatic fibers from S2–S4 form the pudendal nerve, which supplies the perineal surface of the pelvic floor musculature. Sacral nerve root branches also innervate the pelvic floor directly through fibers traveling to the visceral surface of the pelvic floor musculature. Parasympathetic innervation begins with preganglionic fibers emanating from S2–S4, and ends in the postganglionic muscarinic receptors of the bladder wall. Sympathetic innervation arises from T10–L2, with postganglionic fibers traveling to beta-adrenergic receptors in the smooth muscle of the bladder wall and alpha-adrenergic receptors in the smooth muscle of the bladder neck and proximal urethra.2

**Normal Pelvic Floor Function in Pelvic Organ Support and Urinary Continence**

The pelvic floor musculature performs an important role in tonic support of the pelvic viscera. Such support is provided by a preponderance of type I (slow twitch) fibers within the pelvic floor musculature. In the maintenance of urinary continence, tonic muscular forces are provided by the external striated urethral sphincter (composed of the intramural striated sphincter and the periurethral levator ani musculature) and are important in effecting adequate urethral support. In addition, a minority population of type II (fast twitch) fibers within the levator ani musculature provides a mechanism for active periurethral muscular contraction at the time of provocative increases in intra-abdominal pressure.3 Less perceptible tonic increases in the pelvic floor musculature occur during bladder filling as part of a primitive sacral spinal mechanism known as the guarding reflex whereby mechanoreceptive parasympathetic impulses triggered by vesical distention lead to somatic efferent stimulation of the pelvic floor musculature and the external striated urethral sphincter.2 One’s threshold of continence is thus increased throughout bladder distention through a neurologically responsive pelvic floor musculature.

**Low-Tone Pelvic Floor Dysfunction**

**DEFINITION**

Low-tone pelvic floor dysfunction refers to the clinical finding of an impaired ability to isolate and contract the pelvic floor musculature in the presence of weak or atrophic musculature. Urologic and gynecologic manifestations include progressive pelvic organ descent and stress urinary incontinence secondary to a loss of both pelvic floor musculature tone and active periurethral contractile forces.
ETIOLOGY
Low-tone pelvic floor dysfunction may be encountered in patients with partial pelvic floor denervation as a result of parturition, senescence, or some combination. In a sample of 96 nulliparous women, Allen et al.4 examined the effects of childbirth on the nerve supply to the pelvic floor and the pelvic floor musculature. Evaluation performed at 36 weeks’ gestation and at 2 months after delivery included concentric needle electromyography (EMG) and perineometry. Mean duration of motor unit potentials was found to be significantly increased on postpartum EMG studies compared with antepartum values, indicative of the presence of denervated muscle fibers with subsequent peripheral reinnervation after injury. Mean motor unit potential duration was also found to be greater in postpartum samples of women who experienced a prolonged second stage of labor, and in those giving birth to babies with an above-average birthweight. Perineometry measurements antenatally and 2 months postpartum were 15.6 cm H₂O and 10.1 cm H₂O, respectively, consistent with a significant reduction in pelvic floor musculature strength after delivery.

Smith et al5 used single-fiber EMG to provide evidence of age-associated pelvic floor musculature denervation. An increase in motor unit fiber density, consistent with compensatory reinnervation after injury, was found to correlate with increasing age in 41 nulliparous asymptomatic women. Values ranged from 1.2 at 20 years to 1.6 at 77 years, representing an increase of 0.07 fibers per year.

LITERATURE REVIEW
High-tone pelvic floor dysfunction has been described infrequently in the urologic or gynecologic literature; however, the same clinical condition has been reported in colorectal publications as any one of the following clinical entities: coccygodynia, as described by Thiele; tension myalgia of the pelvic floor, coccygeus-levator spasm syndrome; levator syndrome; and levator ani spasm syndrome.

Thiele6 described coccygodynia in 1937 not only as an entity characterized by pain localized to the coccyx, but also as a syndrome noteworthy for the presence of levator ani and coccygeus muscle spasm. In his original communication, 64 of 69 patients with coccygeal pain were found to have spastic pelvic floor musculature on rectal examination. Work published by the same author in 1963 further characterized coccygodynia based on a review of 324 case records.7 Patient symptoms included pain localized to the lower sacrum and coccyx, often exacerbated by prolonged sitting. Few of his patients, however, exhibited tenderness of the coccyx on direct palpation or manipulation, a finding consistent with pain born of pelvic floor musculature spasm and not of primary sacrococcygeal pathology. Common etiologic factors included anal infection and chronic trauma, as identified in 178 (55%) and 106 (33%) patients, respectively. Anal infection was thought to cause reflex pelvic floor musculature spasm through lymphatic drainage of organism-laden lymph. Chronic trauma included poor sitting posture and extended vehicle rides.

Sinaki et al8 used the term tension myalgia of the pelvic floor to describe a sample of
94 patients with spastic, tender pelvic floor musculature. Common symptoms included low back pain in 82% and a “heavy feeling in the pelvis” in 64%, with the appearance of symptom aggravation in 88% of patients after prolonged sitting. Pelvic floor muscle spasm was attributed to habitual contraction of the pelvic floor in addition to a component of hypochondriasis.

Paradis and Marganoff⁹ used the term coccygeus-levator spasm syndrome to characterize 92 patients with pelvic floor spasm and “rectal” pain. Patients were found to be particularly tender at muscular sites adjacent to the ischial spines and coccyx, with a suggestion by the authors of a more significant involvement of musculofascial, ligamentous, and tendinous structures than of the muscles themselves. Neither infection nor trauma was identified in these patients as etiologic factors, with the attribution of disease presence to psychoneurosis.

Grant et al.¹⁰ used the term levator syndrome to describe a sample of 316 patients exhibiting pelvic floor musculature spasm and tenderness. The predominant symptom was rectal discomfort. The etiology of levator syndrome was reported as unknown.

All of the syndromes as presented above represent a similar clinical condition characterized by tender, spastic pelvic floor musculature manifesting as pain localized to the coccyx and lower sacrum, rectal pain, or generalized pelvic discomfort. Etiologic factors as reported are varied and include infection, chronic sacrococcygeal trauma from poor posture or prolonged sitting, and hypochondriasis or hysteria. A definitive cause of high-tone pelvic floor dysfunction as encountered in patients with interstitial cystitis has not been established and is most likely the result of several co-existing factors.

ETIOLOGY

In 1973, Lilius et al.¹¹ published a thoughtful study on the prevalence of levator spasm in patients with interstitial cystitis. Because many of their patients reported pain not only in the area of the bladder, but also in the regions of the sacrum, coccyx, and anus, they investigated the presence of concomitant pelvic floor musculature spasm. Twenty-five (81%) of 31 patients with interstitial cystitis were found to have spasm and tenderness of the levator ani musculature, which they termed levator ani spasm syndrome. The authors postulated that such muscle activity was, in part, the result of bladder pathology, with increased pelvic floor musculature tone appearing in response to afferent autonomic impulses emanating from the bladder wall. These authors also assigned importance to poor sitting or working posture as contributing to the development of levator ani spasm syndrome. Their excellent clinical observations, suggest both a neurologic and musculoskeletal etiology in the development of high-tone pelvic floor dysfunction in patients with interstitial cystitis.

In a nondiseased bladder, mechanoreception in the detection of bladder wall tension is mediated by lightly myelinated Aδ fibers. Nociceptive afferents, known as (unmyelinated) C-fibers, are typically silent, becoming active in response to bladder inflammation or irritation. It is thought from feline studies that such fibers, once triggered, not only fire at low thresholds, but may also fire spontaneously, resulting in pain and reflex voiding. In the normal guarding reflex, parasympathetic afferents lead to a gradual increase in pelvic floor musculature tone as mediated by somatic effectors from the sacral spinal cord, as described above. One speculative possibility in the development of high-tone pelvic floor dysfunction is that the afferent autonomic “bombardment” seen in patients with interstitial cystitis may enhance and maintain a guarding reflex that manifests as pelvic floor hypertonus. This concept of pelvic floor spasticity appearing as a result of a sustained guarding reflex has been previously alluded to by Chancellor.¹³

A musculoskeletal etiology for high-tone pelvic floor dysfunction has been suggested
by several authors. Thiele,7 Sinaki et al,8 and Lilius et al.11 have associated pelvic floor musculature spasm with poor posture and prolonged sitting. This “typical pelvic pain posture,” as termed by Baker,14 characterized by exaggerated lumbar lordosis, anterior pelvic tilt, and thoracic kyphosis, has been implicated in the subsequent development of sacroiliac pathology. As the sacroiliac joint moves, however slightly, through upsip, downslip, or torsion, the pelvic floor musculature to which it is attached is also subject to dynamic change.15 Muscles that are stretched or compressed are prevented from maintaining a normal resting tone and are prone to trigger point formation and hypertonicity.14 Pelvic floor dysfunction is also thought to appear in reaction to overflexion of the coccyx while sitting with incorrect posture.7 Spasm in these patients may be the result of a change in tension of the pelvic floor musculature to which the coccyx is attached.7 The presence of sacroiliac dysfunction with or without the contribution of poor posture may reasonably serve as a trigger for the development of high-tone pelvic floor dysfunction. It is likely that the degree of high-tone pelvic floor dysfunction encountered in interstitial cystitis represents the sum of both neurologic and musculoskeletal components.16

**Evaluation of the Pelvic Floor**

Assessment of the pelvic floor is performed in an effort to determine a patient’s ability to isolate, contract, and relax the pelvic floor musculature. Evaluation is made through intravaginal (or trans-rectal) examination and may include the use of measuring devices for complementary assessment.

Evaluation begins with a single-finger digital examination with light pressure against the inferior lateral wall of the vagina. The patient is then asked to perform a contraction, squeezing the finger to “lift up” the floor of the vagina. Abdominal, gluteal, and adductor muscle recruitment should be observed as a general assessment of pelvic floor musculature isolation. The contraction is based on a five-point scale (Fig. 1).17 The same protocol is performed for both the right and left pelvic floor musculature. The patient is then asked to relax her muscles and tenderness (hypertonus) is graded on a zero-to-four scale (Fig. 2).17

Digital evaluation of the pelvic floor musculature has been described by several authors and varies in regard to scale, number

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no pressure or pain associated with exam</td>
</tr>
<tr>
<td>1</td>
<td>comfortable pressure associated with exam</td>
</tr>
<tr>
<td>2</td>
<td>uncomfortable pressure associated with exam</td>
</tr>
<tr>
<td>3</td>
<td>moderate pain associated with exam, intensifies with contraction</td>
</tr>
<tr>
<td>4</td>
<td>severe pain associated with exam; patient is unable to perform contraction maneuver due to pain</td>
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**FIG. 1.** Pelvic floor muscle contraction scale.

**FIG. 2.** Pelvic floor muscle tenderness (hypertonus) scale.
of fingers used, and specific parameters assessed. Worth et al.\textsuperscript{18} described a one-to-three scale using a one-finger assessment of pressure, duration, “ribbing” (tone during contraction), and position (degree of displacement). Interobserver and test–retest reliability for this technique was proved. Brink et al\textsuperscript{19} reported a one-to-four scale using a two-finger assessment of lateral and anteroposterior pressure, duration, and vertical displacement. Interrater and test–retest reliability for this scale was also proved. The most notable pelvic floor musculature digital assessment tool is that described by Laycock.\textsuperscript{20} This zero-to-five scale is reproducible and assesses pressure and displacement. There is a relative paucity of data regarding digital scoring systems in the evaluation of high-tone pelvic floor dysfunction; most scales seem to address a patient’s ability to contract her pelvic floor musculature without an assessment of tenderness or impaired relaxation.

Perineometry is performed to more objectively assess pelvic muscle strength and baseline tone. A pressure-sensitive intra-vaginal probe within a disposable rubber sheath or glove is zeroed and placed in the vagina to determine resting pelvic floor musculature tone. The patient is then asked to offer and sustain a contraction, the strength and duration of which are measured. She is asked to consciously relax her pelvic floor musculature, and a final perineometry reading is obtained to evaluate the patient’s ability to return to a flaccid state. This tool offers the benefit of measuring impaired relaxation in the form of both an elevated baseline and high postcontraction tone. Perineometry has been shown to correlate with digital examination employing the Oxford Scale in the assessment of impaired pelvic floor musculature function.\textsuperscript{21} Assessment of the pelvic floor musculature can also be made by intracavitary or surface EMG, which has also been shown to correlate with digital evaluation of the pelvic floor.\textsuperscript{18,22} Both perineometry and EMG may not measure solely the activity of the pelvic floor musculature, because these devices can receive input from nonpelvic muscles, including abdominal, gluteal, and adductor musculature. A concomitant assessment through palpation of these extrapelvic muscle groups should be made during testing to provide clinical perspective regarding absolute intravaginal readings.

Findings in patients with low-tone pelvic floor dysfunction include impaired muscle isolation and contraction on digital examination. Perineometry in this population reveals decreased contraction amplitude and duration. Those with high-tone pelvic floor dysfunction exhibit poor muscle isolation, impaired contraction, tenderness, spasticity, and impaired relaxation on digital examination. Perineometry in these patients typically reveals elevated baseline pressures with no significant change in measurement from baseline upon contraction and subsequent relaxation. Patients with high-tone pelvic floor dysfunction who respond to pelvic floor rehabilitation exhibit a decrease in muscle tenderness, a decrease in resting tone, and an increase in the degree of change between resting and contraction perineometry measurements. No standard values for establishing diagnoses of low or high-tone pelvic floor dysfunction through digital examination, perineometry, or EMG have been established.

**Behavioral Therapy**

Initial therapy for overactive bladder typically exists in the form of behavioral techniques, which include dietary modification to limit acidic foods and known bladder irritants, timed voiding to maintain predictable intravesical volumes, and bladder training, in which the patient is instructed to follow a regimen of urge inhibition in an effort to extend voiding intervals and reduce the number of incontinence episodes. Bladder drill (also known as bladder training or bladder retraining) in theory functions by increasing cortical control over lower urinary tract function. In a review by Fantl\textsuperscript{23} examining...
the effect of this technique in a community-dwelling population with urinary incontinence, fewer than 15% of patients exhibited complete symptom resolution, and more than 50% of subjects showed a 50–75% reduction in symptoms. These numbers were based on the collective findings of three randomized clinical trials and seven patient series with urodynamic evidence of detrusor instability, and one series of subjects exhibiting sensory urgency.

Some authors have reported success with behavioral therapy in samples of women with interstitial cystitis. Parsons and Kaprowski24 used bladder training in a sample of 21 patients with interstitial cystitis and predominant symptoms of frequency and urgency. Subjects were placed on a protocol involving progressive increases in time between voids, adding 15 to 30 minutes to the voiding interval every 3 to 4 weeks, with a goal of 3½ to 4 hours between voids. Fifteen (71%) patients exhibited a 50% decrease in symptoms. Data reflecting the use of bladder training in patients with interstitial cystitis versus overactive bladder are scarce.

Treatment of Overactive Bladder

PELVIC FLOOR MUSCLE EXERCISES AND BIOFEEDBACK

Conservative therapy for stress urinary incontinence has commonly included pelvic floor musculature exercises, performed to strengthen periurethral striated musculature and enhance the patient’s ability to inhibit leakage on provocation. Several investigators have more recently described the use of pelvic floor musculature exercises in the treatment of overactive bladder. Nygard et al25 reported a significant decrease in the mean number of incontinent episodes per day (from 2.8 to 0.5) in a sample of 14 women with detrusor instability after a 3-month course of pelvic floor musculature exercises. Seven (50%) participants exhibited excellent or good results at 6-month follow-up. It is thought that pelvic floor musculature exercises in patients with overactive bladder create a reflex inhibition of the bladder in addition to the provision of enhanced periurethral support.

To ensure proper performance of pelvic floor musculature exercises, patients are educated on basic pelvic floor musculature anatomy and assessed with digital examination to ensure pelvic floor musculature isolation. Concomitant monitoring of abdominal, gluteal, and adductor musculature is performed to detect extrapelvic muscular efforts. The patient is instructed to squeeze or “lift up” the pelvic floor musculature and liken the exercise to an effort to prevent leakage of urine or stool. The typical protocol for pelvic floor musculature strengthening involves the performance of 50 contractions per day in two or three divided sessions. Each contraction is sustained for 5 seconds, followed by a 10-second period of relaxation. In patients with overactive bladder, urge inhibition is achieved with 5 to 10 quick contractions 1 to 2 seconds in duration at the onset of symptoms.

In patients who exhibit an impaired ability to isolate and contract their pelvic floor musculature despite appropriate education and coaching, biofeedback is added to aid in appropriate pelvic muscle identification. Imperceptible muscular activity becomes perceptible through visual and/or audio cues, enhancing the patient’s ability to control previously unfamiliar musculature. An intravaginal EMG probe is used to sense pelvic floor musculature activity, with signal conversion to a computer screen or audio source. Abdominal muscular activity is monitored concomitantly with surface EMG patches to ensure pelvic floor musculature isolation. The patient is instructed to perform a contraction around the probe for 5 seconds, followed by rest for 10 seconds. Visually, the patient can see contraction and relaxation cycles, with a goal of sustained peaks of 12.5 µV and resting values of less
than or equal to 2 µV. Each session lasts 15 minutes and is repeated one or two times a week for 6 weeks. No large randomized studies on the use of biofeedback in patients with overactive bladder have, to our knowledge, been published.  

ELECTRICAL STIMULATION

Electrical stimulation has been used in the treatment of stress urinary incontinence since its initial description for such by Caldwell in 1963. Its therapeutic role in patients with overactive bladder has since been reported. The mechanism of electrical stimulation in inhibiting detrusor overactivity involves the inhibition of parasympathetic efferent activity following peripheral somatic afferent stimulation as mediated by central parasympathetic suppression and indirect sympathetic inhibitory impulses.

The application of electrical stimulation in women commonly involves the use of an intravaginal or intrarectal probe (anogenital stimulation) with somatic afferent delivery to branches of the pudendal nerve. Stimulation may be provided at subsensory threshold levels (chronic electrical stimulation) without the elicitation of pelvic floor musculature contractions or at maximum tolerated levels (maximal electrical stimulation) with accompanying pelvic floor musculature activity. For the purpose of this discussion, electrical stimulation will refer to maximal electrical stimulation delivered via the anogenital route. In a review by Payne, 361 patients with overactive bladder treated with electrical stimulation were examined. Seventy-seven (20%) became dry, and 134 (37%) showed significant improvement. In a double-blind, randomized, sham-controlled clinical trial of 121 continent women, Brubaker et al reported that 49% of patients with detrusor instability were cured after electrical stimulation (20 Hz, 20 minutes twice daily for 8 weeks), with no significant postintervention improvement seen in those who used the sham device. Cure was defined as the absence of detrusor instability on posttreatment provocative cystometry performed at the end of the 8-week treatment period. In a more recent double-blind, sham-controlled randomized trial of 68 patients (39 women, 29 men) with detrusor overactivity, Yamanishi et al reported 25% and 62.5% cured and improved rates, respectively, after electrical stimulation (10 Hz, 15 minutes twice daily for 4 weeks) in patients with detrusor overactivity. Cure was defined as a stable cystogram or no evidence of incontinence on voiding diary. “Improved” was defined as a decrease in frequency by greater than 50% or an increase in cystometric capacity by more than 50 mL. Thirteen of 17 patients in the active group were said to have been cured or improved at an average of 8.4 months after completion of the 4-week treatment regimen. Clinical benefit in those receiving electrical stimulation was significantly greater than that seen in the sham group.

COMBINATION THERAPY

Pelvic floor muscle exercises, biofeedback, and electrical stimulation are commonly performed in combination. Our protocol is that of weekly 23-minute sessions over 6 weeks using pelvic floor musculature exercises with intravaginal biofeedback and electrical stimulation. Each session begins with 4 minutes of biofeedback with concomitant abdominal surface EMG measurements, during which the patient is asked to offer pelvic floor musculature contractions for 5 seconds, followed by 10-second intervals of relaxation. A contraction amplitude of 12.5 µV with a baseline of less than 2 µV is desired without significant abdominal muscle activity. Intravaginal stimulation for 15 minutes at 20 Hz is then applied, followed by 4 additional minutes of pelvic floor musculature exercises and biofeedback. Stein et al prospectively evaluated 21 patients with urge (n = 14) or mixed (n = 17) incontinence treated with six sessions of office biofeedback and electrical stimulation over a 3-week period. Each session consisted of 15 minutes of transvaginal or trans-
rectal electrical stimulation at a frequency of 20 Hz. Pelvic floor musculature exercises were then performed for 15 minutes, with simultaneous assessment of abdominal muscle activity by surface EMG. Four (19%) patients were cured and five (24%) were significantly improved at a median follow-up of 18 months (range 3–36 months). This study’s poor rate of success may have been due to the use of relatively rigid definitions of both cure (no pad use, with less than one incontinent episode per month) and significant improvement (no pad use, with less than one incontinent episode per week). Combination therapy may also be offered in the form of a home unit. Although more convenient, home therapy lacks the benefit of the presence of a skilled practitioner.

Treatment of High-Tone Pelvic Floor Dysfunction

PHYSICAL THERAPY
Patients diagnosed with high-tone pelvic floor dysfunction are referred to a physical therapist for assessment to identify sacroiliac malalignment, also known as sacroiliac dysfunction. Evaluation in brief includes a specific assessment of pelvic alignment, lumbar and hip active and passive range of motion, strength and flexibility of the spinal and pelvic stabilizers, and tenderness and spasm of the pelvic supportive musculature. Typical manual therapy techniques used in the correction of sacroiliac dysfunction, if identified, include myofascial release, joint mobilization, muscle energy, strengthening, stretching, neuromuscular re-education, and instruction in an extensive home exercise program. The speculative logic in correcting sacroiliac dysfunction in patients with high-tone pelvic floor dysfunction is such that if sacroiliac alignment is restored, normal tension to the pelvic floor musculature returns, allowing the resolution of a high-tone state.

In a pilot study of 16 patients with high-tone pelvic floor dysfunction, sacroiliac dysfunction, and interstitial cystitis, manual physical therapy was performed to assess the benefit of such treatment in reducing interstitial cystitis symptoms (frequency, urgency, nocturia, pain) as measured by the O’Leary-Sant Symptom and Problem Index. Dyspareunia was also evaluated in these patients using the “sex life” question from the Modified Oswestry Disability Scale. A comparison of pre- and posttreatment Modified Oswestry scores revealed an improvement in dyspareunia in 15 (94%) patients. A comparison of pre- and posttreatment O’Leary-Sant scores also showed improvement in 15 (94%) subjects. Schroeder et al. reported the use of an undefined regimen of physical therapy in a pediatric and adolescent population in which 20 out of 21 patients with musculoskeletal pelvic pain were successfully treated.

THIELE MASSAGE

After sacroiliac realignment, patients are reassessed by digital examination and perineometry. If pelvic floor musculature spasm persists as either diffuse or localized hypertonicity, subjects undergo a regimen of Thiele massage. In his original description of this technique, Thiele reported a personal series of 31 cases of coccygodynia and pelvic floor musculature spasm in which 19 (61.3%) were cured and 17 (35.5%) were improved (undefined criteria) after transrectal massage. The author combined his data with those taken from eight other proctologists using the same technique and reported a 93.7% cured and improved rate in a total of 80 patients. Treatment consisted of an average of 11 treatments over an average of 11 weeks.

In our practice, we perform Thiele massage transvaginally because this is more comfortable for our patients. In performing this technique, pressure is applied to the pelvic floor musculature fibers longitudinally from origin to insertion. Ten to 15 sweeps of maximally tolerated pressure are performed on each side, followed by myofascial massage (10 to 15 seconds of sustained pressure).
to tender points. Patients are treated once or twice a week for 6 to 8 weeks; this is less frequently than practiced by Thiele, who applied therapy every day for 5 or 6 days and then every other day for 7 to 10 days as an initial course.

PELVIC FLOOR MUSCLE EXERCISES AND BIOFEEDBACK

Patients with persistent high-tone pelvic floor dysfunction despite appropriate manual physical therapy and Thiele massage may benefit from pelvic floor muscle exercises and biofeedback. In a study of 60 patients with intractable rectal pain, 70% of whom were diagnosed with either levator spasm or coccygodynia, Ger et al.35 performed biofeedback on 14 subjects, using rectal EMG. After a minimum of six weekly 30- to 60-minute sessions, pain relief was rated as excellent or good (undefined) in six (43%) patients at a mean follow-up of 15 months. Heah et al.36 prospectively treated 16 patients with levator ani syndrome with biofeedback, using a rectal manometric balloon. A significant improvement in pain was achieved with scores recorded on a 0-to-10 linear analog scale (median pain score before biofeedback = 8; median pain score after biofeedback = 2). All patients exhibited nontender musculature after therapy. The goal of biofeedback in the treatment of high-tone pelvic floor dysfunction is to achieve conscious control over pelvic floor musculature contraction and relaxation, thus breaking the cycle of spasm.

ELECTRICAL STIMULATION

The use of electrogalvanic stimulation in patients with levator syndrome was first described by Sohn et al.37 Seventy-two patients were treated with electrogalvanic stimulation at 80 Hz to a point of mild discomfort for 1 hour per day for three sessions over a 3- to 10-day period. Fifty (69%) patients rated treatment as excellent (complete pain relief) and 15 (21%) rated therapy as good (pain resolution with fewer than three recurrences in the 6 to 30 months of follow-up). The mechanism of pain relief in these patients was reported as muscle fatigue after sustained contractions, in addition to motorneuron suppression. Other investigators have reported the use of electrogalvanic stimulation in patients with levator syndrome, reporting variable results with excellent or good improvement ranging from 43–91%.38–41 Electrical stimulation in patients with high-tone pelvic floor dysfunction is delivered with the same intention as electrogalvanic stimulation in creating muscle fa-

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**FIG. 3.** Pelvic floor re-education in the treatment of overactive bladder.
tigue with resultant relaxation; however, electrical stimulation employs low-voltage alternating current, whereas electrogalvanic stimulation employs high-voltage direct current.42

COMBINATION THERAPY
Electrical stimulation may be provided for patients with high-tone pelvic floor dysfunction at the time of biofeedback therapy. Administration of anogenital electrical stimulation is as described for overactive bladder; however, a frequency of 50 Hz is used, with the delivery of stimulation to a point of mild discomfort. Patients with high-tone pelvic floor dysfunction may maintain pelvic floor musculature fitness with a home device.

PHARMACOLOGIC THERAPY
Several authors have reported success in the treatment of high-tone pelvic floor dysfunction with diazepam. Grant et al10 reported the use of this medication in conjunction with heat and transrectal massage, with 68% of patients reporting good results (symptom relief by three or less massage treatments). In a smaller series of six women with external sphincter spasm, sustained relief from urgency, suprapubic discomfort, and voiding dysfunction was achieved after a 2- to 6-month course of diazepam taken in doses of 2 to 6 mg daily.43

We have had anecdotal success with tizanidine hydrochloride in relieving high-tone pelvic floor dysfunction. Because it is a centrally acting α-adrenergic agonist, it should be used with caution in patients taking other centrally acting agents. We usually begin with a low dose of 2 mg at bedtime daily and titrate as appropriate.

Treatment Algorithms
In the treatment of overactive bladder, pelvic floor re-education usually follows an initial trial of behavioral therapy, as described above (Fig. 3). Practitioners commonly offer their patients pharmacologic agents before or in lieu of pelvic floor re-education, because clinicians may not have the equipment or staff to perform appropriate re-education. Additionally, patients may view pharmacologic therapy as more immediate and less labor-intensive. Sacral nerve root stimulation has shown recent success in patients with refractory symptoms. Surgical therapy remains a last resort in the treatment of overactive bladder (and interstitial cystitis). The best therapy before sacral neuromodulation or surgery may be a combination of conservative techniques and oral agents. Magnetic stimulation and peripheral neuromodulation have also been used in patients with overactive bladder.

High-tone pelvic floor dysfunction is treated initially with manual physical therapy performed in an effort to restore sacroiliac and sacroccygeal alignment, with re-
sultant relief from abnormal muscular tension (Fig. 4). Thiele massage is initiated if the pelvic floor musculature exhibits persistent hypertonus despite appropriate bony alignment. Pelvic floor muscle exercise, biofeedback, and electrical stimulation then provide a mechanism to achieve maximal pelvic floor musculature contraction and relaxation in restoration of normal muscular function. Pharmacologic therapy may be used as adjunctive therapy in patients with high-tone pelvic floor dysfunction.

**Summary**

Rehabilitation of the pelvic floor musculature has proven effective in patients with overactive bladder and in those with interstitial cystitis and high-tone pelvic floor dysfunction. Despite the relative time and effort required of both patient and staff in performing these techniques, properly executed pelvic floor re-education has the potential to yield great benefit at minimal risk. Studies prospectively evaluating the benefit of pelvic floor musculature treatment through objective measures such as perineometry and EMG, in addition to validated symptom scales, would do well to further our conviction in employing such therapy.

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