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Quality-of-Life Outcomes Following Surface Electromyography Biofeedback as an Adjunct to Pelvic Floor Muscle Training for Urinary Incontinence: A Case Report

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Abstract

Background—A non-invasive treatment for urinary incontinence (UI) is surface electromyography (sEMG) biofeedback with pelvic floor muscle (PFM) training. A lack of consensus and evidence exists on the Quality of Life (QoL) outcomes following sEMG biofeedback using surface electrodes at the perineum compared to the more invasive intravaginal probe. This case report examines QoL using sEMG biofeedback at the perineum with PFM training for UI.

Study Design—Single subject case report

Case Description—The patient was a 61-year-old woman diagnosed with UI. Her chief complaints were nocturia, urine leakage with urgency, and urine leakage with sneezing and coughing. Physical therapy (PT) treatment focused on behavioral modification, PFM strengthening with and without sEMG biofeedback, and therapeutic exercises with PFM contractions.

Outcomes—At four weeks from baseline, the patient's PFM strength increased from 2/5 to 4/5 based on the Modified Laycock Scale. Her PFM endurance contraction improved from two seconds to ten seconds. The International Continence Impact Questionnaire – Urinary Incontinence Short Form (ICIQ-UI SF) score decreased from 6 to 0, the Incontinence Impact Questionnaire – Short Form (IIQ-7) score decreased from 14.3 to 0, and the 3 Incontinence Questions (3IQ) responses did not change.

Discussion—The outcomes from this case report demonstrate a brief course of PT treatment consisting of perineal sEMG biofeedback in conjunction with PFM training demonstrated clinically meaningful improvements in incontinence-related QoL, in addition to improvements in motor function in a woman with mixed UI and nocturia.

Keywords

urinary incontinence; sEMG biofeedback; pelvic floor; physical therapy; women's health

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INTRODUCTION

Urinary incontinence (UI) is a prevalent health condition that affects 20 million people in the United States.¹ Studies show that UI is 2–3 times more common in women than men,² and the prevalence of UI is estimated at 25–51% in women in the United States.³ Risk factors for UI include: increasing age, Caucasian race, greater body mass index, greater parity, postmenopausal hormone usage, type 2 diabetes, smoking, lower physical activity levels, history of stroke, medications that relax the urethral sphincter, lung disease (associated with chronic cough), history of episiotomy, and prior pelvic or abdominal surgeries.⁴

In addition to the substantial number of women with UI in the United States, UI is an important health issue to address due to its ramifications on quality of life (QoL) and the financial consequences of this condition. Numerous studies have found that women experiencing UI have decreased physical activity, and a negatively affected emotional life, social life, working life, sexual life, and self-esteem.⁵ Studies have also found that UI places an economic burden on individuals with UI as well as society.^{6,7} A systematic review by Coyne et al⁶ reported an estimated cost of \$76.2 billion in 2015 for urgency-related UI in the United States, including direct costs (diagnosis, treatment, and routine care) and indirect costs (lost wages and productivity by patients and caregivers).

A conservative treatment option for UI includes biofeedback training utilizing surface electromyography (sEMG). This technique examines electric potentials produced by muscle fibers upon contraction and can be used as an adjunct to treatments.⁹ Employing sEMG biofeedback allows the patient to better learn how to contract specific muscles, increase awareness and effectiveness of correct muscle activation, and increase their motivation to continue exercising.¹⁰ Equipment needed for sEMG is generally available in outpatient physical therapy settings, it is a well-tolerated method of looking at muscle activation, and it is non-invasive compared to intramuscular EMG which involves using a needle electrode.⁹ For these reasons, sEMG biofeedback is a viable adjunct option for pelvic floor muscle (PFM) training. Two types of sEMG are generally used for PFM training: an intravaginal probe or placing surface electrodes at the external anal sphincter to target the levator ani. Using an intravaginal probe for PFM examination and biofeedback is a more accurate objective measure for assessing muscle activation, compared to using surface electrodes, due to the direct contact of electrodes on the PFM. Although used extensively in research and the clinical setting, not all patients will consent to using an intravaginal probe, a common reason being perceived intrusiveness.¹¹ Furthermore, a recent Cochrane Review by Herderschee et al¹¹ investigated several studies that reported adverse events associated with intravaginal probe use for biofeedback that led to women dropping out of the study or discontinuing treatment. These adverse events included women experiencing pain or discomfort with use of vaginal probe, unpleasant feelings associated with use of vaginal probe, and allergic reactions to lubricant used for the vaginal probe. These explanations for discontinuing treatment are important to consider, as adherence to PFM training has been cited as an important factor in successful treatment of UI.¹² Examining QoL outcomes of surface electrodes as another biofeedback option to offer women for UI treatment is worth

examining given the various reasons that women may refuse use of a vaginal probe or be unable to use a vaginal probe (e.g. PFM spasm, vaginal stenosis).

The effectiveness of completing PFM training with and without sEMG biofeedback is still uncertain in the literature, but in a Cochrane Review, Herderschee et al¹¹ found that augmenting PFM training with biofeedback may benefit women with UI. It was reported that women were significantly more likely to report that their UI symptoms were cured or improved compared to those who received PFM training alone. The study, however, found it difficult to make conclusions regarding the overall effect of QoL with utilization of biofeedback due to heterogeneity of studies and outcomes used.¹¹ Looking beyond the symptom-specific effectiveness of biofeedback for UI and examining any change in QoL seen with treatment is critical given that QoL is the most important outcome reported by patients.¹³ There were 24 studies reviewed by Herderschee et al¹¹ and none assessed mixed UI exclusively. Only eight of the 24 studies included mixed UI, and of these, two examined sEMG biofeedback using perineal electrodes. The remaining studies that included mixed UI employed transabdominal ultrasound, a vaginal probe, or an anorectal probe as their mode of biofeedback. The two studies that included mixed UI and used perineal electrodes did not mention or report QoL outcomes and did not compare outcomes between the different UI types included in the study.

Due to the prevalence of UI among women, as well as the significant impact it has on women's QoL and economic burden, a continued need for examining effective conservative interventions exists. A lack of consensus exists regarding the impact of sEMG biofeedback methods for mixed UI and QoL among women. Furthermore, evidence also lacks for sEMG biofeedback at the perineum used for mixed UI. Thus, the purpose of this case report is to examine QoL outcomes using sEMG biofeedback at the perineum as an adjunct to PFM training for mixed UI.

CASE DESCRIPTION

Patient History

The patient in this case was a 61-year-old, post-menopausal woman diagnosed with UI. She was referred by her gynecologist for a pelvic health physical therapy consultation for UI; the patient was seen at an outpatient physical therapy clinic in Northern Florida. The patient reported that she was prescribed VESIcare® (Northbrook, IL) to treat her urinary urgency approximately four years ago when her first symptoms began. The patient stated that the medication was sufficient to manage her symptoms until several weeks prior to the initial physical therapy evaluation when the intensity and frequency of her UI symptoms increased. The patient reported that her gynecologist increased the dosage of her VESIcare® in the same week of initiating physical therapy.

The patient's urinary symptoms were comprised of the following: 1) awaking to urinate one to four times per night; 2) urine leakage when walking to the restroom associated with urgency; 3) urine leakage with coughing and sneezing. She also reported several episodes of urinary leakage during waking hours. She denied any current pain with urination or in the lumbopelvic region.

The patient stated that her UI symptoms negatively impacted her QoL by limiting her participation in socializing, recreational activities, and traveling for more than 30 minutes by car. Furthermore, she described personal embarrassment with UI episodes and having to rush to the restroom at work. The patient's UI symptoms limited her QoL and participation by 25%, which was her self-reported limitation on the clinic intake questionnaire. Her goals for physical therapy were to decrease her leaking and discontinue incontinence medications.

SYSTEMS REVIEW

The patient presented to the physical therapy evaluation in no acute stress. Her posture was noted to have forward head and rounded shoulders. No gross deviations were observed with gait or functional mobility. As the patient did not have or report any apparent neurological signs or symptoms, an abbreviated lower extremity sensation screen with light touch was performed,¹⁴ which demonstrated intact sensation in her lower extremities. The range of motion and strength of the patient's lower extremities were assessed and found to be within functional limits.¹⁵ No diagnostic imaging or testing had been performed prior to her initial physical therapy visit.

The patient's medical history was significant for: three hysterectomies in the 1990s; history of removal of lipomas and cysts; two vaginal deliveries with two episiotomies (grade unknown); hiatal hernia; breast cancer diagnosis in 1979 with treatment including mastectomy, radiation, and lymph node removal; abdominal surgery for breast reconstruction using rectus abdominus; mesh placement for bladder prolapse; gastroparesis; chronic constipation; and history of recurrent chronic low back pain.

PELVIC EXAMINATION/TEST AND MEASURES

After obtaining consent from the patient, the pelvic examination was performed with the patient in a hooklying position by a trained pelvic health physical therapist with six years of pelvic floor training.

External Perineal Exam: Observation

External examination was unremarkable, with no erythema or irritation present. The vaginal introitus appeared normal with no gaping or restriction observed. Verbal instruction for performing an isolated PFM contraction was given by telling the patient to "pull the pelvic floor muscles up and in as if trying to stop the flow of urine." The patient was able to voluntarily contract her PFM, but unable to voluntarily fully relax her PFM after contraction. The patient exhibited poor isolation and coordination of voluntary PFM contractions. This was evidenced by her inability to coordinate her breath and PFM contractions, demonstration of Valsalva maneuver, and overflow of gluteals and hip adductors during a PFM contraction. The patient reported having a difficult time recognizing when she was actively contracting and relaxing her PFM during the assessment. There was no observable involuntary contraction of the PFM when the patient was instructed to cough.

External Perineal Exam: Palpation

External palpation was performed at bulbocavernosus, ischiocavernosus, transverse perineal muscles, and perineal body. She denied tenderness with palpation to each of these structures.

Internal Vaginal Exam: Palpation

A single gloved and lubricated finger was used to perform the internal assessment after obtaining consent from the patient. Palpation included the vaginal introitus, levator ani, and obturator internus. The patient reported mild tenderness with palpation to levator ani and obturator internus, with increased tenderness on the right side for both muscle groups. She denied any tenderness with palpation to the introitus.

OUTCOME MEASURES

At two time points, an internal assessment of the PFM was performed and the patient was given three outcome questionnaires. These outcome measures were given at the initial evaluation (IE) and visit 5 (four weeks post-IE). The scores at both time points can be found in Table 1.

PERFECT scheme

The internal assessment for PFM function was performed using the PERFECT scheme, an acronym that stands for power (strength), endurance, repetitions, fast, every, contraction, timed.¹⁶ It is used as a simple guide for clinicians to assess the main factors of PFM contractility. Within the PERFECT scheme, strength was assessed using the Modified Laycock Scale, described by Laycock (no contraction = 0, flicker = 1, weak = 2, moderate = 3, good = 4, strong = 5).¹⁷ The reliability and validity of digital palpation for PFM muscle testing using the Modified Laycock Scale has conflicting findings in the research, with both good and poor ratings.^{16,17,18,19,20} Digitally assessing PFM endurance using the PERFECT scheme (timing the PFM contraction until the strength decreased 35% or more) has been shown to be valid and reliable.¹⁷

International Continence Impact Questionnaire – Urinary Incontinence Short Form (ICIQ-UI SF)

The ICIQ-UI SF is used to measure UI symptoms and the impact of these symptoms on QoL. The questionnaire is brief and includes two demographic items, three scored items, and an item that describes situations in which leakage occurs. The three scored items are (1) “How often do you leak urine?”, (2) “How much urine do you usually leak?”, and (3) “Overall, how much does leaking urine interfere with your everyday life?”. The score ranges from 0–21, with a higher score demonstrating greater severity. The questionnaire demonstrates high validity, reliability, and sensitivity, with a test-retest score of 92.0%.²¹ The MCID for the ICIQ-UI SF was reported as a 4 point change in the calculated score at 12 months.²²

Incontinence Impact Questionnaire (IIQ-7)

The IIQ-7 is a seven-item, four-point scale developed for assessing the impact of UI symptoms on activities of daily life.²³ The item categories are physical activity, travel, social/relationships, and emotional health. The scale ranges from 0–100, with a higher score indicating a greater impact of UI symptoms on QoL. The IIQ exhibits high reliability, validity, and sensitivity, and is also highly correlated with measures of condition severity.^{23,24} The IIQ-7, a short form of the original IIQ, is strongly correlated with the IIQ ($r = 0.97$) and has a test-retest of 84%.^{23,24,25}

Three Incontinence Questions (3IQ)

The 3IQ is a three-item questionnaire used to categorize the type of UI in women. It can be utilized to direct the initial treatment sessions based on the type of symptoms experienced over the past three months. The accuracy of the using the 3IQ to correctly categorize the type of UI symptoms is modest but acceptable.²⁶ A sensitivity of 0.75 (95% CI) and specificity of 0.77 (95% CI) were reported for classification of urge incontinence, and a sensitivity of 0.86 (95% CI) and specificity of 0.60 (95% CI) were reported for classification of stress incontinence.²⁶

EVALUATION

Based on the subjective and objective findings, this patient was classified as having mixed UI, which is defined by the International Continence Society as the “complaint of involuntary loss of urine associated with urgency and also with effort or physical exertion or on sneezing or coughing.”²⁷ This diagnosis was supported by objective findings of an absent involuntary PFM contraction, poor PFM strength and endurance, poor coordination of PFM contraction and relaxation, and her answers on the 3IQ describing both urgency-related and stress-related UI symptoms. The patient’s subjective complaints of urinary leakage with walking to the bathroom associated with urgency, as well as with coughing and sneezing, also support the diagnosis of mixed UI. The patient’s rehab prognosis was considered good, as she presented with pelvic region musculoskeletal dysfunction and behavioral factors that research has found to respond well to skilled PT interventions,²⁸ and she was also motivated to decrease her urinary symptoms. The patient had no other significant musculoskeletal or neurological considerations that needed to be taken into account, also lending to a better prognosis. It was anticipated that the patient would need a relatively short course of treatment based on these factors, as well as research showing improvement in UI using a combination of behavioral training techniques can take from four weeks to six months.²⁹ Following the examination, it was determined that sEMG biofeedback using external electrodes would be appropriate and beneficial for the patient. Indicators for utilization of sEMG biofeedback as an adjunct treatment for this patient included incoordination of PFM contraction and relaxation, the patient’s subjective reports of having decreased awareness of voluntary PFM activity, the patient stating that receiving visual feedback would assist her in correctly isolating the PFM, and the patient’s personal preference of using external electrodes versus an intravaginal probe.

INTERVENTION

Women are more likely to report improvement in UI symptoms with more frequent appointments and increased supervision.³⁰ Thus, the physical therapy plan of care consisted of one-hour long treatment sessions, once per week, for six weeks. The plan of care focused on patient education and rehabilitation for the PFM both in isolation and in a functional capacity, with use of sEMG biofeedback. The interventions in the plan of care included behavior modification, PFM training with and without sEMG biofeedback, and therapeutic exercises with PFM contraction. The physical therapy intervention was initiated following examination on the first day and continued for five additional sessions over six weeks. The patient's physical therapy interventions and home exercises are detailed in Table 2.

Initial Evaluation Patient Education and Treatment

During the initial evaluation session, the patient was educated about her condition/diagnosis, role of PT for treatment of UI symptoms, the anatomy and function of the PFM, why it was important to isolate PFM, how to correctly perform a PFM contraction, and use of sEMG biofeedback at future treatments. The patient was instructed in two PFM exercises, as outlined in table 2, which were performed with internal digital feedback and verbal cues in the clinic. Although many PFM training protocols have been developed over the years, none have been deemed most effective or optimal for PFM rehabilitation.³¹ A meta-analysis found that completing at least 24 PFM contractions per day is adequate dosing for a PFM training program.³² It has also been recommended to prescribe low repetitions several times throughout the day to avoid muscle fatigue, and to increase the repetitions and length of contraction as the patient is able.³¹ Additionally, quick contractions and sub-maximal endurance contractions are used to address both fast and slow twitch muscle fibers. The patient's PFM training program described in Table 2 was progressed throughout her treatment based on the previous research findings and recommendations, as well as her PFM functioning at each visit.

Behavior modification was initiated during the first session by encouraging the patient to eliminate bladder irritants in her diet, with an emphasis on carbonated and caffeinated beverages, given that she consumed these multiple times per day. Additionally, the patient was instructed to increase the amount of time between urinary voids until she was able to void every two hours. Urge suppression was used to address urgency symptoms and time between voiding. For urge suppression, the patient was instructed to take several diaphragmatic breaths, remain calm, and perform 10 one-second PFM contractions to decrease urgency. Once the peak of urgency had subsided, and if she still felt the need to void, then she was to calmly walk to the bathroom. Decreasing the volume of bladder irritants as well as the use of these urgency suppression techniques has been found to be useful in treating urinary urgency and urgency-related UI.^{29,33,34,35,36} Handouts were given at the first visit outlining her home exercise program and all educational points described.

The remaining treatments following the IE were carried out in two phases: (1) PFM exercises with sEMG biofeedback at visits 2–4, and (2) PFM exercises without sEMG biofeedback at visits 5–6.

Visits 2–4

Patient education was provided at each visit emphasizing dietary modifications, condition/diagnosis, anatomy and function of the PFM, proper isolation of the PFM, urgency suppression, and use of sEMG biofeedback. Points of education were addressed based on what was deemed most important following the subjective interview at the beginning of each treatment.

To ensure correct sEMG electrode placement for biofeedback, the patient was positioned in hooklying and instructed to perform a PFM contraction while the physical therapist palpated at the external anal sphincter. Two electrodes were placed on the right and left side of the external anal sphincter, and a third electrode was placed at the anterior superior iliac spine as a reference point. A MyoTrac Infiniti standalone unit (Thought Technology Ltd., 2180 Belgrave Avenue, Montreal, Quebec, Canada, H4A 2L8) was used for sEMG biofeedback and the patient used this hand-held unit for visual feedback during PFM exercises in clinic. Her PFM training program was progressed by increasing the length of the endurance PFM contractions, increasing the number of repetitions of one-second PFM contractions, and advancing her body position for PFM exercises (supine to sitting to standing) at each visit; these are factors to consider for PFM training progressions. The patient was instructed in a PFM pre-contraction and cough (a technique also known as the Knack), which results in urethral closure, stabilization, and opposing downward movement to decrease stress-related UI.^{37,38}

The patient was also instructed in isolated transversus abdominus contraction, diaphragmatic breathing, and hooklying single-leg marching with PFM pre-contraction to complement her PFM exercises for a comprehensive program. It has been demonstrated that abdominal muscles co-contract with PFM and may aid in coordination and support to treat UI.³⁹ These exercises were introduced gradually at each treatment session and progressed in difficulty when deemed appropriate by the quality of PFM contractions seen on the biofeedback unit and the patient's subjective statements of what exercise goals were being attained at home. Hooklying single-leg marching with PFM pre-contraction was initiated later in her treatment due to the more advanced requirement of being able to sustain a PFM contraction with lower extremity movement.

Visits 5–6

The sEMG biofeedback was discontinued at visit 5 because the patient reported significantly decreased leakage and nocturia episodes, improved awareness of PFM contraction and relaxation, and demonstrated the ability to correctly isolate the PFM via external and internal digital palpation. The patient continued visits 5 and 6 with exercises previously performed at visits 2–4, and also progressed to additional therapeutic exercises while contracting her PFMs. The patient performed hooklying clamshells with a resistance band around her lower thighs, as several studies have demonstrated that both hip external rotation and abduction produce a co-contraction of the PFM.^{40,41,42} Pelvic floor muscle contractions during supine straight leg raises and bridges were also prescribed as progressions for her core strengthening and stabilization program that was initiated in visits 2–4. It may be

important to include these exercises, which involve hip and abdominal strengthening, to assist PFM functioning and decrease UI.³⁹

It has been found that women with incontinence have delayed postural activation of PFM, and that voluntary PFM contraction with activities that challenge posture may decrease UI and improve lumbopelvic stability.⁴³ To address this, the patient was also instructed in PFM contractions during activities that challenged the postural muscles. These included standing shoulder extension with a resistance band, static tandem stance, static single-leg stance, and static stance on a BOSU® ball to advance her PFM exercises in a functional manner.

A seventh visit was scheduled to ensure the patient's UI symptoms continued to improve or be maintained, confirm that she was completing her comprehensive home exercise program correctly, educate the patient on when and how to modify her exercises for a maintenance program, and complete a third time-point of outcome measures; unfortunately, the patient did not follow up for this seventh visit. Although she discontinued physical therapy after visit 6, she had made substantial progress with her goals and demonstrated a basic understanding of what was required to independently manage her condition.

OUTCOMES

The patient reported an improvement in her UI symptoms limiting her participation in socializing, recreational activities and traveling by car for more than 30 minutes, from 25% at IE to 0% at visit 5. She stated at visit 5 that she was able to decrease the dosage of her incontinence medications by half, experienced no leakage, was having less intense urgency during the day, and had decreased nocturia episodes to 1–2 per week. The patient reported that she was experiencing less daily embarrassment and was participating more in social and recreational activities. She described significantly more confidence in performing her PFM contractions correctly at home and was able to suppress her urgency effectively during the day and night.

Improvements were seen in objective measures from IE to visit 5. The PFM strength and endurance improved, as seen with the PERFECT scores in Table 1, and although not treated directly, it's of note that the tenderness with palpation at her bilateral levator ani and obturator internus muscle groups was decreased to no tenderness. The outcome questionnaire scores improved for both the ICIQ-UI SF and IIQ-7, while there was no change in her 3IQ score. The ICIQ-UI SF score changes exceeded the reported MDC. Based on the symptom severity rating scale developed by Klovning et al⁴⁴ for the ICIQ-UI SF (Slight: 1–5, Moderate: 6–12, Severe: 13–18, Very severe 19–21), the patient improved from symptoms of moderate severity to below the threshold for slight severity. The patient's IIQ-7 responses showed improvement of her QoL across all items (physical activity, travel, social/relationships, and emotional health). The patient recorded the same symptoms with the 3IQ at IE and visit 5, indicating that her stress and urgency-related UI symptoms had not changed within the past three months.

DISCUSSION

The patient in this case report exhibited a decrease in nocturia episodes, resolution of leakage, and improved QoL after six one-hour physical therapy sessions over a six-week period. Overall, the patient's UI symptoms decreased and her QoL and perception of participation limitation improved during and beyond the sEMG biofeedback intervention phase. A key factor in overcoming UI symptoms is adherence to UI treatment.¹² The patient's strong desire to resolve her UI symptoms was considered to have a role in her positive outcomes by acting as a motivator for her compliance with home exercises and modify her dietary habits. Eliminating daily bladder irritants could have also been a contributing factor to her decreased UI symptoms, in combination with the PFM training using sEMG biofeedback, though the authors are unable to separate these variables to determine their individual effectiveness. An encouraging development included the patient being able to decrease the amount of her incontinence medication with minimal UI symptoms.

The scores of the patient's outcome measure questionnaires improved during the sEMG biofeedback intervention phase, and although there is literature lacking in examining sEMG biofeedback at the perineum for UI management, it has been reported that supplementing PFM training with biofeedback may lead to better outcomes in women with UI.¹¹ Urinary incontinence has been shown to have a detrimental effect on QoL;⁵ therefore, we hypothesized with this case that the patient's ICIQ-UI SF and IIQ-7 scores would improve as her UI symptoms decreased, and in fact they did. The unchanged answers from the 3IQ were not unexpected due to the questions addressing the type of UI being experienced within a time period of the last three months. A change in the type of symptoms was not anticipated largely because her physical therapy intervention was not long enough to exceed the three month time period and therefore be able to report that she was no longer currently experiencing any change in urinary symptoms. In this way, the 3IQ did not have a time-period sensitive enough to show a change in symptoms for this patient.

The positive results of urinary symptom and QoL improvement in this case report are comparable to other studies assessing sEMG biofeedback for UI with perineal electrodes, vaginal probe, anorectal probe, and transabdominal ultrasound.^{10,11} There have also been UI studies that show no significant difference in QoL measures using biofeedback.^{10,11} There is limited comparability of QoL results of this case report to the literature, as studies assessing specifically mixed UI and QoL with use of sEMG biofeedback are lacking. Additionally, many studies assessing QoL in the pelvic dysfunction population use generic health-related QoL measures, despite evidence demonstrating these outcomes may be less sensitive for detecting changes compared to disease-specific outcomes;⁴⁵ this can further make comparisons between studies difficult.

Using sEMG biofeedback as visual feedback during PFM training appeared to be useful in assisting the patient isolate her PFM contractions. During the IE and visit 2, the patient had a very difficult time recognizing when she had fully contracted and fully relaxed her PFM. Being able to visualize the sEMG amplitude of her resting tone, contractions, and relaxations greatly assisted her in identification of a correct, isolated PFM contraction and

relaxation. Over the subsequent sessions using sEMG biofeedback, the patient required less visual assistance from the sEMG biofeedback unit and demonstrated improved coordination, strength, and endurance of an isolated PFM contraction. These outcomes are consistent with evidence supporting that biofeedback may enhance an individual's ability to effectively learn how to correctly contract and relax their PFM. ¹¹

Despite this case report being a relatively short course of intervention of six weeks compared to most reported interventions lasting at least eight weeks, the results seen in urinary symptom decrease and QoL improvement were similar to studies examined in prior systematic reviews and meta-analysis. ^{10,11} Future directions of research should include larger population studies to assess the optimal length of intervention for treatment of mixed UI with sEMG biofeedback as an adjunct to PFM training with disease-specific QoL outcomes.

Limitations

Several limitations exist within this case study. This was a single-person case report and the ability to generalize the outcomes to a population of women experiencing mixed UI is limited. There was no bladder diary given to the patient at the IE, which would have provided an objective assessment of UI symptoms and fluid intake. The patient's increased dosage of incontinence medication occurring at the same time of initiating physical therapy may have affected the outcomes. Additionally, it would have been useful to have the ability to record each sEMG biofeedback session graph. This would have allowed reporting of the amplitude of her baseline resting tone and PFM contractions and objectively measure changes in PFM activity during treatment; unfortunately, this software was not available at the clinic. Furthermore, although the patient stated that she felt she was able to sustain her PFM contractions during the therapeutic exercises, it may have been beneficial to continue the sEMG biofeedback during these tasks to visualize if she was, in fact, able to sustain a PFM contraction. Her initial difficulty in recognizing when she correctly contracted and relaxed her PFM may have been an indicator to continue sEMG biofeedback as she progressed to more difficult tasks. Finally, this case report only examines the short-term outcomes with utilizing sEMG biofeedback to treat mixed UI and does not include any long-term follow-up.

CONCLUSION

This case study supports the use of sEMG biofeedback with surface electrodes at the perineum as a potentially useful intervention for women with mixed UI symptoms to improve QoL. Surface electrodes are a viable option for patients who are unwilling or unable to use internal devices for biofeedback, but may benefit from an adjunct to PFM training for better QoL and PFM functioning. Future research on conservative treatment for mixed UI should examine the effectiveness of utilizing sEMG biofeedback at the perineum as an adjunct to PFM training for QoL with long-term follow up.

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Table 1

Summary of patient outcomes

	Initial Evaluation	Visit 5
Pelvic Floor Examination		
PFM voluntary contraction	Present – with overflow	Present – without overflow
PFM voluntary relaxation	Absent	Present
PFM involuntary contraction	Absent	Present
PFM involuntary relaxation	Present	Present
Tenderness to palpation: levator ani	Bilateral, worse on right side	None
Tenderness to palpation: obturator internus	Bilateral, worse on right side	None
Outcome Measures		
PERFECT Scheme	Power: 2/5 Endurance: 2 seconds Quick PFM contractions in 10 seconds: 2	Power: 4/5 Endurance: 10 seconds Quick PFM contractions in 10 seconds: 10
International Continence Impact Questionnaire – Urinary Incontinence Short Form (ICIQ-UI SF)	6	0
Incontinence Impact Questionnaire Short Form (IIQ-7)	14.3	0
Three Incontinence Questions (3IQ)	1. Yes 2. Stress & urgency 3. Stress & urgency	1. Yes 2. Stress & urgency 3. Stress & urgency

Table 2

Summary of physical therapy interventions

	Visit 1 (Initial Evaluation)	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
Graded PFM exercises: 3 consecutively increased PFM contractions followed by 3 consecutive relaxations to baseline	Digital internal feedback. 10 r, 1 set HEP: 10 r, 2–3 sets per day, supine and sitting	Not completed in clinic HEP: 10 r, 2–3 sets per day, supine and sitting	Not completed in clinic Discontinued from HEP	sEMG biofeedback. 10 r, 2 sets Discontinued from HEP	Visual observation of perineum. 10 r, 1 set Discontinued from HEP	Not completed in clinic Discontinued from HEP
One-second PFM contraction and two-second rest	Digital internal feedback. 10 r, 1 set HEP: 10 r, 2–3 sets per day, supine and sitting	sEMG biofeedback. 10 r, 1 set HEP: 10 r, 2–3 sets per day, supine and sitting	sEMG biofeedback. 10 r, 2 sets HEP: 10 r, 3 sets per day, supine, sitting, and standing	sEMG biofeedback. 10 r, 2 sets HEP: 10 r, 3 sets per day, supine, sitting, and standing	Visual observation of perineum. 10 r, 2 sets HEP: 10 r, 3 sets per day, supine, sitting, and standing	Decreased rest time to one-second. 10 r, 2 sets HEP: 10 r, 3 sets per day, supine, sitting, and standing
Sub-maximal PFM endurance contractions with exhale	Not initiated	sEMG biofeedback. 5 second hold (length of breath) 10 r, 1 set HEP: 10 r, 2–3 sets per day, supine and sitting	sEMG biofeedback. 5 second hold (length of breath) 10 r, 1 set HEP: 10 r, 3 sets per day, supine, sitting, and standing	sEMG biofeedback. 8 second hold, 10 r, 1 set HEP: 10 r, 3 sets per day, supine, sitting, and standing	Visual observation of perineum. 10 second hold, 10 r, 1 set HEP: 10 r, 3 sets per day, supine, sitting, and standing	10 second hold. 10 r, 1 set HEP: 10 r, 3 sets per day, supine, sitting, and standing
PFM pre-contraction and cough (the Knack)	Not initiated	Not initiated	sEMG biofeedback. 10 r, 1 set HEP: incorporated throughout the day	sEMG biofeedback. 10 r, 1 set HEP: incorporated throughout the day	Discontinued in clinic HEP: incorporated throughout the day	Discontinued in clinic HEP: incorporated throughout the day
PFM pre-contraction with transversus abdominus contraction and diaphragmatic breathing in hooklying	Not initiated	Not initiated	sEMG biofeedback. 10 r, 1 set	sEMG biofeedback. 10 r, 2 sets	Discontinued (progressed to single-leg marching)	Discontinued (progressed to single-leg marching)

	Visit 1 (Initial Evaluation)	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
PFM pre-contraction and single-leg marching: patient in hooklying and instructed to contract PFM before lifting one leg. PFM contraction sustained during single-leg march and relaxed with both legs resting	Not initiated	Not initiated	Not initiated	sEMG biofeedback. 10 r each leg, 1 set	10 r each leg, 1 set	10 r each leg, 1 set
Clamshells: hooklying position with resistance band proximal to the knees. Exhale as hips externally rotate	Not initiated	Not initiated	Not initiated	Not initiated	Orange resistance band (light resistance), 10 r, 1 set HEP: 10 r, 1 set	Orange resistance band (light resistance), 10 r, 1 set HEP: 10 r, 1 set
PFM pre-contraction with bridges: hooklying position with a 5-second hold while exhaling and lifting buttocks	Not initiated	Not initiated	Not initiated	Not initiated	Not initiated	10 r, 1 set HEP: 10 r, 1 set
Standing shoulder extension with resistance band: resistance band tied to door handle. Arms kept straight during shoulder extension to hips with exhale	Not initiated	Not initiated	Not initiated	Not initiated	Not initiated	Orange resistance band (light resistance), 5 second hold with exhale, 10 r, 1 set HEP: 10 r, 1 set
PFM pre-contraction with balance exercises	Not initiated	Not initiated	Not initiated	Not initiated	Not initiated	Tandem stance: 30 seconds, 2 r each leg Single-leg stance: 30 seconds, 2 r each leg Static stance on BOSU® ball: 3 minutes HEP: Tandem stance and single-leg stance 30 seconds, 2 r of each. Instructed to complete at counter.

Abbreviations: PFM = pelvic floor muscle, r = repetitions