

Use of NMES in Conjunction with An Abdominal Strengthening Program to Address Diastasis Recti Abdominis And Chronic Low Back Pain in A Patient 11 Years Postpartum: A Case Report

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Received: 📅 2025 May 11

Accepted: 📅 2025 Jun 02

Published: 📅 2025 Jun 12

Abstract

Background: *Diastasis Recti Abdominis (DRA) is a prevalent postpartum condition that can persist chronically, contributing to low back pain (LBP), impaired function, and reduced quality of life. While conservative treatment is recommended, evidence for effective interventions beyond the early postpartum period is limited.*

Purpose: *This case study examines the outcomes of an eight-week physical therapy intervention combining neuromuscular electrical stimulation (NMES), core stabilization exercises, and scar tissue mobilization for a 54-year-old postmenopausal woman with chronic DRA and acute-on-chronic LBP, 11 years after her last Cesarean delivery.*

Methods: *A tailored home exercise program (HEP) was designed and progressed to include NMES, abdominal bracing, scar mobilization, and graded functional core strengthening. Weekly in-clinic physical therapy sessions were conducted to assess progress, provide manual therapy, and adjust interventions based on tolerance and performance. Outcomes were measured using the Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI), palpation-based inter-recti distance (IRD), and functional strength tests.*

Results: *The patient reported complete resolution of LBP (VAS 0/10), improvement in ODI from 22% to 0%, and subjective improvements in abdominal control and appearance. While IRD at rest remained unchanged, active IRD decreased from three to one fingerbreadth above and at the umbilicus. Functional strength markedly improved across all tested domains, and scar tissue mobility significantly increased, potentially contributing to symptom resolution and improved muscular coordination.*

Conclusion: *This case highlights the potential efficacy of combining NMES, targeted core stabilization, and scar mobilization to manage chronic DRA and LBP. While further research is needed, particularly in long-term postpartum populations, these results suggest that functional improvements and symptom reduction are achievable with conservative treatment strategies even many years after childbirth.*

1. Introduction

Diastasis Recti Abdominis (DRA) is a common condition among postpartum women, often resulting from pregnancy-related changes. DRA is characterized by the thinning, widening, and bulging of the linea alba caused by elevated intra-abdominal pressure as well as a separation of the rectus abdominus muscles. Prevalence is 100% at 35 weeks of gestation, decreasing to 50-60% at six weeks postpartum, and around 39-45% by six months postpartum. DRA is found to be present in 36% of women at 12 months postnatally [1,2].

Factors such as maternal age, multiparity, and cesarean delivery are linked to DRA, though consensus on specific risk factors remains elusive. Fei et al. studied DRA, as defined by an inter-recti distance (IRD) of \geq two centimeters (cm),

in women during the first postpartum year, concluding that risk factors for persistent DRA included multi-parity and cesarean section (CS) birth. The most recent guidelines recommend that DRA management be primarily conservative, with Physical Therapy being the preferred treatment approach. Effective rehabilitation is crucial as DRA can lead to long-term complications including low back pain (LBP) and stress urinary incontinence [3-9].

Several studies have shown that LBP is common in postpartum women, regardless of the type of delivery, with prevalence ranging from 21-55%. There are many treatment strategies, though no gold standard exists for DRA treatment, particularly in patients over 10 years postpartum. One encouraging study by Kamel et al. sought to uncover the efficacy of the use of neuromuscular electrical stimulation

(NMES) in women with DRA who were two months post-vaginal delivery. They found that the treatment, which included eight weeks of thrice weekly administration of 30 minutes-per-day NMES followed by a series of specific abdominal exercises, was effective in reducing DRA and was statistically significant compared to abdominal exercises alone. Similarly, Vanderthommen et al. proved that when combined with voluntary training, NMES can lead to greater gains in muscle strength and power compared to training alone [7-14].

NMES has been proven in the literature to increase motor units, muscle bulk, and muscle strength in healthy individuals as well as those with central nervous system insults (CVA, MS, SCI, etc.) by stimulating the peripheral nerve to evoke a muscle contraction. NMES enhances muscle protein synthesis and targets type II muscle fibers, also known as fast-twitch muscle fibers, that are responsible for short, powerful bursts of energy. This is in opposition to our physiological muscle recruitment pattern which favors type I/slow-twitch muscle fibers that allow for muscular endurance [15-18].

Given this research, it was hypothesized that NMES combined with an abdominal strengthening program could offer a promising treatment strategy for a patient with chronic DRA and LBP. The patient in this case reflection is a 54-year-old woman who self-referred to Physical Therapy in the setting of acute on chronic LBP with known but untreated DRA. She had previously met with a surgeon about surgical correction of her DRA in 2019 and while deemed a good candidate, she decided against pursuing it at that time due to potential risks associated with surgery as well as wishing to avoid a prolonged absence from her job. The patient's obstetric history included three gestations and three live births via Cesarean section deliveries (2005, 2007, and 2012) where a Pfannenstiel incision approach was used. She was hoping to have a vaginal birth after cesarean delivery (VBAC) for her second and third children. However, even though over 70% of women have successful VBAC, she was dissuaded by her OBGYN from pursuing it due to the risk of uterine rupture. Other notable past medical history includes hypercholesterolemia, for which the patient takes 10mg of atorvastatin daily. The patient lives with her three children, husband, and mother and works as an acute care Physical Therapist, a job that involves heavy lifting, bending, squatting, guarding patients from falls, ambulating frequently, and sitting for 30-60-minute periods for documentation. Additionally, she had just embarked on a new fitness program including indoor and outdoor rowing, which precipitated her acute onset of LBP. She reports experiencing occasional LBP (one to two times per year, two to seven days in duration) throughout the last 15 years which would typically resolve with ice, rest, and stretching. During the patient's initial evaluation, she expressed an interest in decreasing her DRA to feel more comfortable in her clothes. She often would choose loose-fitting shirts to draw attention away from her DRA. This patient reported a hesitancy to perform abdominal exercises in the past due to fear of worsening her DRA and the overall appearance of her abdominal wall. She stated that before her first pregnancy

nineteen years ago, she had a "six-pack" with clearly defined rectus abdominus muscles, though, since her deliveries, she had become self-conscious of her DRA. Women with increased IRD have reported decreased body image and perceptions of physical function and ability as compared to before their DRA [19-20].

As a Physical Therapist herself who had taken a few obstetric Physical Therapy courses, the patient felt encouraged that, despite the chronicity of her condition, there were interventions worth trying.

The patient vocalized a desire to reduce her LBP and enhance functional capacity for rowing exercises without visibly doming at her abdominals. The patient described her pain as soreness or achiness in nature, noting that it was primarily in the right lower back though occasionally in the right lower abdomen with rowing. Her pain started approximately one week prior to the initial evaluation. Pain in these locations could be due to fibroids, myofascial pain, hernia, neuralgias, and lumbar disc issues. Since the pain occurred with or immediately following movement, and the patient was post-menopausal, visceral pathology or menstrual-related pain were considered unlikely causes, and therefore, the focus shifted to a musculoskeletal differential diagnosis. This included myofascial pain/adhesions from the Pfannenstiel scar, abdominal wall strain, sacroiliac joint pain, lumbosacral pain syndrome, muscular strength/length imbalances, and low back muscle strain due to overuse. Hence, it was determined that, in addition to performing a full Physical Therapy evaluation including strength, range of motion, and pertinent special tests, assessing mobility at the patient's Pfannenstiel scar was also included. Women with CS as compared to vaginal deliveries have been shown to have thinner muscular tissues in their rectus abdominus, wider IRD, and thicker loose connective tissue and abdominal perimuscular fascia which may cause deficits in muscular strength, coordination, and fascial mobility, particularly at and surrounding the scar. Hypomobility of CS scar tissue can contribute to chronic LBP. Given the initial gathered information, this author decided to incorporate NMES in combination with abdominal exercises to address strength deficits and thus improve the coordinated control of the patient's core muscles to reduce LBP. Furthermore, based on the subjective assessment and subsequent finding of scar adhesions, scar massage techniques would be employed at the patient's weekly sessions [21,22].

2. Examination

Upon physical examination, no "red" or "yellow" flags were identified to warrant a referral to the patient's primary care provider nor prevent her from participating in Physical Therapy interventions. Significant findings included postural, strength, range of motion (ROM), and myofascial restrictions. In standing, the patient demonstrated a chest-dominant breathing pattern, increased lumbar lordosis with anterior pelvic tilt, and mildly rounded shoulders. Lumbar active ROM revealed decreased left lateral side flexion with right LBP/tightness as compared to right lateral side flexion. Total lumbar flexion, extension, rotation left and

rotation right were all within normal limits and pain-free aside from mild bilateral hamstring tightness reported with lumbar flexion. The lumbar exam did not reproduce pain that indicated neural involvement. The slump test in sitting was chosen due to its high sensitivity at 82.6%. In a supine position, the patient did not demonstrate any lumbopelvic neural involvement with the Straight Leg Raise (SLR) Test either. To rule out hip and sacroiliac joint dysfunction, flexion-abduction-external rotation (FABER) and flexion-adduction-internal rotation (FADIR) tests were performed, both of which were negative bilaterally. The FABER/Patrick's test was chosen because it has a sensitivity of 81%. The FADIR test was chosen because it has a sensitivity of 94% and a specificity of 8%. The Thomas test was also negative bilaterally, ruling out iliopsoas tightness or concordant groin pain as a cause [23-27].

Prone instability testing (PIT) along the right lumbar spine at levels L3-5 proved positive, suggesting lumbopelvic instability. The PIT has a 71% sensitivity rate and a 57% specificity rate.

When assessing the posterior trunk, the patient reported tenderness to palpation (TTP) along the right erector spinae and right quadratus lumborum, indicating her pain level as a 4/10 on the visual analog scale (VAS). The VAS is commonly considered a reliable tool for measuring pain levels.

The Oswestry Disability Index (ODI) was used as a functional outcome measure for this patient. The ODI is widely used in the assessment of the impact of LBP on a patient's daily life and overall disability. As an assessment tool, it has been proven to have good construct validity, acceptable internal consistency, and high test-retest reliability and responsiveness. At the time of the initial evaluation, the patient scored 22% on the ODI, with increased difficulties noted with prolonged sitting, standing, heavy lifting, and mild challenges with sleep, travel, and personal care [28-30].

Lower extremity strength manual muscle testing (MMT) was all 5/5 except 4/5 bilateral hip adduction and 4+/5 bilateral hip abduction. Single leg glute bridge on the right was performed for 15 seconds and on the left for 20 seconds prior to fatigue, as evidenced by a loss of original hip elevation of 25% or more. While not a statistical marker for low back pain, both values were on the low-end range or below normal for endurance testing, as averages range between 60-100 seconds. Forearm plank and right and left side plank endurance were evaluated at 32, 20, and 22 seconds respectively, all significantly below average values for females, which range in the literature from 60-90 seconds for forearm plank and 30-45 seconds for side plank [31-33].

As previously discussed, this patient had undergone three Cesarean sections; the last one was eleven years prior. Pfannenstiel scar mobility was assessed in four segments: left, center left, center right, and right. Skin and scar tissue were able to move freely in all directions on the left and center left segments. Minimal restrictions were noted in the center right segment in the inferior and right lateral directions.

Moderate restrictions were felt in superior, inferior, left, right, and diagonal directions on the right segment of the scar, and two small adhesions were palpated. The patient reported mild TTP in the right segment, with a pain rating of 2/10 on the VAS, and Carnett's test confirmed positive. Carnett's sign was used to differentiate between abdominal wall versus visceral involvement. The Carnett's test has an 81% sensitivity and 88% specificity for abdominal wall pain [34].

Finally, DRA was tested using the method of palpation, identified as the number of fingers that fit between the medial borders of the rectus abdominus muscles, as this method is what is most used in the clinic and is considered "good" intra-rater reliability. A tape measure was used for assessment of the patient's DRA at 4.5cm above the umbilicus (a), at the umbilicus (b), and 4.5 cm below the umbilicus(c). DRA was measured at rest and with active sit-up at the a, b, and c levels with findings of (a): three fingers width at rest, two fingers active; (b): three fingers rest, two fingers active; (c): two fingers rest, zero fingers active respectively. IRD of greater than or equal to two fingers or two cm was considered positive DRA [35-37].

3. Evaluation and Diagnosis

In summary, the patient had postural, abdominal, and hip strength deficits, muscular and fascial restrictions at the lumbar spine, and hypomobility of the right and center right segments of the CS scar. She was TTP along the right erector spinae and quadratus lumborum, in the area in which she had been experiencing pain, and the PIT was positive. A score of 22% on the ODI indicated moderate disability from her LBP. DRA was considered moderate at three fingers at rest above and at the level of the umbilicus, and mild below the level of the umbilicus. This therapist's Physical Therapy diagnosis was that the patient's scar tissue adhesions and lumbar muscular restrictions as well as deficits in hip strength and abdominal strength, as evidenced by the presence of DRA, were contributing to an acute on chronic onset of low back pain. It was believed to be exacerbated by the patient's new rowing exercise program that heavily relied on engaging her trunk muscles. Rowers with low back pain compared with those without low back pain exhibited significantly higher thoracic and lumbar erector spinae muscle activities [38].

4. Prognosis and Plan of Care

The prognosis for this patient was considered good as she was highly motivated to improve her physical appearance, reduce low back pain, and stay committed to a new rowing program. She also considered herself to be highly likely to meet external expectations and thus was seen as a patient who would be adherent to a three times per week home exercise program (HEP). However, given the length of time postpartum, as well as the patient's post-menopausal status, it was unclear what extent of change at the IRD could be expected, particularly as no literature currently exists on the efficacy of a HEP for people with chronic DRA greater than two years postpartum. The duration of the Plan of Care (POC) was based on the patient's availability as well as time for adequate muscle strength gains, and consequently, was

set to one time per week for eight weeks with the patient's adherence to a three times per week HEP consisting of NMES and abdominal strengthening exercises. Previous studies have shown that early improvements in muscle strength are primarily due to neural factors, such as enhanced neural innervation. After three to five weeks of strength training, increased neural innervation and muscle hypertrophy contribute to strength gains; however, hypertrophy becomes the dominant factor after this period. The American College of Sports Medicine Guidelines recommend that strength training for healthy individuals should consist of a minimum of two to four sets of 8–12 repetitions per set, at 60–70% of one-repetition maximum, performed at least two to three days per week with progressively increasing exercise intensity. An eight-week timeframe was chosen to capture both neural and hypertrophic changes in muscle strength. At the evaluation, the patient and this Physical Therapist established four goals: LBP reduction to one day or less per week at a VAS of $\leq 2/10$ while adhering to three to four days per week of rowing exercise; decrease in ODI from 22% to $\leq 12\%$ to reflect minimal disability; reduction in DRA to one finger or less actively and to two fingers or less at rest to improve her abdominal appearance and feel more comfortable in shirts; no noticeable doming at the abdomen during a 15-minute rowing session [39-43].

5. Intervention

The patient attended weekly sessions over eight weeks. In determining which exercises to prioritize and what frequency and exercise progression to use, recently published review studies on DRA and exercise were used. Berg-Poppe et al performed a systematic review of the "Use of Exercise in the Management of Postpartum Diastasis Recti" and concluded that motor control exercises that optimally engage the inner and outer abdominal muscles significantly reduced IRD, though no protocol was found more beneficial than the others. Skoura et al. analyzed 28 full-text articles for identifying current exercise interventions and adjunct modalities and summarized the latest clinical Physical Therapy practices for the treatment of DRA. Exercise program duration varied in most studies between six and twelve weeks with frequency from one to three times per week. The Transversus Abdominus (TrA) was a key element in most DRA treatment protocols. TrA muscle activation is facilitated by an abdominal drawing-in maneuver performed after a deep exhalation. In 2016, a cross-sectional repeated measures study tested the hypothesis that activation of the TrA before a curl-up would improve IRD narrowing, with less linea alba (LA) distortion/deformation, which could allow for better force transfer between sides of the abdominal wall. The study found that the pre-activation of TrA resulted in reduced IRD [44-46].

The reduction in DRA during curl-ups was found to be similar in women with vaginal deliveries and those with cesarean sections. The difference between decreasing IRD in research participants performing curl-ups vs. sit-ups was negligible and both were found effective as they address strengthening the rectus abdominus muscles. Walton, Costa, and LaVanture studied the effects of traditional exercises given to women

with DRA. Each of the exercises employed the use of a sheet to help approximate the DRA and the following exercises were performed: abdominal crunch, pelvic floor muscle contraction, posterior pelvic tilt, and Russian twist, with the addition of a plank in the experimental group. The traditional treatment group proved superior in the reduction of the DRA. Similarly, Thabet and Alshehri performed a randomized control trial that showed that an additional focus on activating the deep core with diaphragmatic breathing and pelvic floor muscle (PFM) contractions was superior to traditional exercises alone in reducing DRA. Based on this literature review, diaphragmatic breathing, TrA and pelvic floor muscle co-activation, sit-ups, trunk rotation, and approximating the DRA were considered of high importance to include in the HEP for this patient [47-50].

As previously reported, the patient demonstrated a positive PIT. Sung et al. concluded that patients with a positive PIT could benefit from a core stabilization exercise program. While the Kamel et al. study has been one study of significance using NMES to treat DRA in recent history, NMES to the abdominal musculature of healthy individuals has been proven to increase strength by 14-22% since initially published by Alon et al. in 1987. NMES was thus chosen to be added to the established core strengthening program. Additionally, given the patient's decreased scar tissue mobilization, scar massage techniques were employed at the patient's weekly sessions starting at week two. While scar tissue mobilization is most effective within the first two years after surgery, there are benefits to scar massage even in chronic states for pain reduction and increased mobility.

Since the patient expressed TTP along the right erector spinae and quadratus lumborum and reduction in LBP was one of her primary goals, it was considered important to address her pain at the initial evaluation by providing manual therapy techniques. As defined by the APTA, "Manual therapy techniques are skilled hand movements and skilled passive movements of joints and soft tissue and are intended to improve tissue extensibility; increase range of motion; induce relaxation; mobilize or manipulate soft tissues and joints; modulate pain; and reduce soft tissue swelling, inflammation, or restrictions." Therefore, the initial session included soft tissue mobilization to the patient's right erector spinae and quadratus lumborum. This Physical Therapist established the NMES parameters for the patient's HEP and the patient was instructed on the selected abdominal exercises during the first Physical Therapy session, both of which are explained in detail later in this case reflection. The patient reported an immediate improvement in LBP following the soft tissue mobilization from a 4/10 to a 2/10 on the VAS. NMES parameters for the HEP were as follows: frequency of 50 pulses per second (pps), pulse width of 250 μ s, starting intensity of 20 milliamps, on time of five seconds, off time of ten seconds, total duration time of 30 minutes. One 2x4 inch electrode was placed horizontally two fingers above and one 2x4 inch electrode was placed two fingers below the umbilicus bilaterally. For the initial session, NMES was applied for five minutes to establish adequate muscle contraction parameters and comfort, as well as to confirm

that there were no adverse reactions from the treatment. The patient tolerated the NMES well. The electrode placement followed the same design as the Kamel et al. study, as were the parameters of on/off times and duration. Frequency and pulse width were mildly different (from 80pps in the Kamel study to 50pps in this case reflection and from a range of 100-500µs pulse width in the Kamel study to a static 250µs pulse width in this case reflection). The decision to reduce the frequency was based on research revealing that higher frequencies can lead to earlier muscle fatigue. The handheld NMES device used for this patient offered a static pulse width option, thus 250µs pulse width was chosen as a midrange as it allowed for a strong but comfortable muscle contraction while the milliampage was increased. Per the patient's request, pictures were provided as well as an NMES unit in which the pulse width, frequency, duration, and on/off time parameters were locked. The patient was free to increase the intensity of the electric stimulation via the milliamps based on tolerance and muscle contraction noted, with the goal of a strong but tolerable intensity that elicited a coordination muscle contraction at bilateral rectus abdominus muscles [13-57].

Once the NMES portion of the HEP was established, the patient was then provided with therapeutic exercises. She practiced one set of three to five reps of each of the exercises with tactile and verbal cueing to ensure understanding and proper performance. Again, per the patient's request, pictures and written descriptions were provided to ensure adherence to the protocol. The initial HEP for these exercises was as follows, all starting in the hook-lying position: (1) 10 reps of diaphragmatic breath inhalation followed by abdominal bracing muscle co-contraction (TrA + PFM) with a five-second hold, 20 reps of sit-ups to a 45-degree angle (inferior angle of scapula coming off of the mat) in combination with abdominal bracing while using both hands crossed over midline on each lateral side body to approximate the abdominals (abdominal approximation), 20 reps of single knee reverse sit-ups: one knee starting from 90/90 degrees of hip/knee flexion with opposite knee in a hook-lying position, patient initiating with abdominal bracing and abdominal approximation, slowly lowering the elevated foot to the ground and then back to 90 degrees, 20 reps of reverse trunk twists: both hips/knees in 90/90 degrees flexion, patient initiating with abdominal bracing and abdominal approximation and slowly rotating legs from side to side. As previously established, while there is no gold standard for core strengthening to address a patient with DRA experiencing an acute bout of LBP, these exercises or similar were most consistently used. Appropriate time was spent to ensure an adequate understanding of the performance of each activity, particularly concerning diaphragmatic breathing as the patient was noted to be a chest-dominant breather. The patient-initiated exercises 2-4 with abdominal bracing and abdominal approximation to help minimize doming. Doming or tenting of the abdomen is a sign of DRA that occurs when the abdominal muscles bulge because of increased pressure. The patient departed the initial evaluation with a reduction in pain and a good understanding of the HEP. Mid-way through the first week,

the patient was contacted by phone to ensure initiation and continued understanding of the program and to address any concerns, for which she expressed none. In each subsequent session, the patient's pain and compliance with the HEP were assessed. If relevant, soft tissue mobilization techniques to address LBP were used. Starting on the second session and each session thereafter, scar tissue mobilization was performed. Scar tissue mobilization using a direct technique focused on the right center and right aspects of the scar in the restricted directions. Longitudinal, inferior, and cross-pattern stretching techniques were utilized, as well as methods of skin rolling and lift and rolling. A low load, prolonged duration was applied to the adhesions. Initially, the right and right center segments of the scar were still mildly TTP, rated at a 2/10, lessening following 15 minutes of treatment [50].

During the second session, the therapeutic exercises were reviewed, with the patient performing five reps of each of the exercises. The patient was asked to provide a rating of perceived exertion (RPE) with the total routine at home and stated it was at a 6/10 on the modified Borg scale. RPE is a valid measure of intensity and physiological exertion during strengthening exercises. Based on this patient's compliance, tolerance, and quality demonstration of the exercises, isometric hip adduction (ball squeeze between her knees) was added to exercises 2-4 to address hip adduction weakness. Decreased hip adduction strength is associated with lumbopelvic pain in women postpartum. A discussion of incorporating abdominal bracing into the patient's work activities to prevent pain exacerbation was also had, with good understanding reported. The patient noted at the third session that her low back pain was already starting to improve, with a 2/10 on the VAS following rowing sessions that would often resolve by midday. In addition, the patient subjectively reported reduced doming with rowing, though still needed to consistently mentally attend to activating her abdominals throughout the entire workout. With regards to the NMES portion of the HEP, the patient gradually increased the NMES as she accommodated to the intensity within each session as well as session to session, starting at 20mA and increasing over time to a maximum of 35mA. Application and performance were reviewed at the third session to ensure consistency with original instruction. The patient reported that she always required 2-4mA higher on the right side to achieve the same muscle recruitment as the left. At the fourth session, the patient reported an RPE of 4/10 with the exercises and was able to advance exercise 3 from a single to bilateral knee reverse sit-ups as well as add four reps to each of the exercises 2-4. During the sessions at weeks five and seven, the patient added four reps to each of the exercises 2-4 each week, resulting in her performing a total of 32 reps for each exercise in weeks seven and eight. She was encouraged to break up the repetitions into two to three consecutive sets if her form worsened with fatigue.

Scar tissue mobilization remained a weekly focus. By the patient's fifth session, the center right segment of the scar had a persistent minimal restriction in the right lateral direction, though freely moving in the inferior direction.

The right segment of the scar continued to have two small adhesions though with overall improved mobility qualified as minimal restrictions in all directions.

Additionally, at week five, the patient expressed available time and interest in self-performing scar tissue mobilization. She was educated in performing a direct approach with massage to the right center and right segments of the scar in all directions as well as lifting and rolling the scar for 10 minutes, right before performing the HEP. She was provided with a written handout on this topic created by the APTA Pelvic Health Academy [57].

By the patient's sixth session, she reported no longer being afraid to perform the abdominal exercises due to a subjective report of decreased doming. She reported 0/10 pain on the VAS in her low back and abdomen with or following rowing exercises and less than one day per week of LBP at rest or with other activities. At her final session, week eight, the patient subjectively reported improved confidence and abdominal muscular function. She endorsed 100% compliance with the established program for the eight weeks, including the addition of scar tissue massage starting at week five. The scar tissue at the patient's center right segment moved freely in all directions. In the right segment of the scar, adhesions were no longer palpated, with the patient endorsing 0/10 on the VAS with palpation, and only minimal restrictions were noted in the right lateral and inferior directions.

6. Outcomes

As established at the evaluation, the patient had four goals including reduced LBP during and after rowing, improved disability scoring on the ODI, improved abdominal appearance as evidenced by decreased IRD, and no noticeable doming at the abdomen during a 15-minute rowing session. Overall, the patient achieved meaningful results from the Physical Therapy interventions. Objectively, on her final session, week eight, the patient reported 0/10 on the VAS at her low back. She scored 0% on the ODI, indicating minimal/no disability. Unfortunately, no significant change was detected via palpation at her DRA at rest, remaining at the initial assessment measurements above, at, and below the level of the umbilicus (three fingers, three fingers, and two fingers respectively). However, with active testing, palpation of the IRD was reduced to one finger above and at the level of the umbilicus, remaining zero fingers actively below the level of the umbilicus.

Repeated strength testing showed marked improvements in abdominal and hip strength. First, hip adduction and abduction bilaterally tested 5/5 on MMT, an improvement from 4 and 4+/5 respectively. The patient improved her forearm plank duration from 32 to 60 seconds, side plank right from 20 to 35 seconds, and side plank left from 22 to 33 seconds, all without visibly doming. The patient's single-leg glute bridge improved from 15 to 50 seconds on the right leg and from 20 to 52 seconds on the left leg. These muscle strength test gains are all of significance as, aside from the addition of the patient adding an isometric hip adduction to the HEP, she did not train any of the other muscles in a

task-specific manner. This could suggest that improved strength in the patient's abdominal muscles as well as lack of pain inhibiting muscle activation enhanced the coordinated control of her core musculature [58-59].

While not a specific goal, the patient's scar tissue mobility was also much improved, which may correlate to the elimination of pain in her low back as well as coordinated muscle movement at her abdominals with rowing. The patient was able to successfully participate in 45–60-minute outdoor rowing sessions three times per week without pain and reported an ability to automatically incorporate diaphragmatic breathing with abdominal bracing for stabilization for the duration of the workout.

7. Case Reflection

The patient in this case achieved great outcomes as a result of the chosen Physical Therapy interventions. The integration of NMES and a structured abdominal strengthening program significantly improved the patient's symptoms related to DRA and low back pain. The patient's motivation and compliance with the HEP, as well as her knowledge and skill set as a Physical Therapist herself, were all major factors in the improvements in muscle strength and pain she achieved. Extrapolating these results to a patient who lacked these skills and enthusiasm for participation could be limited. Additionally, addressing hypomobility of the CS scar resulted in an eradication in her right lower abdominal pain and potentially contributed to the elimination of low back pain. Even though the patient was only seen once per week, she began self-massaging the CS scar at week five, and this additional mobilization may have increased the rate at which her mobility improved. While the patient's IRD did not improve at rest, it did improve with active engagement during a curl-up, reflecting improved coordinated abdominal muscle strength. One limitation of this study could be duration. Given the chronicity of her DRA, the capacity for improvement could be reduced and, despite this patient's compliance with the eight-week HEP, she may require a longer duration of intervention to impart changes in the resting assessment of her IRD. Other studies that have assessed muscle strength changes in post-menopausal women have suggested 10-12 weeks as ideal for observing statistically significant change. Another limitation is the method by which the patient's IRD was assessed. The palpation method, while considered "good" intra-rater reliability and the method most used in the clinic, is not as sensitive in measuring change as compared to the gold standard of ultrasound assessment. Because the NMES was performed in conjunction with the abdominal strengthening program, it is unclear in this patient that, had these treatments been performed separately (ie NMES or strengthening alone), she would have had the same outcomes. Based on the Kamel et al. study, the combination of the abdominal strengthening exercise program and NMES was more effective than exercise alone, though this study was performed on women who were only two months postpartum from vaginal birth [35-61].

No research articles were found by this author that addressed the treatment of DRA in patients greater than

two years postnatally. Having this data may have altered the chosen Physical Therapy interventions. The chronicity of this patient's DRA in combination with her post-menopausal status could impact her ability to make meaningful change at the resting IRD as reduced production of sex hormones is associated with a loss of skeletal muscle mass. This Physical Therapist was not trained in Functional Dry Needling, which could have been used initially to address the patient's low back pain in those areas that were TTP. Additional assessment of the patient's overall abdominal wall mobility and subsequent application of myofascial release techniques in this area could have been included as well, which may have decreased the time needed to improve the scar mobility. The addition of a specific scar mobility assessment like the Vancouver Scar Scale or the Patient and Observer Scar Assessment Scale could have provided more quantitative results on the patient's scar tissue mobility [62-65].

In summary, this patient achieved significant improvements including strength gains and pain elimination because of her consistency with the HEP and in-person Physical Therapy treatment interventions, and she was pleased with the results. The patient was encouraged to continue to include abdominal strengthening into her regular exercise routine to complement her rowing activities and help prevent future occurrences of LBP.

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