[CASE REPORT]

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Low Back and Hip Pain in a Postpartum Runner: Applying Ultrasound Imaging and Running Analysis

SUPPLEMENTAL VIDEO ONLINE

Lumbopelvic pain during pregnancy, including low back pain (LBP) and posterior pelvic pain, affects 50% of women.[3] Although the majority of symptoms subside 1 to 3 months after delivery,[1,33] up to 37% of women continue to have symptoms that last beyond the postpartum period (initial 3 months postdelivery).[35] Oftentimes, these symptoms become chronic in nature,[35] with approximately 7% of women exhibiting substantial disability.[42] Predictors for having persistent postpartum pain include low endurance of trunk flexors, older age, and pain in early pregnancy,[12] and the method of delivery does not appear to be a factor related to postpartum LBP.[40] The persistence of lumbopelvic pain can delay or prevent postpartum women from returning to an active lifestyle. This can have substantial health consequences, as women who are unable to return to a healthy weight within 6 months postpartum are at an increased risk for the development of chronic disease.[27]

STUDY DESIGN: Case report.

BACKGROUND: Postpartum low back and hip dysfunction may be caused by an incomplete recovery of abdominal musculature and impaired neuromuscular control. The purpose of this report is to describe the management of a postpartum runner with hip and low back pain through exercise training via ultrasound imaging (USI) biofeedback combined with running-form modification.

CASE DESCRIPTION: A postpartum runner with hip and low back pain underwent dynamic lumbar stabilization training with USI biofeedback and running-form modification to reduce mechanical loading. Muscle thickness of transversus abdominis and internal oblique was measured with USI preintervention and 7 weeks after completion of the intervention. Additionally, 3-dimensional lower extremity joint motions, moments, and powers were calculated during treadmill running.

OUTCOMES: The patient's pain with running decreased from a constant 9/10 (0, no pain; 10, worst pain) to an occasional 3/10 posttreatment. Transversus abdominis muscle thickness increased 6.3% during the abdominal drawing-in maneuver and 27.0% during the abdominal drawing-in maneuver with straight leg raise. Changes were also noted in the internal oblique. These findings corresponded to improved lumbopelvic control: pelvic list and axial rotation during running decreased 38% and 36%, respectively. The patient's running volume returned to preinjury levels (8.1-9.7 km, 3 days per week) with no hip pain and minimal low back pain, and she successfully completed her goal of running a half-marathon.

DISCUSSION: The successful outcomes of this case support the consideration of dynamic lumbar stabilization exercises, USI biofeedback, and running-form modification in postpartum runners with lumbopelvic dysfunction.

LEVEL OF EVIDENCE: Therapy, level 4.
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KEY WORDS: *abdominal drawing-in maneuver, pregnancy, running mechanics, transversus abdominis*

Although the exact causes of postpartum lumbopelvic pain are unclear, altered neuromuscular function of the abdominal and back muscles has been suggested as an important contributing factor.[11,32,42] An exercise program that addresses muscular dysfunction, such as dynamic lumbar stabilization (DLS), is frequently initiated postpartum.[10,37] One common issue in beginning such an exercise program is the difficulty the patient may have in perceiving the intended muscle contraction. As such, ultrasound imaging (USI) may be implemented as a biofeedback tool to improve the intended response and expedite recovery.[2]

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With this compromised muscular function in the postpartum woman, returning to an active exercise lifestyle can be challenging, especially for those involved in more vigorous activities such as running. While exercise programs alone have enabled a successful recovery,[2,4] modifying the running form to reduce the mechanical demands encountered by the body may expedite the return to running.[15] For example, a 10% reduction in stride length can reduce the mechanical energy absorbed by the lower extremities by approximately 20%, thereby decreasing the load imparted on the lower extremities.[16] Thus, the physical demands of running can be reduced, which may prove beneficial in returning to running without symptom provocation. Similar efforts of gait retraining have been helpful in reducing symptoms of other running-related injuries such as iliotibial band syndrome or patellofemoral pain.[5,31] The purpose of this case report is to describe the management of a postpartum runner with hip pain and LBP through the use of DLS exercises with USI biofeedback in combination with running-form modification. Changes in muscle thickness of the abdominal wall and running mechanics were objectively assessed before and after care to characterize the degree of changes associated with symptom improvement.

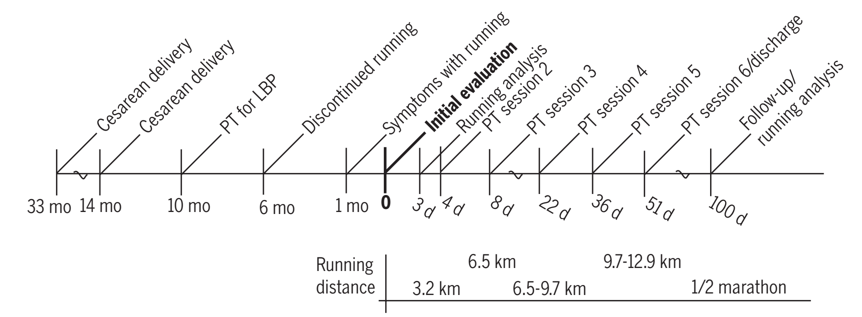

FIGURE 1. Timeline of patient's pertinent medical history, PT sessions, and running analyses, as well as the patient's typical running distance. Abbreviations: LBP, low back pain; PT, physical therapy.

TABLE 1 OBJECTIVE MEASURES FROM INITIAL PHYSICAL EXAMINATION

Test	Result
Passive range of motion (right, left)	
Hip flexion	120°, 120°
Hip extension	10°, 15°
Hip external rotation	60°, 60°
Hip internal rotation	30°, 30°
Active lumbar movement	• Full in all planes. End-range lumbar extension re-created LBP
Muscle-length tests (right, left)	
90-90 hamstring test	Normal, normal
Ober test	Positive, positive
Thomas test (2-joint muscles)	20° (hip abduction noted), 10°
Thomas test (1-joint muscles)	Normal, normal
Strength testing (right, left)	
Iliopsoas	4–/5,* 4+/5
Gluteus medius	3+/5, 4–/5
Gluteus maximus	4/5, 4+/5
Quadriceps	4/5, 4+/5
Hamstrings	4–/5, 4/5
Palpation	• The patient's right-side thigh pain was provoked with palpation and contraction of the sartorius muscle
Standing posture	• Increased lumbar lordosis • Increased thoracic kyphosis • Anterior pelvic tilt • Mild genu recurvatum

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CASE DESCRIPTION

History

The patient was a 33-year-old female, examined without referral, who presented with a chief complaint of right anterior lateral thigh pain with associated LBP. Ten days prior to the examination, she experienced a sudden, severe onset of LBP and right anterior lateral thigh pain, accompanied by a sense that her right knee "gave way" while running, which prevented her from completing her run. In subsequent running sessions, she experienced 2 to 3 similar episodes, rating her pain intensity during running as a 9/10 (0, no pain; 10, worst pain) on a visual analog scale. Exacerbating factors included lifting and carrying her 1- and 3-year-old children and getting in and out of a car. She rated her pain intensity as 0/10 at rest. She was currently taking no medications.

In addition, the patient described a history of recurrent LBP prior to the present episode. The patient had 2 Cesarean-section deliveries 19 months apart, the most recent 14 months prior to the initial examination (**FIGURE 1**). Four months after the birth of her second child (10 months prior to the initial examination), she had been treated by a different physical therapist to address an episode of LBP that also limited her tolerance to running. Treatment emphasized abdominal strengthen-

TABLE 1 — Objective Measures From Initial Physical Examination (continued)

Test	Result
Joint play assessment (spinal level)	
Posterior/anterior	
Normal	L1-L3
Hypermobile	L5
Pain limited, end range not assessed	L5
Unilateral posterior/anterior	
Pain limited, end range not assessed	L4, L5
Neurologic screen	• Neurological exam was negative for neural tension, myotomal weakness, abnormal reflexes, abnormal sensation to light touch, and clonus and Babinski signs bilaterally
Special tests (right, left)	
Straight leg raise	Negative, negative
Patrick (FABER)	Negative, negative
FADIR	Negative, negative
Sign of the buttock	Negative, negative
Prone instability test	Positive,† negative
Beighton scale (right, left)	
Genu recurvatum greater than 10°	Positive, positive
Elbow extension greater than 10°	Positive, positive
Wrist flexion with the thumb touching the forearm	Positive, positive
Fifth MCP extension to 90°	Positive, positive
Palms to floor	Positive

Abbreviations: FABER, flexion-abduction-external rotation; FADIR, flexion-adduction-internal rotation; LBP, low back pain; MCP, metacarpophalangeal.
**Pain.*
†Provoked pain and re-created symptoms at the L5 level.

ing, and the patient returned to running (9.7 km, 4 days per week) over the subsequent 4 months. However, she then experienced an exacerbation of her symptoms with unknown etiology. Magnetic resonance imaging (MRI) of her lumbar spine demonstrated multilevel degenerative disk disease and degenerative facet disease, most notable at L4-5 and L5-S1. She discontinued running for 5 months due to pain. Approximately 1 month prior to the initial examination, she attempted to resume running (6.5 km, 3 days per week) but continued to have intermittent exacerbations of LBP that prevented her from running sequential days or running more than 6.5 km per session.

Examination

Physical examination findings are summarized in **TABLE 1**. The patient demonstrated limited right hip extension. In addition, she experienced LBP provocation at end-range lumbar extension, whereas other trunk motions were pain free. With forward trunk flexion, aberrant motion of the lumbar spine was noted and the patient was able to place her palms on the floor. This led to measurements of the other Beighton variables, resulting in a Beighton score of 9/9.[34]

The patient had bilateral iliotibial band tightness per the Ober test. The Thomas test for 2-joint muscles indicated less flexibility on the right side as compared to the left side. In the 90-90 position, the patient was able to fully extend each knee, indicating normal hamstring flexibility.

With joint play assessment of the lumbar spine, LBP was provoked with posterior/anterior assessment of L5 and bilateral unilateral posterior/anterior pressures of L4 and L5. Due to muscle guarding with these techniques, end range was not assessed. The prone instability test was also positive at L5. Strength testing revealed weakness of the right iliopsoas, gluteus medius and maximus, quadriceps, and hamstrings, as compared to the left side. Functional testing revealed increased right hip internal rotation and medial deviation of the right knee with unilateral squatting.

An ultrasound imaging system (Aquila Pro; Esaote Europe BV, Maastricht, the Netherlands), with a 3.5/5.0 MHz, R40 HiD, curved-array probe, set at 5.0 MHz, was utilized to evaluate the thickness of the abdominal wall musculature by a physical therapist trained in its use. Assessment of the transversus abdominis (TrA) and internal oblique (IO) muscles via USI has variable interimage, intrarater correlation coefficients ranging from 0.62 to 0.97.[14] A relationship between increases in muscle thickness measured by USI and increases in muscle activation, as measured by fine-wire electromyography, has been established.[8,24,30]

For the assessment of TrA and IO muscles, the patient was positioned in hook-lying and the transducer was placed midway between the iliac crest and the 12th rib, lateral to the umbilicus.[39] The TrA and IO muscles were observed at rest, during the abdominal drawing-in maneuver (ADIM), and during the ADIM with a concurrent straight leg raise (SLR). Two measurements of muscle thickness (interimage) were taken for the TrA and IO muscles on the right side by the same physical therapist (intrarater), after the patient received verbal and manual cuing. When asked to perform the ADIM, the patient was not able to actively isolate her TrA muscle with cues to "draw her belly in and up" or "try to stop the flow of urine" and, instead, demonstrated a strong contraction of her IO musculature. With approximately 10 minutes of manual cues and additional

TABLE 2 Muscle Thickness Measurements (mm) of the Right Transversus Abdominis and Right Internal Oblique at the Initial Examination and at the 7-Week Posttreatment Follow-up (100 Days After Initial Examination)

	Initial Examination	7-Week Posttreatment	Percent Change
At rest			
TrA	5.5	4.2	–23.6%
IO	8.5	9.0	5.6%
ADIM			
TrA	7.4	7.9	6.3%
IO	11.1	11.4	2.6%
ADIM with straight leg raise			
TrA	6.8	9.3	27.0%
IO	13.3	11.0	–17.3%

Abbreviations: ADIM, abdominal drawing-in maneuver; IO, internal oblique; TrA, transversus abdominis.

verbal cues and visual cues via USI, the patient was able to successfully contract her TrA muscle. The 2 measurements of muscle thickness of the right TrA and IO muscles at rest, during the ADIM, and during the ADIM with a concurrent SLR were averaged (**TABLE 2**).

Three days after the initial examination, a qualitative video analysis of the patient's running mechanics was performed by a physical therapist experienced with this technique. The patient ran at her preferred speed (2.68 m/s), on a 0% incline treadmill, in her typical running shoes, while video was recorded (30 Hz) nonsynchronously in the frontal and sagittal planes. Review of the video indicated a distinct heel-strike pattern, with a near fully extended knee at initial contact. Excessive lateral tilt (pelvic list) was noted during midstance of each lower limb, with a step rate measured at 168 steps per minute. Based on these observations, the patient was advised to reduce her running stride length by 10%, as an initial strategy to reduce the mechanical load to her body.[16] This was immediately achieved during the session by having the patient run at her preferred speed, while temporally matching her foot strikes to an audio metronome set to 185 beats per minute. The patient was also instructed in a running program designed by the primary physical therapist, which emphasized a slow progression of distance of approximately 10% per week.

To provide an objective measure with which to assess treatment effect, a 3-dimensional analysis of the patient's running mechanics was performed according to a standardized protocol described elsewhere.[16] In brief, whole-body kinematics were recorded (200 Hz) synchronously with ground reaction forces (2000 Hz) while the patient ran at her preferred speed (2.68 m/s) on a treadmill. The body was modeled as a 14-segment, 31-degrees-of-freedom articulated linkage. Joint angles were computed at each time step using a global optimization routine to minimize the weighted sum of squared differences between the measured and the model marker positions.[29] Joint powers were computed as the product of the joint moment and angular velocity for each joint. Considering the patient's chief complaint and history, the biomechanical outcome parameters were limited to (1) pelvic excursion in each plane of motion defined relative to the global coordinate system, and (2) the negative work performed by the lower extremity joints during the loading response (foot contact to peak knee flexion during stance phase of the gait cycle) for both lower extremities. The analysis revealed 16° of pelvic list excursion (frontal plane motion of the pelvis) during midstance of each lower limb (**FIGURE 2**). On average, females exhibit a pelvic list of 8.5° when running at 2.7 m/s with 0% incline.[6] Similarly, the patient exhibited 14° of pelvic rotation excursion during running, whereas the average for females at this running speed is 10.5°.[6] Pelvic tilt excursion was 6°, consistent with published data for this motion.[36] The total negative work performed by the right lower extremity (combined negative work at the hip, knee, and ankle) was 1077.4 J, whereas that of the left lower extremity was 758.1 J (**FIGURE 3**). Thus, the right lower extremity had to absorb 30% more mechanical energy during running than the left lower extremity.

Diagnosis and Prognosis

The patient had hip pain and LBP with altered lumbopelvic neuromuscular control. Furthermore, she met specific criteria indicating that a lumbar stabilization program might be beneficial: (1) postpartum female less than 40 years of age, (2) positive prone instability test, and (3) aberrant movement during trunk flexion.[9] She did not demonstrate excessive hamstring flexibility, as the 90-90 hamstring flexibility test was normal. Gross systemic hypermobility was observed, as her Beighton score was 9/9, where scores greater than 4/9 indicate benign systemic hypermobility.[34]

Based on the USI assessment, the patient had greater thickness of her IO musculature as compared to her TrA muscle at rest, during the ADIM, and during the ADIM with SLR. The decreased ability to thicken the TrA muscle during the ADIM, in addition to her gluteal strength deficits, was a likely contributing factor to her altered lumbopelvic control during running, thereby contributing to her LBP.

The short-term prognosis for this patient was good secondary to the number of impairments deemed treatable. The long-term prognosis for this patient was also good, given that the patient reported good compliance with previous home exercise programs. In addition, she was able to preferentially contract the TrA muscle after minimal visual feedback using USI.

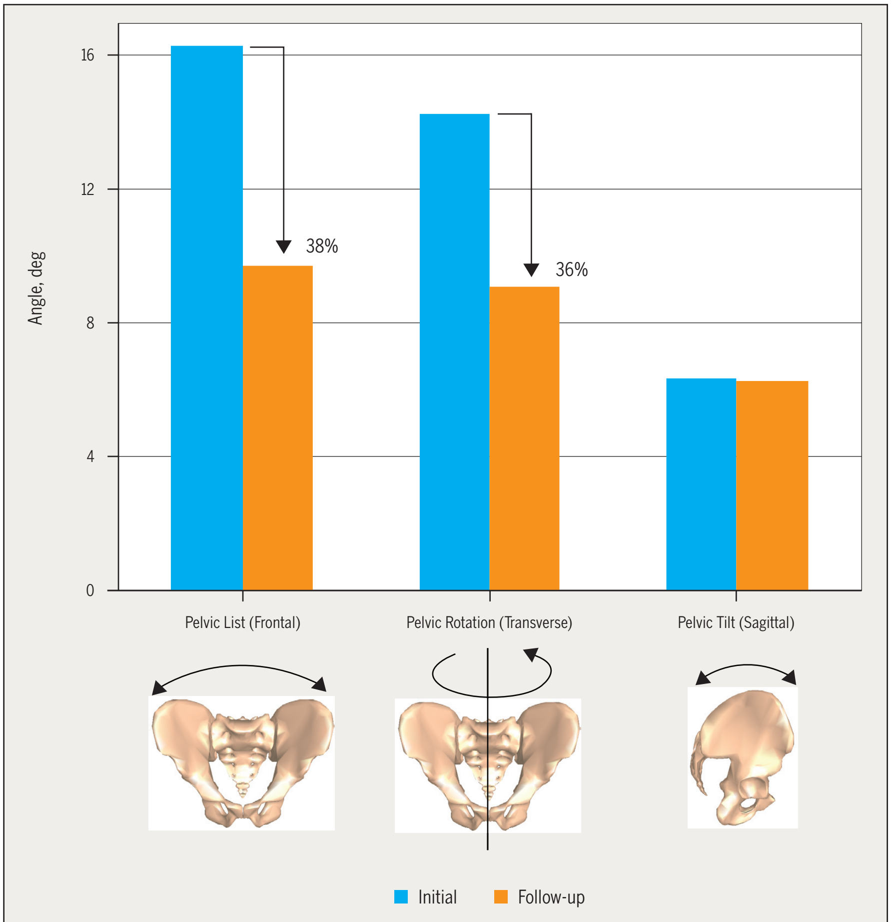

FIGURE 2. Angular excursion of the pelvis was measured during treadmill running at the initial assessment (2.68 m/s; 168 steps per minute) and at the 7-week posttreatment follow-up (2.68 m/s; 192 steps per minute). Pelvic list (38%) and rotation (36%) showed a substantial decrease in total excursion, whereas pelvic tilt remained unchanged. Average pelvic excursions for females when running at or near 2.68 m/s are 8.5° (list), 10.5° (rotation), and 8° (tilt).[6,36]

Intervention

Session 1 (**Day 1**) Treatment on the day of the initial evaluation focused on management of right anterolateral hip pain and improving her lumbar spine neuromuscular control. The patient was instructed to perform a daily standing hip flexor stretch and prone body ball-rolling exercise in order to facilitate a passive stretch of the soft tissue in the same area. In addition, the patient was instructed to perform the ADIM submaximally, at 50% effort, in a hook-lying position on a daily basis (**TABLE 3**).

Session 2 (**Day 4**) The patient reported that her thigh pain had resolved and her pain was now limited to her low back. She ran 3.2 km (2 mi) on day 2 but experienced an exacerbation of LBP. The patient was instructed and trained in running with a 10% increase in step rate, as determined during the qualitative running analysis. The ADIM was reviewed using USI biofeedback, and the patient demonstrated an improved ability to thicken the TrA muscle. The patient was treated with manual therapy, which included a sidelying lumbar mobilization of the right L4-5 and right lumbosacral facet joints, facilitating a flexion-opening pattern to the affected area.[7] Her daily home program was advanced to include supine bridging on her heels, with a between-the-knees ball squeeze, as well as a sidelying iliotibial band and quadriceps stretch (**TABLE 3**).

Session 3 (**Day 8**) The patient reported resolving LBP. She had tolerated running a distance of 6.5 km (4 mi) on 2 occasions, with minimal exacerbations of LBP. The ADIM was again reviewed with USI biofeedback. Although progression to bridging with marching was attempted, the patient demonstrated difficulty maintaining a neutral lumbar spine position and maintaining TrA muscle contraction. With repeated verbal and manual cues, and USI biofeedback, she was able to successfully perform a few repetitions during the session, but the exercise was not prescribed at this time. She was instructed to continue with her current home exercise program.

Session 4 (**Day 22**) The patient reported running 6.5 to 9.7 km (4-6 mi) 3 days per week with mild LBP. The bridging-with-marching exercise was attempted,[26] and the patient again demonstrated difficulty maintaining a neutral spine. She was not able to successfully perform prone hip extension due to hyperlordosis, presumably caused by continued abdominal strength deficits and bilateral hip flexor tightness. She was instructed to perform daily ADIM in prone with concurrent knee flexion.[26] The bridge was progressed to weight shifting via alternating heel raises. Standing squats with concurrent ADIM were also added (**TABLE 3**).

Session 5 (**Day 36**) The patient reported that she was running 9.7 to 12.9 km (6-8 mi) 3 days per week, with a total weekly distance of 32.3 km (20 mi). She reported occasional, manageable exacerbations of LBP (3/10 on a visual analog scale) on the days she ran 12.9 km (8 mi). She reported no episodes of hip or knee pain. With assessment via USI, the patient demonstrated improved thickness of the TrA muscle while maintaining only minimal changes in IO muscle thickness during the ADIM. In addition, with multiple verbal and manual cues and USI biofeedback, the patient was able to successfully perform the bridge-with-marching exercise. This exercise was prescribed to be performed daily, in addition to sideplanks on knees and 4-point opposite arm/leg extension exercises (**TABLE 3**). The patient was treated with manual therapy, which included a sidelying lumbar mobilization of the right L4-5 and right lumbosacral facet joints, facilitating a flexion-opening pattern to the affected area.[7]

Session 6 (Day 51) At the patient's final visit, her subjective report (0/10 pain at rest, 3/10 occasional pain with running) and running distance were similar to her previous visit. She was progressed to sideplanks on heels with her back against the wall. Because she demonstrated appropriate technique with unilateral one-quarter squats, they were added to her home exercise program. In addition, eccentric hamstring strengthening via the windmill exercise, as described by Heiderscheit et al,[17] was added. Because the patient felt that she could independently manage her condition and had successfully returned to running, she was discharged (**TABLE 3**).

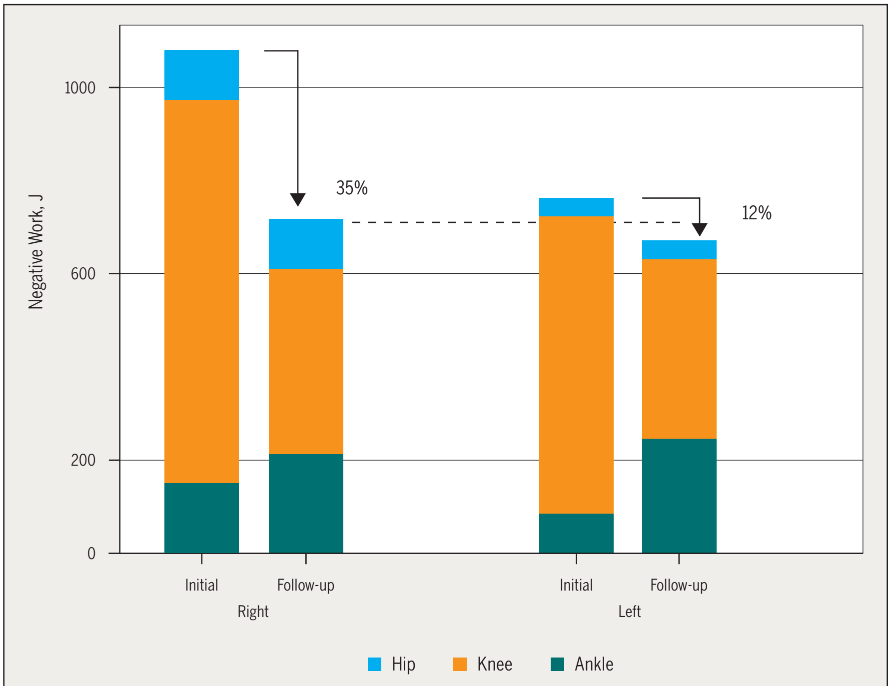

FIGURE 3. Negative work (J) performed by the lower extremity joints during treadmill running was measured on the patient at the initial assessment (2.68 m/s; 168 steps per minute) and at the 7-week posttreatment follow-up (2.68 m/s; 192 steps per minute). At the initial assessment, the patient demonstrated a substantial asymmetry, with the right lower extremity (1077.4 J) absorbing 30% more mechanical energy than the left lower extremity (758.1 J). At the follow-up, the negative work performed by the right lower extremity was 35% less than at baseline, resulting in a bilateral asymmetry of less than 6%.

OUTCOME

7-Week Follow-up (100 Days)

Although a daily exercise log was not used, verbal questioning of the patient at each treatment session and follow-up visit revealed she was compliant with the prescribed interventions and running step rate change. Improvements were maintained 7 weeks after discharge. She reported running 8.1 to 9.7 km (5-6 mi) 3 days per week with no hip pain and minimal LBP. She had also successfully completed her goal of running a half-marathon with no exacerbation of prior symptoms. She demonstrated a unilateral bridge on the right with minimal movement of her pelvis. She successfully performed a 30-second sideplank with her back against the wall, and demonstrated appropriate technique during unilateral one-quarter squats. USI assessment of the TrA and IO muscles was performed according to the protocol used during the initial examination. As compared to her initial examination, the patient's TrA muscle thickness at rest decreased 23.6% and her IO thickness increased 5.5%. Her TrA and IO muscle thicknesses during the ADIM increased 6.3% and 2.6%, respectively, from initial examination. For the ADIM with a concurrent SLR, her TrA muscle thickness increased 27.0%, while her IO muscle thickness decreased 17.3% (**TABLE 2**).

The 3-dimensional running analysis performed near the start of care was repeated at the same running speed (2.68 m/s). She was instructed to run at the step rate that she had been using over the past 2 months, which was subsequently determined to be 192 steps per minute. Compared to the initial assessment, frontal plane angular excursion of the pelvis (pelvic list) was reduced by 38%, with a similar reduction (36%) observed in the transverse plane (axial rotation) (**FIGURE 2**). With regard to the total negative work performed by the right lower extremity, a 35% reduction was present at the initial assessment to be reduced to less than 6% (**FIGURE 3**). This resulted in the 30% bilateral asymmetry in mechanical energy absorption present at the initial assessment, which reduced to less than 6% at the follow-up.

DISCUSSION

This case report demonstrates the successful management of hip and LBP in a 33-year-old postpartum female who reported difficulty returning to activities of daily living and running. The patient was successfully managed through a combination of interventions, including DLS, USI biofeedback, as well as alteration of running form.

TABLE 3 Progression of Home Exercise Program Throughout the Treatment Period

Intervention	Parameters	Treatment Sessions: Session 1 (IE)*	Session 2 (IE + 2 d)	Session 3 (IE + 6 d)	Session 4 (IE + 20 d)	Session 5 (IE + 36 d)	Session 6 (IE + 51 d)
ADIM	10 s, 10 repetitions, once per d	X	X	X			
ADIM with bridge on heels with ball squeeze	10 s, 10 repetitions, once per d		X	X			
Prone ADIM with knee flexion	10 s, 10 repetitions, once per d				X		
ADIM with bridge with unilateral heel raise	10 s, 10 repetitions, once per d				X		
ADIM with hip flexion march	10 s, 10 repetitions, once per d					X	X
ADIM with standing bilateral squat	10 repetitions, 2 sets, once per d				X	X	
ADIM with unilateral squat	20 repetitions, 2 sets each leg, 3 times per wk						X
ADIM with 4-point opposite arm/leg reach	10 s, 10 repetitions, once per d					X	X
ADIM with side-plank on knees	10 s, 6 repetitions each side; progress to 30 s, 2 repetitions, once per d					X	
ADIM with side-plank on heels	10 s, 6 repetitions each side; progress to 30 s, 2 repetitions, 3 times per wk						X
Windmill for hamstrings	10 s, 10 repetitions each leg, 3 times per wk						X
Body-rolling hip flexor release	2 min per side, once per d	X	X	X	X		
Hip flexor stretching	30 s, once per d	X	X	X	X	X	X
Sidelying quadriceps and ITB stretch	30 s, once per d		X	X	X	X	X

Abbreviations: ADIM, abdominal drawing-in maneuver; IE, initial examination; ITB, iliotibial band.

Dynamic Lumbar Stabilization Exercises

DLS exercises selectively activate key abdominal musculature, including the TrA musculature.[18,21-23,25] There is evidence that the ability to increase the thickness of the TrA muscle is delayed[8,25] in individuals with LBP as compared to healthy controls.[21] Although these deficits and associated symptoms commonly resolve through the use of DLS exercises in the general population,[22] the benefit of DLS exercises in postpartum women with lumbopelvic pain is not as clear.[13,37,38] The patient successfully performed progressively challenging DLS exercises throughout the rehabilitation process. Initially, the ADIM was prescribed in isolation. As the patient improved, lower extremity exercises with double-limb support (supine bridging) were performed concurrently with the ADIM. Eventually, the patient performed single-limb activities (one-quarter squats) with concurrent ADIM, to more closely approximate the body posture during running. Therefore, we believe utilization of DLS exercises played an important role in the patient's recovery.

Ultrasound Imaging

USI can be used for the real-time evaluation of muscle function, including thickness, cross-sectional area, and atrophy.[24,30,41] A systematic review determined that USI is a valid measure of trunk muscle thickness and activation during submaximal contractions.[28]

Although a decrease in TrA muscle thickness at rest was observed from initial examination to the 7-week follow-up after discharge, the greater concern in individuals with LBP is the ability to increase muscle thickness during contraction.[19] Our patient displayed an increased ability to thicken both the TrA and IO muscles during the ADIM from baseline to follow-up. Given that she was performing exercises that targeted the TrA and IO musculature, an increase in muscle thickness was expected over the period of observation. However, during the ADIM with SLR, only the TrA muscle displayed an increase in muscle thickness, as the IO muscle showed a decrease of approximately 17%. The preferential effect on the TrA musculature was expected, as USI biofeedback during exercise was used to ensure that the patient was indeed increasing thickness of the TrA muscle. We believe that the increased ability to thicken the TrA musculature may necessitate a smaller increase in IO thickness, resulting in a more balanced relative contribution of the 2 muscles during a dynamic task.

Although muscle activity was not directly measured in our patient, prior studies have demonstrated a correlation between muscle activity and changes in muscle thickness of the TrA and IO musculature using USI.[24,30] These latter findings suggest that muscle thickness determined via USI may be used as a surrogate index of how well the patient can activate the muscle. In our patient, this would seem to indirectly support her decrease in pain and improved function, as these changes coincided with the changes in muscle thickness during contraction.

Changes in Running Form

The decision to modify the patient's running form was based on the findings from the qualitative video analysis of the patient's running mechanics. Specifically, it was concluded that her heel-strike landing in near knee extension was causing greater mechanical loading during landing, and contributing to her excessive pelvic motion.[16] Near the baseline assessment, an attempt was made to reduce the mechanical loading to the body during running by increasing the step rate from 168 to 185 steps per minute, necessitating a proportional decrease in stride length, assuming that her running speed remained constant. At the 7-week posttreatment follow-up, the patient demonstrated the increased step rate (192 steps per minute) without cuing, suggesting that she had successfully learned the new running form. Further, the 3-dimensional running analyses performed at follow-up demonstrated a reduction in the frontal plane (38%) and transverse plane (36%) angular excursions of the pelvis compared to baseline.

In addition to reduced pelvic motion during running, the total negative work performed by the right lower extremity decreased by 35%, closely approximating that of the left side. This decrease in energy absorption is most evident at the knee and hip, reflective of less work required of the more proximal joints.[16] Although the lumbar spine was not directly assessed, it is reasonable that decreased load in the lower extremities would be associated with decreased load in the lumbar spine. The reduced motion and mechanical loading likely contributed to improvement in clinical outcomes, such as symptom reduction and increased running distance, observed within days of starting the intervention.

Combined-Interventions Approach

The combined use of DLS exercises, USI biofeedback, and alteration in running form proved to be successful in decreasing our patient's pain and improving function, including a return to running. Because all components were implemented concurrently, we were unable to determine if one intervention was more beneficial to rehabilitation than the others. However, we believe that the combined approach was necessary to achieve the positive clinical outcomes.

The DLS exercises and USI biofeedback were used to address neuromuscular impairments that were believed to be key contributors to the patient's symptoms. Given the patient's inability to appropriately perform the ADIM at the initial examination, USI biofeedback was used in conjunction with verbal and manual cuing to help train the patient to do so. This approach likely enabled her to more quickly learn the ADIM than she would have if verbal cuing alone had been used.[20] She was subsequently able to be more rapidly progressed into the DLS exercises. The use of USI biofeedback was further warranted given the patient's prior unsuccessful attempt to address LBP with abdominal training, as evidenced by symptom recurrence. Prior work has shown lower recurrence rates of LBP at 1- and 3-year follow-ups when patients received training with USI biofeedback.[21]

The running form the patient displayed at the start of care was modified to reduce the mechanical loading to the body. Visual observation revealed a heel-strike landing pattern, combined with a nearly extended knee at initial contact, both of which are associated with increased mechanical loading.[16] Reducing the patient's stride length by increasing her step rate achieved a posture at landing that reduced the mechanical loading of her lower extremity and back, as evidenced in the 3-dimensional analyses. Further, the improved pelvic control during running that was evident at the 7-week postintervention follow-up session was likely the combined result of the reduced mechanical loading and the DLS exercises.

While USI and computerized motion analysis were used with this case, we believe that the findings from this case are still very relevant for those who do not have access to this equipment. In particular, the computerized assessment of running mechanics was not used as part of the diagnostic or treatment process, and the recommended change in running form was based on the qualitative assessment using a conventional video camera. USI was used as biofeedback with our patient to facilitate contraction of the targeted abdominal muscles. Although this approach likely accelerated our patient's progress, similar gains might have been achieved over a longer period without the use of USI biofeedback, were the equipment not available.

While caution must be taken when generalizing findings from a single patient, the combined-treatment approach may be useful in enabling other postpartum women to return to running and similar activities. Although the patient in our case delivered children through Cesarean section, women who display altered neuromuscular function of the abdominal and back muscles after vaginal delivery may benefit from this same approach. However, it should be noted that women experiencing a vaginal delivery may have greater involvement of the pelvic floor musculature, which may, ultimately, require additional management.

CONCLUSION

THIS CASE REPORT HIGHLIGHTS THE use of DLS exercises and USI biofeedback in conjunction with running-form modification to treat a postpartum runner with hip pain and LBP. The combined-interventions approach resulted in objective improvements in the ability to thicken the TrA muscle during exercise, as well as in the lower extremity loading and pelvic control during running. Ultimately, this patient was able to return to all activities of daily living and resume a running program. The positive outcomes from this case warrant systematic investigation of the combined approach in postpartum runners with lumbopelvic dysfunction. ⦿

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