A Regional Interdependent Approach For The Treatment Of Symptoms For An Adult Female Long Distance Runner With Patellar-Femoral Pain Syndrome

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ABSTRACT

In recent years, regional interdependence has come to the forefront of physical therapy. It has been a method of evaluating structures distal or proximal to an injured area.[1] The purpose of this case report was to demonstrate a regional interdependent evaluation and treatment approach for a patient with patellofemoral pain syndrome (PFPS) that was efficient and effective. **Case Description:** A 26 year old female marathoner presented with a diagnosis of PFPS. A regional interdependent approach, focused on her hip, knee, and ankle, consisted of manual therapy, therapeutic exercises, and taping was implemented over 7 weeks. The patient's goal was to run in a marathon within 5 weeks. She attended physical therapy 2x a week for the first 5 weeks. She came for one visit per week on week 6 and 7, for a total of 12 visits. **Outcome:** At discharge, the patient made improvements in pain scores, strength, and range of motion. She met her physical therapy goal and was able to complete the marathon. The patient was able to improve her function and activities of daily living after her physical therapy session. **Discussion:** This case report demonstrated outcomes in support for a regional interdependent evaluation and treatment of PFPS. A basic regional interdependent guideline was developed from this case report, but there should be further investigation for the validity and reliability of specific treatment guidelines for the patellofemoral joint or other joints.

Key Words: Regional Interdependence, Physical Therapy, Runner's Knee, Patellofemoral Pain Syndrome, Marathon

BACKGROUND AND PURPOSE

Over the past few years, “Regional Interdependence” has gained much attention in physical therapy research and by physical therapists in the clinic. The premise of regional interdependence is that everything connected above or below the painful structure could be a contributing factor to that very structure. A thorough evaluation would yield a better framework for a treatment plan. This may reveal a superior approach to evaluating and treating patients as compared to the traditional impairment based system. If physical therapists continue to follow this traditional impairment based system there may be a possibility that the initial complaints could return. In some cases other joints would be compromised and the painful problem associated with the structure remains unresolved.[1,2,3,4]

Patellofemoral pain syndrome (PFPS) has been the subject of extensive research and is defined as pain anterior or retro to, as well as in areas surrounding the patella. There has been disagreement over the etiology of PFPS but most authors agreed that there is interplay between anatomy, biomechanics, task, and environment.[5,6.7,8,9,10,11,12]

Applying regional interdependence methods to evaluation and treatment would yield a superior method to impairment based evaluations/treatments. PFPS is a debilitating injury to competitive runners.[2,4] If it is not treated effectively, PFPS can impede a

marathoner's progress. Furthermore, PFPS can cause great discomfort in daily activities that require weight bearing, such as walking, ascending and descending stairs.

Anatomy and Pathophysiology

Overall, the knee is stable due to the femur, tibia, and patella bones. The joints that comprise the knee are the tibiofemoral, tibial-fibular, and the patellofemoral joint. The patellofemoral joint consists of the patella, a sesamoid bone that is encapsulated by the quadriceps and patellar tendons. The patella is positioned between the femoral condyles within the trochlear groove and helps increase the pull of the quadriceps muscle to extend the knee.[12] When the knee is flexed, the patella medially tilts and glides distally. Muscle tightness at the quadriceps or iliotibial band (ITB) could decrease this mechanism at the patella. The mechanics of the pelvis/femur as well as those of the tibia/ankle could affect the kinematics at the patellofemoral joint.[5] The sensitive changes to the proximal or distal structures of the leg could therefore alter connective structures and cause the patella to track improperly.

Cibulka et al.[6] reported that pelvic misalignment contributes to patellofemoral pain by the creation of a functional leg length discrepancy. The knee mechanics are, therefore, affected when improper alignment of the pelvis distorts the hips' biomechanics. The result is excessive lateral rotation at the femur, as the ground displaces forces up the

leg. For instance a longer left leg producing an adduction moment causes a muscle, such as the ITB, at the knee to increase its eccentric control. The ITB has connective fibers that pull the patella laterally with knee extension.[6,13] The biomechanics of the shorter right leg causes increased flexion at the hip due to a shorter gait cycle. The rectus femoris pulls on the patella to create a higher resting position of the patella called patella alta. [6,12] Ireland et al.[7] showed that weak hip stabilizers produce a reduction in mechanical advantage at the knee in patients with PFPS. The absence of hip stabilization also perpetuates a vicious cycle of affects at the knee which includes excess knee adduction moments.[7]

A discussion of the seated position is warranted as it contributes to gait dysfunction. The patient who participated in this case report also spent most of her day sitting. The seated position can contribute to pelvic misalignment by creating tightness in the hip flexor and rectus femoris. The seated position also decreases the utilization of the posterior hip muscles and can weaken the gluteus maximus and medius for push off at the hip during gait. While seated the knee is often flexed and the calves shorten. A shortened calf muscle will be more advantageous for knee flexion or plantar flexion, but will inhibit terminal knee extension. Without terminal knee extension and hip extension during the gait cycle there will be no medial quadriceps (Vastus medialis obliqus (VMO)) activity. Without proper VMO activity the lateral muscles have a mechanical advantage and cause a lateral shifting of the patella.[14] Teichtahl et al.[15] explored foot, hip, and knee mechanics and found that there is an association between foot rotation and the

knee adduction moment in women. "Women who walk with external rotation at the foot reduce their knee adduction moment during late stance. This result implies that changes in foot kinematics could modify the medial tibiofemoral load during gait." [15]

The purpose of this case report is to demonstrate an efficacious application of a regional interdependent approach from initial evaluation of the patient to the intervention for a common pathology of the knee such as PFPS. Mascal et al, reported from 2 cases that an exercise program that was focused on the hip, pelvis, and trunk musculature applied to patients with PFPS improved functional outcomes and decreased pain.[16] Vaughn et al.[2] showed in a case report that one session of treatment of the sacroiliac joint returned a runner with PFPS back to running. There was a biomechanical solution for a biomechanical dysfunction. Intervention with manual physical therapy, exercise and taping can correct boney and muscular alignment to improve biomechanics at the patellofemoral joint for activities such as running.

Case Description

The patient agreed and signed a consent form to release information for the purposes of writing this case report.

The patient was a 26 year old Middle Eastern female who presented with the diagnosis of “Runner’s Knee” from a doctor of chiropractic. She was referred to physical therapy for evaluation and treatment of her symptoms that included acute pain in her right knee during weight bearing and functional tasks of her lower extremities. She felt pain in activities of daily living that included but were not limited to descending stairs, running, squatting, and lunging. She had decreased active and passive range of motion (AROM/PROM) in her right knee, and decreased strength in both hips. She complained of a cracking sound and a felt misaligned at the knee which led her to “adjust” her patella with a forceful knee extension thrust in order to increase her knee ROM and decrease discomfort. The patient was unable to detect swelling or inflammation around her knee following the initial onset of pain. She reported intermittent sharp pain with walking that made her stop activity until the pain resolved.

The patient reported she had been training for 6 months for a marathon and had 5 weeks remaining in order to participate. She initially felt pain in her medial and inferior right knee that started 2 weeks prior to the physical therapy evaluation. Running her usual 22 mile daily routine was more difficult due to the pain. Prior to coming to see the physical therapist, the pain was too intense at mile 3 for her to run any further. She described the pain as sharp, cramping, and achy accompanied with stiffness in her right knee during the episodes of pain.

The patient had no significant past medical history. She was taking birth control medication, a daily multivitamin, and a glucosamine supplement. She also took NSAIDS when the pain was moderate to severe at her right knee. She was 161 cm tall and weighed 63.6 kg. Her social history included working at a desk for a majority of a 40 hour work week. She had an initial blood pressure of 110/76 and a pulse rate of 60 beats per minute.

Her initial level of pain was reported with a reliable 11 number verbal pain scale from 0 to 10; 0 was designated as no pain and 10 as worst pain ever experienced.[17] Bolton et al.[17] found the numerical pain scale was reproducible with a strong positive intra-class correlation coefficient (ICC=0.66).[17] A strong correlative value means that when the patient reported her pain at different sessions her pain level given could be reproduced reliably. She reported an initial level of 3/10 and 7/10 at worst when the patella felt immobile.

A quick systems overview was performed for sensation, lumbar reflexes, and ligamentous stress tests such as the medial and lateral collateral stress tests and Apley's test as described by McGee.[12] All tests were within normal limits. This ruled out any possible underlying factors that could influence the patient's anterior knee pain.

The unobstructed acute symptoms at the patient's knee made her a good candidate for this intervention. The physical therapist assessed the patient's AROM, strength, pelvic and patellar alignment, visual gait analysis, muscle length, patellofemoral pain, special tests, and joint integrity of the lumbar spine, hips, knees, and ankles bilaterally.

A total of 12 treatments were allotted by the patient's insurance for the proper treatment of her symptoms. The prognosis at the time of the evaluation was that the patient would be able to run the marathon with little to no pain within the 5 week time frame given to prepare the patient for marathon.

Examination

Initial evaluation, re-evaluations, and treatments including manipulation and Muscle Energy Techniques (MET) of the Sacroiliac Joint (SIJ)/lumbar spine were performed by a physical therapist with 3 years experience. The physical therapist had taken continuing education courses in all areas of intervention. Treatment of the patient was performed at a clinic located in Arlington, Virginia, in an outpatient orthopedic setting with physical therapy and chiropractic services.

Visual Alignment

The patient had a patella that was more proximal on the right leg also known as patella alta. Ward et al.[18] and Fitzgerald et al.[9] found that patellofemoral visual alignment measures were not reliable. There was a poor inter-rater reliability with a kappa coefficient ranging from .10-.36. These numbers revealed a poor correlation between the patellar alignment and knee extension strength. Regardless of the poor correlation, a visual exam of the patellar position was necessary to determine if further investigation of muscle length was needed.[10,19]

The physical therapist examined the alignment because the position of the patella could be caused by rectus femoris, hip flexor, or ITB/TFL tightness. [10,19] Tests such as the Thomas and Ober's determined that there was muscular influence on the patella.

McGee[12] performed the Thomas test with the patient at the edge of the examination table with both knees to the patient's chest. One leg was then released to passively hang in extension while the other leg was held in flexion by the physical therapist or the patient. If the test was positive then the patient's hanging leg remained in a flexed position relative from the trunk to hip and the hip to knee This flexion could be measured or viewed in the sagittal plane.

McGee reported the Ober's test was a test for TFL/ITB contracture.[12] The patient was positioned in side lying and the therapist passively extended the patient's hip of the upper leg with the knee bent to 90º. The physical therapist's other hand was stabilizing and supporting the patient's pelvis. If the upper leg remained abducted it was a positive test. Normal muscle length at the TFL/ITB would present with a natural fall to the table with the hip extended and knee flexed.

The patient's symmetry of leg length was examined and noted that the right medial malleolus was more distal than the left. A positive supine to long sit test and an equal measurement of 89 cm from the anterior superior iliac (ASIS) to the inferior aspect of the medial malleolus bilaterally, revealed there may be a sacroiliac dysfunction. [6]

Bemis et al.[20] reported the supine to long test was a valid method of testing for SIJ dysfunction. The study showed a significant alpha value of .01 meaning it had a strong validity in testing for misalignment of the SIJ if the patient had a positive test. Supine to long sit was tested by having the patient lie supine and visually checking for 1 of the following 4 conditions: right innominate posteriorly rotated, left innominate posteriorly rotated, right innominate anteriorly rotated, and left innominate anteriorly rotated.[6]

Cibulka et al.[6] defined a patient to have a positive SIJ dysfunction when presented with at least 3 of the following 4 tests: the standing flexion test, the prone knee flexion test, the supine long sitting test, and palpation of posterior superior iliac spine (PSIS) heights in a seated position.[6,7,9,10,12,21]

Supine to long sit was tested with the patient supine and palpation of the inferior aspects of the medial malleolus. If the patient had an observed difference in length of greater than 2.54 cm it was positive.[8] The standing flexion test was visually determined to be positive when the PSIS position was uneven after the patient bends forward to touch the floor. The seated PSIS palpation was positive when there was visual determination of one PSIS positioned higher than the other, with a weak kappa coefficient (.02-.22). [22]

During the initial evaluation, the patient presented positive in 3 out of 4 exams. The positive exams were the standing flexion test, supine long sitting test, and palpation of her PSIS while seated. The prone knee flexion test was not tested secondary to time constraints during the evaluation. Therefore these exams showed that the patient with diagnosis of PFPS also had a SIJ dysfunction.

The patient's patellofemoral joint play was tested with Kaltenborn's method for end-feel. Kaltenborn described end feel as the "sensation imparted to the therapist's hands at the limit of the available range of movement."[23] End feels should be pain free. It is considered overpressure when the first restriction of passive movement is met. When testing for joint play, the patient's joint should be set in the resting position, also known as the loose packed position. The loose packed position of for the patellofemoral joint is with the knee held in extension. The loose packed position for the lumbar spine is when the patient is lying prone. The loose packed position of the ankle is determined when the joint is at talar neutral. The joint is considered pathological when there is an earlier restriction to the passive movement or an increased end feel is assessed. Normal joint play in the 3 joints evaluated should yield a natural firm capsular/ligamentous end feel.

The patellofemoral joint should normally be a springy firm end feel as described by Kaltenborn.[23] The patella's inferior glide was tested from proximal to distal. Medial glide was tested from the lateral to medial direction and the lateral glide was tested from the medial to lateral direction. Patellar tilts were tested by applying pressure on the medial poles of the patella for medial tilt and lateral poles for lateral tilt. The patient presented with hypomobility in the medial glide, inferior glide, and medial tilt. She had hypermobility with her lateral glide and a normal end feel for her lateral tilt. (See Table 1) Warasyz noted a high 92% specificity and 43% sensitivity for hypomobility when patellar tilts are examined in the correlation to patients with PFPS. [11]

The patient's ankle talocrural joint was assessed with traction of the talus from the distal tibiofibular joint. At end feel, normal was described as springy and firm. Normal L4-L5 and L5-S1 joint play was described as springy firm end feel during posterior to anterior (P/A) gliding.[23] The patient presented with early resistance at end feel of both Lumbar P/A and talocrural joint glides, which was consistent with hypomobility.

Nijs et al.[10] found that the eccentric step down test, single leg squat, and vastus medialis obliques (VMO) coordination tests were reliable for predicting PFPS. Nij et al.[10] and Warasyz et al.[11] noted Clarke's grind test was not reliable (56% sensitivity and 55% specificity) in predicting PFPS. However, this method was commonly used by therapists to reproduce the pain behavior and was also used for this study.[8,10,11]

The eccentric step down test evaluates motor control at the knee. The test was performed as the patient was asked to step down from a 15 cm wood box.[11] A positive test had pain produced with step down. The VMO coordination test was performed with the patient lying supine. The therapist placed his fist under the symptomatic knee. The patient was then asked to extend her knee in a controlled manner without lifting off of the therapist's fist. A positive test was indicated if patient was unable to fully control the extension or the VMO muscle was not initiated.[11] The Clarke's test was performed with

the patient lying supine and knee extended. The therapist pressed the patella distally and asked the patient to perform an isometric quad contraction. The test was positive if pain was produced.[10] The patient was assessed and all three tests were positive at initial exam.

Table 1: Weekly Progress Note Flow Sheet for Special Tests

	Initial Exam	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Hip Alignment								
Supine-Long Sit	Positive	Positive	Positive	Positive	Negative	Negative	Negative	Negative
Standing Flexion (Forward Bend)	Positive	Positive	Positive	Positive	Negative	Negative	Negative	Negative
PSIS Palpation (Sitting)	Positive	Positive	Positive	Negative	Negative	Negative	Negative	Negative
Muscle Length								
Thomas Test	Positive	Positive	Positive	Positive	Negative	Negative	Negative	Negative
Ober's Test	Positive	Positive	Positive	Negative	Negative	Negative	Negative	Negative
PFP Test								
Patellar Grind Test (Clarke's)	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Eccentric Step Down Test	Positive	Positive	Positive	Negative	Negative	Negative	Negative	Negative
Single Leg Squat	Positive	Positive	Positive	Negative	Negative	Negative	Negative	Negative
VMO Coordination	Positive	Positive	Positive	Negative	Negative	Negative	Negative	Negative
Joint Play								
R SIJ P/A	Hypomobile	Hypo	WNL	Hypo	Hypo	WNL	WNL	WNL
L SIJ P/A	Hypermobile	Hyper	WNL	WNL	Hyper	WNL	WNL	WNL
R Patella								
Inferior Glide	Hypomobile	Hypo	Hypo	Hypo	Hypo	Hypo	Hypo	Hypo
Medial Glide	Hypomobile	Hypo	Hypo	Hypo	WNL	WNL	WNL	WNL
Lateral Glide	Hypermobile	Hyper	Hyper	Hyper	Hyper	WNL	WNL	WNL
Medial Tilt	Hypomobile	Hypo	Hypo	Hypo	Hypo	WNL	WNL	WNL
Lateral Tilt	WNL	WNL	WNL	WNL	WNL	WNL	WNL	WNL
L4 -L5 P/A	Hypomobile	Hypo	Hypo	Hypo	WNL	WNL	WNL	WNL
L5-S1 P/A	Hypomobile	Hypo	WNL	WNL	WNL	WNL	WNL	WNL
R Talocrural	Hypomobile	Hypo	Hypo	WNL	WNL	WNL	WNL	WNL
L Talocrural	Hypomobile	Hypo	Hypo	WNL	WNL	WNL	WNL	WNL

Visual gait analysis was tested. The patient was unable to reach terminal knee extension and appropriate hip extension for push off at the ankle. Her foot did not achieve appropriate heel strike. The patient had an uneven stride length and cadence, and she favored her left side secondary to pain in her right lower extremity. She presented with pronation of bilateral feet and pes planus feet.[13] There was no visual analysis of the patient's running biomechanics secondary to the clinic's constraints.

Patient's right knee pain at rest and at worst was tracked over the 7 week period. As treatment progressed from initial evaluation to week 7, her pain level report improved to pain free from an initial 3/10. At worst, her pain was 7/10 and improved to 1/10 with a dull ache to the right knee on occasion. (See Table 2)

Patient's AROM and manual muscle testing were assessed. (See Table 2) The most significant result of the AROM was the patient's hip internal rotation difference greater than or equal to 14º.[4] Manual muscle tests revealed weak hips and core muscles which produced increased rotational and sheering moments at the tibiofemoral and patellofemoral joints.[7]

Table 2 Weekly Progress Flow Sheet for Pain, AROM, and Strength

	Initial Exam	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Pain at rest	3/10	2/10	1/10	1/10	0/10	0/10	1/10	0/10
Pain at worst	7/10	7/10	5/10	5/10	4/10	3/10	3/10	1/10
AROM								
R Knee								
Flexion	125°	130°	129°	132°	131°	132°	133°	132°
Extension	0°*	-3°*	-2°*	-1°	0°	0°	1°	2°
R Hip								
Flexion SLR	45°	49°	57°	63°	65°	78°	70°	75°
Extension	31°	29°	25°	32°	35°	30°	35°	33°
ER	53°	48°	45°	50°	35°	42°	33°	40°
IR	27°	35°	40°	37°	38°	41°	47°	47°
Abduction	21°	20°	25°	40°	37°	35°	35°	35°
L Hip								
Flexion SLR	66°	75°	75°	70°	72°	75°	80°	80°
Extension	35°	35°	31°	33°	33°	30°	27°	33°
ER	45°	46°	50°	41°	44°	45°	43°	43°
IR	42°	38°	40°	42°	51°	40°	41°	41°
Abduction	40°	43°	42°	41°	40°	45°	41°	41°
R Ankle								
Dorsiflex	-5°	-2°	0°	5°	3°	5°	0°	6°
Plantarflex	45°	44°	47°	50°	45°	48°	51°	49°
Strength								
R Knee								
Flexion	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
Extension	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
R Hip								
Flexion	4-/5	4-/5	4/5	4/5	4-/5	4+/5	4+/5	4+/5
Extension	3+/5	4-/5	4-/5	4+/5	4+/5	5/5	5/5	5/5
ER	4-/5	4/5	4/5	4-/5	4/5	5/5	5/5	5/5
IR	4-/5	4/5	4/5	4/5	4/5	4/5	4+/5	4+/5
Abduction	4-/5	4-/5	4/5	4/5	4/5	4+/5	5/5	5/5
L Hip								
Flexion	4-/5	4-/5	4/5	4/5	4/5	5/5	5/5	5/5
Extension	4/5	4/5	/5	4+/5	4+/5	5/5	5/5	5/5
ER	4-/5	4/5	4/5	4+/5	4+/5	5/5	5/5	5/5
IR	4/5	4/5	4/5	4+/5	4+/5	5/5	5/5	5/5
Abduction	4/5	4-/5	4/5	4+/5	4+/5	4+/5	5/5	5/5
R Ankle								
Dorsiflex	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5
Plantarflex	5/5	5/5	5/5	5/5	5/5	5/5	5/5	5/5

(*)Indicates Pain

CLASSIFICATION AND INTERVENTION

Intervention was developed so that joint mobilizations or manipulations were provided before strengthening. Correcting misalignment before further treatment facilitated healing to the right knee due to biomechanical and neuromuscular corrections[6,19] Lowry et al.[24] showed that there was benefit for patients with treatment consisting of manual therapy, exercise, taping, and orthotics. Four of 5 patients (80%) demonstrated a decrease in pain and an improvement in function with a median of 11 sessions during the course of care. The patients' gains were maintained at a 6-month follow-up.

Strengthening the patient's right knee when it was in a misalignment would facilitate her body to remain in misalignment.[6] The first goal was to correct the misalignment and any neuromuscular timing dysfunctions, then followed with strengthening, then by taping for a lasting carry over after the patient was finished with therapy.[7,8]

Thrust manipulation on the hip/SIJ was performed if the patient presented with a positive supine to long sit test and/or visual alignment of pelvis.[4, 22] The set up for the thrust manipulation was performed in side lying. Hip/SIJ manipulation was attempted 1-2 times on each side. If there was a cavitation produced in the first attempt then there were no further attempts.

Muscle energy technique (MET) to realign the patient's pelvis was performed with push pull method (Figure 1) and with the pubic shot gun (Figure 2). The patient's shorter leg or anterior innominate rotation was corrected with a push in order to trigger hamstring activity and longer leg or posteriorly rotated innominate was flexed towards her head for rectus and hip flexor contraction to reposition the pelvis. The pubic shot gun was applied 3 times for 5 sec each; the patient was supine and then performed isometric resistance with the therapist's forearms.

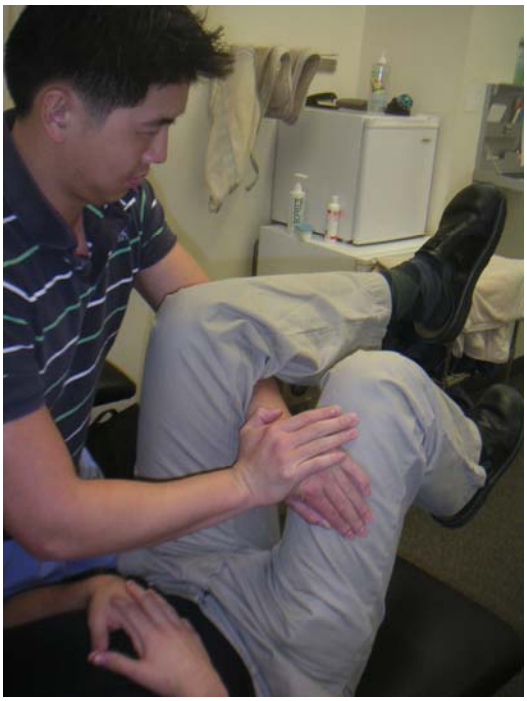

FIGURE 1. (Left) Push-Pull

FIGURE 2. (Right) Pubic Shot Gun

Patellar mobilizations to improve inferior and medial glides were applied while the patient was in resting knee extension in supine. Other mobilizations to the patella were

performed with an inferior glide with knee flexed to 45-60º. The therapist's hand placement was applied from superior aspect of the patella with pressure distally for the inferior mobilization and pressure lateral to medial for the medial mobilization.[23]

Contract/relax stretch technique was used to affect the quadriceps and hip flexor shortened length. The patient's muscles were stretched to her tolerance while she was prone with her knee placed in a flexed position by the therapist. After 30 sec at the initial end-feel, three resistive isometric contractions of 5 sec duration were applied in the knee flexed position followed by a 15 sec stretch at the new end feel.[23]

After the MET and contract relax stretches, hip mobilization-distraction at the patient's hip acetabular joint was conducted with a mobilization belt placed at the proximal point of the medial hip. The hip was mobilized inferior-lateral and slightly posterior while the patient was supine in hooklying position.[23]

Exercises followed manual therapy to encourage proprioceptive neuromuscular facilitation (PNF).[22] Progressions were assessed on the basis of difficulty. If the patient was not adequately isolating or contracting the correct muscles the exercise was neither progressed nor advanced. A program of stretches and self myofascial releases built on

the previous routine every week. All exercises and stretches were considered to benefit the patient throughout the course of the plan of care.

Self myofascial release using a standard sized foam roller was used as a warm up followed by stretching and then movement exercises with and without resistance. Changes to foam rolling and stretches were made when the patient was able to retain and independently repeat the initial foam rolling and stretches.

There was no particular order in which the strength exercises were to be performed. Progressions and changes to strengthening exercises were made in the program as soon as the patient was able to independently perform the exercises with correct form and without losing stability. Exercise progressions used therabands (TB), ankle weights, and therapeutic balls in order to challenge the patient. The patient's exercise progressions involved increasing levels of kinetic chain involvement, balance, core muscle involvement, and a decreased environmental stability. (See Table 3 for full list of exercises)

A general running routine was set up by the physical therapist based on his prior knowledge of running progression from his background as a track and field athlete. The patient was able to increase her regiment when there was no pain greater than 3/10

with her run. Running would cease if she felt pain greater than 3/10. (See Table 3 for running regiment)

WEEK 1

1 minute each per muscle group
Terminal Knee Extensions 20x 2 sets each side
Hip Extensions 20x 2 sets each side
Hip Abductions 20x 2 sets each side
Transverse Abdominus bracing 5-10 second holds 5x
Hip Flexor Stretch 30 seconds (sec) x2 each side
Calf Stretch 30 sec x2 each side
Thomas Stretch 30 sec x2 each side

Manual Therapy

Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations

Taping

McConnell Taping

HEP

Walk Incline 10-15 minutes (min) 3.5 MPH on treadmill working on heel to toe running as well as longer strides.
No Run for the first week.

WEEK 2

(same repetitions and sets as week 1)

Exercises

Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions
Hip Extensions red theraband (TB)
Hip Abductions red TB
Transverse Abdominus supine marching
Hip Flexor Stretch
Calf Stretch
Thomas Stretch
Self Patellar Mobilizations inferior oscillating 10 sec holds 10 times

Manual Therapy

Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations

Taping

McConnell Taping

HEP

Warm Up: Walk Incline 5 min 3.5 MPH on treadmill work working on heel to toe running as well as longer strides.
Run at 5.0-6.5 MPH No incline on treadmill up to 10 miles. Stop or decrease MPH if painful

Week 3
(same repetitions and sets as week 1)
Exercises
Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions blue TB
Hip Extensions blue TB
Hip Abductions blue TB
Transverse Abdominus dead bug
Hip Flexor Stretch
Calf Stretch
Quadriceps Stretch
Self Patellar Mobilizations Inferior
Manual Therapy
Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations
Taping
McConnell Taping
HEP
Warm Up: Walk Incline 5 min 3.5 MPH on treadmill working on heel to toe running as well as longer strides.
Run at 5.0-6.5 MPH No incline on treadmill up to 10 miles.
5 miles on the road. Stop if painful or decrease MPH

Week 4
(same repetitions and sets as week 1)
Exercises
Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions with step up red tband 20 times
Hip Extensions- prone add 2 # ankle
Hip Abductions- side-lie 2# ankle weights
Transverse Abdominus –planks
Bridges 20x 2
Hip Flexor Stretch
Calf Stretch
Quadriceps stretch
Step up 6 inches 20x2
Step down 6 inches 20x2 each side
Lateral steps up 6 inches 20 x 2
Self Patellar Mobilizations Inferior
Manual Therapy
Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations
Taping
KinesioTaping
HEP
Warm Up: Walk Incline 5 min 3.5 MPH on treadmill working on heel to toe running as well as longer strides
Run at 5.0-6.5 MPH No incline on treadmill up to 5 miles.
15 miles on the road. Stop if painful or decrease MPH

Week 5
(same repetitions and sets as week 1)
Exercises
Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions with step up blue tband
Hip Extensions- prone add 5 # ankle
Hip Abductions- side-lie 5# ankle weights
Transverse Abdominus –planks
Bridges on ball
Hip Flexor Stretch
Calf Stretch
Quadriceps stretch
Step up 10 inches
Step down 10 inches
Lateral steps up 10 inches
Self Patellar Mobilizations Inferior
Manual Therapy
Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations
Taping
KinesioTaping
HEP
Warm Up: Walk Incline 5 min 3.5 MPH on treadmill working on heel to toe running as well as longer strides.
25 miles on the road. Stop if painful or decrease MPH

Week 6
(same repetitions and sets as week 1)
Exercises
Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions with step up blue TB
Hip Extensions- prone add 5 # ankle
Hip Abductions- side-lie 5# ankle weights
Transverse Abdominus– planks on ball
Bridges on ball
Hip Flexor Stretch
Calf Stretch
Quadriceps stretch
Step up 10 inches
Step down 10 inches
Lateral steps up 10 inches
Self Patellar Mobilizations Inferior
Manual Therapy
Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax quadriceps and Hip flexors
Hip Mobilizations
HEP
Warm Up: Walk Incline 15 min 3.5 MPH on treadmill working on heel to toe running as well as longer strides.

Week 7
(same repetitions and sets as week 1)
Exercises
Foam Rolling Myofascial Release: Calf, ITB, Adductor, Piriformis, Quadriceps
Terminal Knee Extensions with step up blue TB
Hip Extensions- prone add 5# ankle
Hip Abductions- side-lie 5# ankle weights
Transverse Abdominus– planks on ball
Bridges on ball
Hip Flexor Stretch
Calf Stretch
Quadriceps stretch
Step up 10 inches
Step down 10 inches
Lateral steps up 10 inches
Self Patellar Mobilizations Inferior
Manual Therapy
Muscle Energy Technique Realign
Side posture hip manipulation when out of alignment
Patellar Mobilizations Inferior and Medial
Contract Relax Quadriceps and Hip flexors
Hip Mobilizations
HEP
Warm Up: Walk Incline 15 min 3.5 MPH on treadmill working on heel to toe running as well as longer strides.

TABLE 3: Weekly Exercise Programs

Taping was applied first with the McConnell technique using endurafix and enduratape. Taping later progressed to Kinesiotape but did not continue past Week 5 as there was no intense training after the conclusion of the marathon. Taping was the last treatment performed after all exercises were performed. This method was used because Kase et al.[26] and McConnell et al. [27] proposed that the repositioning of the patella provides feedback and neuromuscular re-education to the patient. The tape also provided a stretch to the tissue around the fascia.[26, 27]

The McConnell taping method for the knees was applied with endurafix applied medially from lateral femoral condyle to the notch of the medial hamstring. Enduratape was then fixed on the lateral pole towards the medial hamstring to provide a medial glide. A medial tip was produced with the tape on the medial pole of the patella and pulled towards the medial hamstring.[27]

The Kinesiotape, with its stretchable properties, was later added to provide a flexible support to the patient's knee. Two pieces of tape were cut to a length of 9 cm. Then each piece was cut longitudinally to 6 cm creating a "Y". The first piece of tape was applied from proximal to distal in a downward "Y" pattern starting 1 cm above the superior aspect of the patella. The second piece was then applied in a "Y" pattern starting from the tibial tuberosity from distal to proximal.[23] (See Figures 3, 4, and 5)

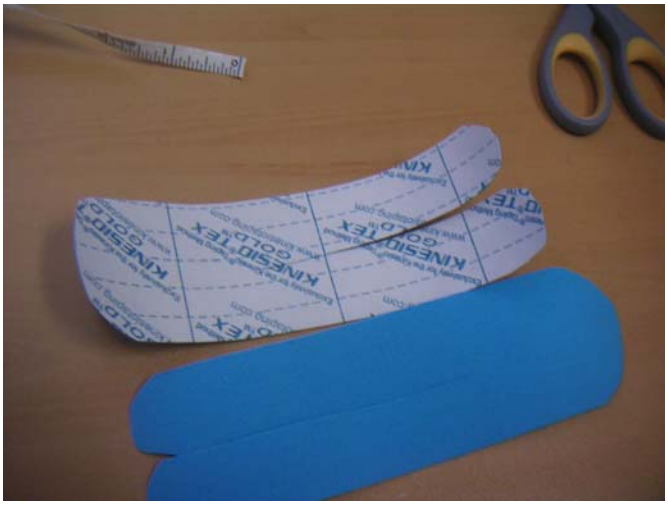

FIGURE 3. (Left) Kinesio Tape

Figure 4. (Right) First piece of tape applied

Figure 5. Second piece of tape applied

The patient was referred to a local podiatrist to get fitted for orthotics. Her right and left feet were scanned and orthotics were ordered. The orthotics arrived in 4 weeks but were not implemented until after marathon training was completed. The patient was instructed to start wearing the orthotics after Week 5 and to wear them in slowly. The physical therapist advised that she wear them for 4 hours for the first week, 8 hours for the following week and then all day by the third week.

The patient attended physical therapy treatments at the clinic twice a week for the first 5 weeks until the marathon and decreased to 1 session for the following 2 weeks. The patient performed a home exercise program (HEP) on the days she did not come for treatment. The program was consistent to the exercises performed during each physical therapy visit while at the clinic. All weekly exercise progressions were incorporated into the patient's HEP.

OUTCOME

Based on the final assessment at Week 7 (see Tables 1 and 2), the patient improved in her strength and AROM. Since the first week, the patient had reported a decline in pain at rest and during running. (see Table 2) The patient's patellar inferior glides remained hypomobile likely due to the inherent tightness of the rectus femoris muscle fibers (see Table 1) The patient was able to meet her treatment goal of running in the marathon.

She was able to finish the race. She reported muscle soreness that was no worse than 2-3 out of 10 pain at the onset, during, and at the end of the race.

After the first lumbar-SIJ manipulation the patient reported that her ensuing run was less painful. She noted that both types of taping, McConnell and Kinesiotape, added global confidence and a feeling of support. She noted that with the assistance of the manual therapy and the taping there were decreased sharp pains as she progressed in her training.

The patient reported the hip strengthening exercises increased her terminal knee extension and terminal hip extension. This allowed her to have a stronger push off and a longer stride. As she continued to get stronger with the exercises plan, the running program was progressed accordingly to meet her new strength demands.

A follow up call to was made 12 weeks post treatment and the patient reported continued training for another marathon. She reported that she had some intermittent pain but with foam rolling and some therapeutic exercise the pain quickly resolved.

DISCUSSION

The patient achieved her individual physical therapy goal of running and completed the marathon. (See Figure 6) Her improvements in function and impairment during a 12 treatment regimen that stretched over 7 weeks were correlated to a regional interdependent approach. This approach revealed the affects different joint systems had on the knee and their contribution to the patient's patellofemoral pain syndrome (PFPS). The different stresses to the patellofemoral joint needed to be discovered to capture the whole picture of the patient's problems. Her quick recovery for competition in the marathon was due to an interdependent method of evaluating and treating.

A regional interdependent approach to the patient's examination uncovered dysfunctions to her SIJ and patellar tracking. The exam also revealed a need to focus on her hip weakness and increased pronation at her foot and ankle. Without a thorough evaluation, a proper intervention could not be developed to address the patellofemoral pain. Intervention based on an interdependent application was used to enhance the biomechanics of several joints at the lumbar spine, hips, knees, and ankles.

A home exercise program (HEP) developed from the patient's dysfunctions focused on therapeutic exercises, stretching, self myofascial releasing to different joints. In a short period, the patient was compliant and able to independently perform her home exercise program and empower herself in her healing.

Foam rolling for myofascial release was necessary to decrease the length tension on both the quadriceps muscle and the TFL/ITB's pull on the patella. Foam rolling to the muscles was a viable option because of the ease of use. The patient was able to perform this task daily as a part of her HEP. This increase in frequency gave her a greater likelihood to change the tension of the muscle tissue. Myofascial releasing to the patient's calf tightness and stretching allowed her foot to have an increased dorsiflexion. This increase in the patient's dorsiflexion biomechanically assisted her terminal extension at her knee and created a more stable knee joint without excess torque.

In traditional impairment based methods, therapists tried to address pain, weakness, and decreased ROM as the primary problem. In some cases, this method would be enough to address the pain for the short term. However, the pain would often return because there was a biomechanical flaw at the patellofemoral joint caused by the pelvis, hips, and ankles.[1,2,3,6,11,15,21,24,28] As discussed, the patellofemoral joint was biomechanically sensitive to any disruption from joints proximal or distal to the knee.

The SIJ misalignment was treated with a thrust manipulation. Following the manipulation, exercises focused on core strengthening were implemented in order to

decrease instability in the pelvis and SIJ. Had the patient been treated with just manipulation alone then the disposition to return to the misalignment was likely as the muscles and tendons that were shortened would have retained the pull on the joints.[4,19]

Another focus for the patient was her hip joint. Her tight hip flexor and weak hip musculature contributed to the SIJ misalignment. This weakness could also be generalized to other patients with similar problems. The treatment plan was then to align, increase hip strength, and create stability at the SIJ. Stretches and strengthening exercises were combined to stabilize the interplay at the hip. With increased hip strength and a proper SIJ alignment, the ground reaction forces while running would be controlled.

The knee and the patellofemoral joint were treated with taping methods to stimulate the VMO, while the VMO was facilitated through her daily tasks and runs. As noted by the patient, the taping provided a sense of security while she trained for her marathon.

In conclusion, the development of a regional interdependent focused guideline for examination and intervention would be a helpful application for therapists in a clinical setting. An intervention based double blind study to test the efficacy of an interdependent approach would be beneficial to add to existing research. Waryasz et

al.[11] developed a specific intervention guideline from a research review of several studies for patients with PFPS that had yet to be tested. A study could be conducted based on this guideline within a randomized double blind format. Other studies for regional interdependence could be focused on other joints such as hip pain, shoulder pain, or other chronic pain cases for a number of athletes or other people.

Figure 6: (Top) Patient finishing the marathon

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