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Bilateral Hip Apophysitis in Young Athlete: A Case Report

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Bilateral Hip Apophysitis in Young Athlete: A Case Report

by

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This Scholarly Project, submitted by Brooke VandenBergh in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Cindy Flom-Meland
(Graduate School Advisor)

(Chairperson, Physical Therapy)

PERMISSION

Title Bilateral Hip Apophysitis in Young Athlete: A Case Report

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Signature Brad VanderKam

Date 9/11/15

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ABSTRACT

Study Design: Case Report

Background and Purpose: Today, children are beginning to partake organized sports at a younger age. With this increased demand on their young bodies, the medical field is seeing an increase in acute and overuse injuries. Muscle imbalance and weakness have been linked to overuse injuries in athletes. The purpose of this case study is to examine the benefit and treatment effect of physical therapy guided exercise focusing on the individuals' muscle imbalances and correcting movement patterns to relieve stress on the iliac crest.

Case Description: Patient was a 16-year-old female who was seen at Physical Therapy for bilateral hip pain. She was an active high school student who participated in cross-country, basketball and track, track being her main sport.

Intervention: The clinic implemented an eight-phase lower extremity protocol. The protocol focused on hip strengthening and movement correction and awareness.

Outcomes: The patient was able demonstrated above normal strength in her hips and more importantly a balance in strength between her left and right hips. She also reported 0/10 pain with activity and sprinting. The running evaluation showed an improvement in knee valgus and improved running mechanics.

Discussion: Overall, the patient had great results due to her motivation and willingness to adhere to the protocol, home exercise program and restrictions. The patient showed substantial strength gains, a reduction in pain and improved running mechanic

CHAPTER I

Background and Purpose

Introduction

Today, children are beginning to partake in organized sports at a younger age. It is estimated that approximately 30 million children and teenagers participate in organized sports in the United States each year.[1] Some children begin to train year round and compete at an "elite" level in their age bracket. With this increased demand on their young bodies, the medical field is seeing an increase in acute and overuse injuries. Over one-third of school-age children will sustain an injury severe enough to be treated by a doctor or nurse.[2] Children and adolescence are at an increased risk of injury due to improper technique, poor protective equipment, poor training and muscle weakness and imbalance.

The most common overuse injuries in young athletes consist of muscle strains, ligament sprains, tendinitis, and growth cartilage injuries.[1] In children, growth cartilage is located in the physeal plates of long bones, articular cartilage and the apophyseal insertions of muscle tendon units.[3] An apophysis is an out growth on a bone that provides an attachment site for tendons and

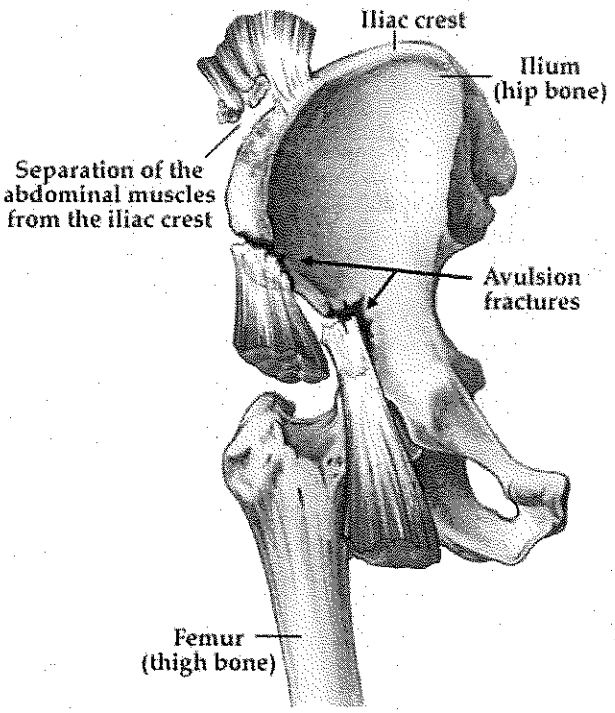


Figure 1- Iliac apophysitis[7]

ligaments. In some overuse injuries, the bone is unable to handle the stress and tension that is applied from the muscles during a given activity. Once the bone is weakened, the repetitive stress from the muscles will begin to pull the apophysis away from the underlying bone. This would be a severe form of apophysitis and would cause injury to the underlying growth tissue in children. Figure 1 shows an example of iliac apophysitis.

Muscle imbalance and weakness have been linked to overuse injuries in athletes. For example, the hip joint, although it is a ball-and-socket configuration that provides a high degree of bony stability, the joint is dependent on a complex set of muscles to create motion and provide dynamic stability.[4] Impaired hip muscle performance can cause dysfunction in the hip joint in all planes.[4] In the case of bilateral hip apophysitis, excessive muscle strength or tension in muscles that attach to the anterior pelvis (quadriceps) along with weakness of the muscles attaching to the posterior pelvis (hamstrings and gluteus maximus and medius) will overload the anterior pelvis. If the patient is a quadriceps dominant athlete and demonstrates weak gluteal and hamstring strength compared to the quadriceps, the patient will be at a greater risk of injuring the anterior iliac crest. Figure 2 shows the attachments of the quadriceps and hamstrings and the effects the two muscles

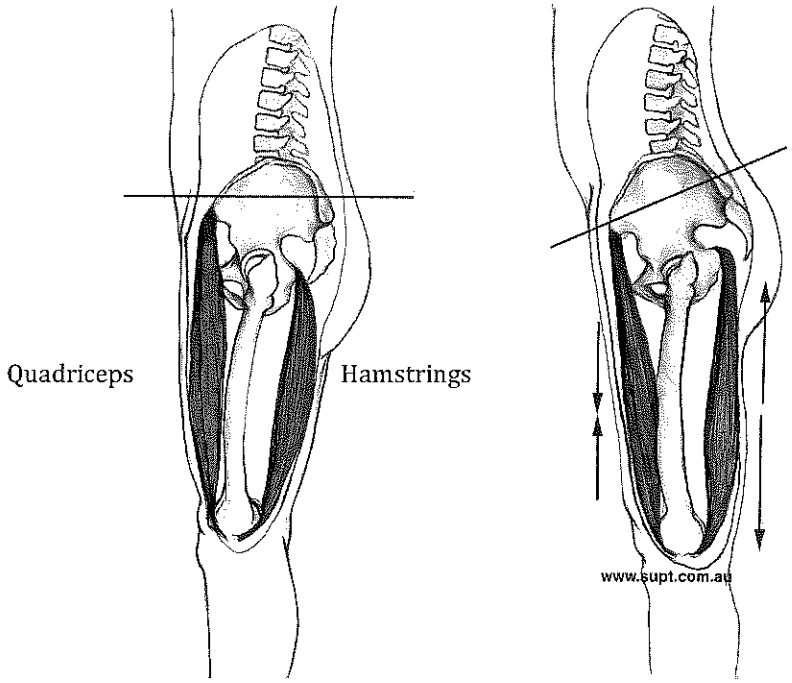


Figure 2- Muscle imbalance[8]

have on pelvic tilt. The first picture in figure 2 shows neutral position and the second picture shows tight quadriceps and the effect the muscle has on the pelvis such as an anterior tilt. This idea is applied to muscle imbalance as well. As stated earlier, a quadriceps dominant athlete will overload the anterior pelvis and can cause injury. Hip muscle strength, specifically gluteus maximus and gluteus medius, plays a crucial role during athletic endeavors by balancing important biomechanical forces in the body.[5, 15]

A study in *Sport Med*[5] looked at hip muscle weakness and overuse injuries in recreational runners. The study found that there was a significant association between hip muscle strength imbalances of the hip flexor, abductor, and adductor muscle groups and lower extremity overuse injuries. The study suggested screening of hip muscles during an evaluation and implementing hip strengthening. "Adding hip strengthening exercises for weak hip muscle groups may possibly prevent injury or assist injured runners in returning to their previous levels of training."[5p.20] In the case of bilateral hip apophysitis, with strong quadriceps and weak gluteus maximus, gluteus medius and abductors, it is important to correct the muscle imbalance and relieve stress on the anterior pelvis.

A study investigating various forms apophysitis reported only 32 cases of iliac crest apophysitis out of a total of 445 apophyseal injury cases treated during that time (1980 to 1990) for a total of 7% iliac crest apophysitis cases.[3] "Although relatively uncommon, iliac crest apophysitis can be difficult to resolve."[3p.144] With the increase in adolescent injuries, it is important that health care professionals develop an appropriate treatment plan. As stated earlier, muscle weakness and imbalance can result in injuries like apophysitis. Unfortunately, there is a lack of research and literature that addresses the treatment of apophysitis. The article reported treatments such as physical therapy, activity modification, anti-inflammatory medications, and

compressive garments.[3] The purpose of this case study is to examine the benefit and treatment effect of a physical therapy guided exercise program focusing on the individual's muscle imbalances and correcting movement patterns to relieve stress on the iliac crest for a young patient with iliac crest apophysitis.

CHAPTER II

Case Description

Patient History

The patient was a 16-year-old female who was seen in physical therapy for bilateral hip pain. She was an active high school student who participated in cross-country, basketball and track. Overall the patient was healthy for her age, 5 foot 5 ½ inches tall, weighed 107lbs, blood pressure on examination day was 106/68, and complained of 5/10 pain in bilateral hips. The patient had no significant family history of health conditions and other co-morbidities.

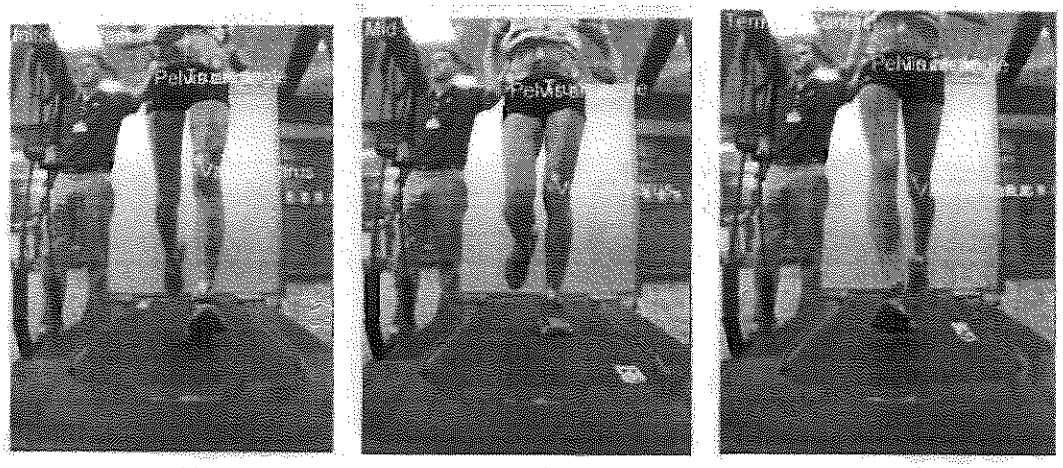
The patient was sent to physical therapy (PT) by her family physician who has been treating her on and off for a little over a year for bilateral hip pain. While under the physician's care the patient received x-rays and discovered open growth plates in the iliac crest and early signs of iliac crest apophysitis and hip flexor tendinitis. The physician advised against any running for 3 weeks and placed the patient on 400mg of ibuprofen twice a day for inflammation. The patients physician also sent her to see a physical therapist that provided her instructions on icing and quadriceps and hamstring exercises (the physical therapists and physicians notes were unspecific as to what the exercises were), which her high school athletic trainer monitored.

Examination and Evaluation

Tests and Measures

On examination day, the first assessment performed was a running evaluation using Simi video analysis. With the Simi program PT was able to assess a complete gait cycle and joint

angles frame, by frame shown in Figure 3. For the exam, the treadmill was set at 5.3 mph, no incline and both front and lateral views were assessed. The runner's evaluation showed a crossover sign. A common cause of crossover during running is tight hip flexors which PT evaluated soon after the running session using the Modified Thomas test and the results will be given later in the report.[9] PT also found that during initial contact on her left leg, she had 11.19° of valgus. The ankle on the left leg did not show collapse into pronation and manual muscle testing confirmed normal strength in her plantar flexors/everters/inverters so we ruled out ankle instability as the cause of knee valgus during running. PT suspected that the valgus was caused by hip weakness, which was later confirmed by manual muscle testing (MMT) and Biodex testing of the abductors and extensors. Decreased strength of the gluteus maximus and gluteus medius can cause the knee to fall into valgus due to the muscles inability to externally rotate the femur.



(A) (B) (C)

Figure 3. Running analysis, frontal view. (A) initial contact, (B) mid stance, (C) terminal contact

Following the running evaluation, we performed a gross range of motion (ROM) assessment on the patients lower extremities. All passive ROM (PROM) was within normal limits and was performed with no pain reported from the patient except during hip extension

where the patient reported pain bilaterally. Hip extension measurements were 30 degrees, within normal limits, and had a guarded end feel due to pain.

The patient's gross strength of the lower extremities was tested using MMT. Table 1 shows the results of MMT.

Table 1. Gross Lower Extremity Strength, MMT Results

	Right	Left
Hip	Abduction: 4/5 Flexion: 4/5* Extension: 4/5	Abduction: 4/5 Flexion: 4/5* Extension: 4/5
Knee	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension: 5/5
Ankle	Plantar Flexion: 5/5 Dorsiflexion: 5/5 Eversion: 5/5 Inversion: 5/5	Plantar Flexion: 5/5 Dorsiflexion: 5/5 Eversion: 5/5 Inversion: 5/5

* Indicates pain with test

Following the gross strength exam, PT found hip weakness and decided to use the Biodex to give us more specific data. We were unable to obtain Biodex test results on her quadriceps (knee extension) due to the bilateral anterior hip pain. Biodex testing revealed a significant muscle imbalance between the left and right hip. When comparing extremities bilaterally, Davies[16] states that muscle weakness between 10-15% is considered to indicate significant asymmetry. The patient's physician and the overseeing PT consider anything between 1% and 10% difference in the percent deficit category to reflect that there is no significant difference between extremities. The patient was significantly weak in extension and abduction, weaker in the left hip than right, but still able to run record times in track. The patient had over 50% difference between right and left hip measurements classifiying her as having signicicant muscle imbalance between her hips. We assumed both quadriceps were strong based on the patients running ability and signs and symptoms. Table 2 shows the results of the Biodex strength test.

Table 2. Biodex Test Results

	Average Peak Torque (ft lbs)	% Deficit
Right Hip		
Extension	111	-12.90%
Abduction	77.1	-13.80%
Left Hip		
Extension	51.8	47.30%
Abduction	57	15.90%

** Negative values in "% Deficit" represent a strength measurement*

We found it interesting that her right hip was overall strong compared to the normative data but her left hip showed considerable weakness revealing that the right hip was actually twice as strong as the left hip. The muscle imbalance between the right and left hip in both extension and abduction was substantial as you can see from the test results. Due to the patients quadriceps dominance, and gluteus maximus and gluteus medius weakness, her bilateral muscle imbalance caused knee valgus on the left and increased stress to the anterior pelvis. Mechanically, she was overloading the quads and putting increased stress on the anterior superior iliac spine (ASIS) and anterior inferior iliac spine (AIIS) insertion.

Table 3. Special Tests and Results.

	Positive/Negative	**Sensitivity**	**Specificity**
FABER	(-) Bilaterally	0.82[10]	0.25[10]
Hip Scour	(-) Bilaterally: Pain felt in bilateral anterior hip	0.5[10]	0.29[10]
Ober's	(-) Bilaterally	No Data	
Ely's	(+) Bilaterally	.56-.59[11]	.64-.85[11]
Modified Thomas	(+) Bilaterally	No Data	

To rule out other possible diagnoses we also performed a hip scour test, FABER test, Ely's test, modified Thomas and Ober's test, and assessed overall flexibility of the lower

extremities. Results to these special tests can be found in Table 3 along with the sensitivity and specificity of each test performed.

Evaluation

The patient's results were consistent with hip weakness and bilateral hip apophysitis. The patient demonstrated a muscle imbalance in the hips causing excess stress on the anterior pelvis. She also showed hip flexor tightness bilaterally which could have been caused by the hip pain and the patient's unwillingness to allow her hips to extend. The patient had significant pain in the anterior hips during the examination that limited the amount of strength testing and exercises we were able to perform. The patient was still able to perform all activities of daily living (ADLs) but did have restrictions on gym classes and sports practices such as track.

The patients problem list included: 1) decreased bilateral hip strength (extension and abduction), left weaker than right, 2) increased pain in anterior hip, and 3) knee valgus/crossover sign with running. The patient was diagnosed with hip apophysitis and according to the Guide to PT Practice, the diagnosis falls under the ICD-9 code of 732.6 for juvenile apophysitis.

Prognosis and Plan of Care

The patient's prognosis was excellent based on the underlying issues the patient demonstrated and her willingness and motivation to participate in physical therapy. The patient decided not to run cross-country the current year and was fully motivated to work with PT to be pain free for the track season the following spring. Based on our evaluation and her commitment to physical therapy, we planned to see the patient 2 times per week for the first 3 weeks, then reduced to 1 time per week for 3-6 weeks, then reassess for discharge.

The patient's short term goals included: 1) Following PT intervention, patient will decrease pain to 3/10 at rest and with activity to improve gait (to be completed in 2 weeks), and

2) Following PT intervention, patient will be independent and compliant with home exercise program (HEP) to allow therapy to progress (to be completed in 1 week). The patients long term goals included: 1) Following PT intervention, patient will demonstrate 5/5 hip strength bilaterally to allow the patient to return to gym class safely (to be completed in 8 weeks), 2) Following PT intervention, patient will decrease her pain to 0/10 with activity to perform ADLs pain free (to be completed in 6 weeks), 3) Following PT intervention, patient will decrease the degree of knee valgus and crossover sign with running to return to gym class safely (to be completed in 8 weeks), 4) Following PT intervention, patient will return to gym class and track safely and pain free to improve the patients quality of life (to be completed in 8 weeks).

By implementing the lower extremity (LE) movement protocol developed by Chris Powers[12] we expected the patient to gain strength and move in a safe, pain free way by track season 2015. We did advise against any running for at least 2 months until we felt that she was stronger and had corrected her movement patterns.

CHAPTER III

Intervention

Therapeutic exercise is one of the most important interventions that physical therapists can utilize for the treatment of lower extremity pathologies.[15] A study found that correcting muscle imbalances through hip strengthening improves lower extremity pain in runners.[15] The patient participated in the clinic's 8 phase program for rehabilitation after a lower extremity injury, specifically an anterior cruciate ligament, or ACL, injury. The program focuses on hip strength and neuromuscular reeducation to activate and utilize appropriate muscle groups during movement. Studies suggest that strengthening alone may not be enough to correct abnormal running or movement patterns and neuromuscular reeducation can be an important component in treatment.[13] In this case, the patient demonstrated weakness and abnormal running mechanics which is why PT incorporated both strength and movement pattern training.

The program progress in a simple manner with phase one starting with non-weight bearing activities and progressing to weight bearing double limb static, single limb static, double limb dynamic, single limb dynamic, double limb ballistic, single limb ballistic, and lastly sport-specific movements. The progression of the phases is important to both strengthening and reeducating the patient's muscles and movement patterns.

Each phase has goals that must be completed before the patient advances to the next phase. The exercises in each phase will help teach the patient proper movement and muscle activation to be able to perform the goal exercise properly. Some phases require the patient to

pass exercises using video analysis. In Phase 5, the patient must pass a video analysis of a step down on each leg in order to move on to Phase 6. During Phase 6, the patient must perform a drop jump to move on to Phase 7. After the patient has finished all the phases, PT planned to re-evaluate with a video analysis running assessment using the Simi system used in the initial evaluation.

Phase 1: Weeks 0-1

On our evaluation day, we started the patient on Phase 1 of the Bellin protocol. She was given a binder that contained the directions, log sheet and exercises in Phase 1; see Table 4. The patient was to bring the binder with her to every appointment so we can answer any questions, ensure exercises are done properly and add Phases to the binder when the patient was ready. We taught the patient how to properly perform the exercises with a green thera-band, which was the easier of the two colored bands.

Table 4. Phase 1

Phase 1: Non-Weight Bearing		
Goals	Exercises	
1. Minimize Swelling 2. Control Pain to minimal intensity 3. Perform Clam Shell exercise with good form, hold for 60 seconds, blue band, bilaterally 4. Perform Abduction Straight Leg Raise exercise with good form, hold for 60 seconds, blue band, bilaterally 5. Perform hydrant exercise with good form, hold for 60 seconds, blue band, bilaterally	Clam Shell Abduction SLR Hydrant	Repeat 3 holds each leg. Work up to 60-second hold with blue band

With Phase 1 exercises, we also used electromyography (EMG) to give the patient visual guidance. We placed two EMG electrodes over the gluteus maximus and gluteus medius on the

left and right and two sensors on the quadriceps, left and right. The patient demonstrated both the clam shell and abduction straight leg raise (SLR) exercises in front of a monitor. The monitor showed four labeled bars, one bar for each electrode. Our goal for her was to keep the quadriceps as relaxed as possible while contracting both the gluteus maximus and gluteus medius. On the monitor, she was able to see both the quadriceps bars remain small without movement and both gluteus bars grow with the contraction when performing the exercise properly. This visual input seemed to help her understand how the exercise should feel when performing the exercises correctly. It also helped us as PTs to see that the proper muscles were firing with these simple muscle activation exercises. We were able to move through Phase 1 quickly.

Although Phase 1 seems short and easy, it is a very important phase. Current studies suggest that non-weight bearing (NWB) exercises recruit the gluteus maximus muscle fibers more effectively than weight bearing exercises.[14]

Phase 2: Weeks 0-1

After the first visit with the non-weight bearing exercises, the patient was ready to move to Phase 2 (Table 5). We combined Phases 1 and 2 because the patient had no restrictions besides running. In Phase 2, the patient continued to do Phase 1 exercises on her own and use Phase 1 as a warm up when at the clinic. We focused on double leg static weight bearing exercises in Phase 2. The patient responded well to using EMG in Phase 1 and we decided to implement it again in Phase 2 with the squat hold. She worked very hard on the first two phases and completed Phase 2 in one week.

Table 5. Phase 2

Phase 2: Weight Bearing, Double Leg Static		
Goals	Exercises	
1. No increased joint swelling 2. Control Pain to minimal intensity 3. Perform Squat Hold 60° to 90° utilizing a good hip strategy of movement for 60 seconds, blue band 4. Perform Surfer Squat Hold 60° to 90° utilizing a good hip strategy of movement for 60 seconds, blue band	Squat Hold Surfer Squat Hold Bridge hold Front Plank Side Plank	Repeat 3 holds each leg. Work up to 60-second hold with blue band
	Hamstring curl on ball	20-30 curls with blue band

Phase 3: Weeks 1-2.5

The patient, being a high school athlete, was able to demonstrate the exercises in the first two phases with good form, especially non-weighted squats. In Phase 3 we moved into single leg, static exercises. Due to the patients hip muscle imbalance, left weaker than right, we had the patient perform twice the number of exercise repetitions (reps) on the left leg with most single leg exercises. This phase was very important for her, as runners spend a lot of time on a single leg. We took our time in Phase 3 to ensure a solid base before moving to more challenging phases. The main exercise we focused on was the standing hydrant in Figure 4.

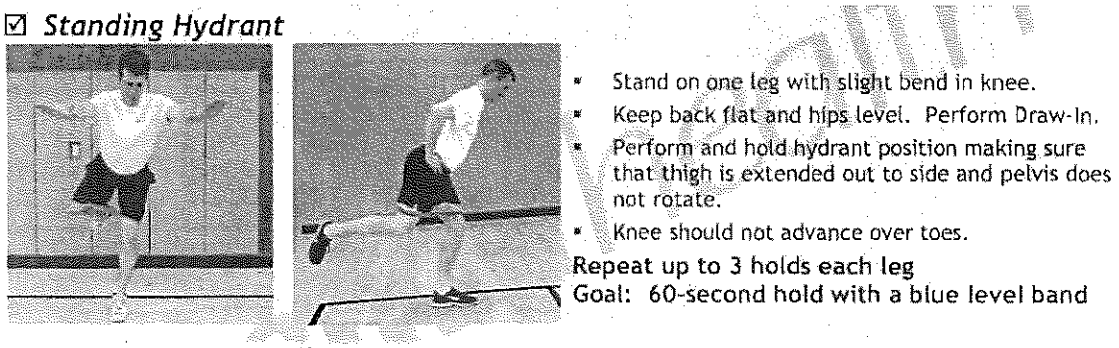


Figure 4. Standing hydrant[12]

This was a great exercise for her because it enforced the use of the gluteus maximus and gluteus medius over the quadriceps. It also required a great deal of balance, working the core all the way down to the ankle stabilizers. She started this exercise with the green band and was able to work up to a blue band after one week.

In Phase 3, we also added in a hip flexor stretch, quadriceps stretch and foam roll for the hip flexor, quadriceps and iliotibila band (IT band). At the beginning of Phase 3, the patient had been seeing us for two full weeks and our focus was on pain control and gluteus maximus and medius activation. We waited until Phase 3 to add in stretching at home to make sure the exercises we were performing at PT were not aggravating the apophysitis. A complete list of Phase 3 exercises can be found in Table 6.

We spent about two weeks in Phase 3 working on muscle activation, step-ups and standing hydrant. According to a recent literature review, a forward step-up generated very high levels of gluteus maximus activation (>60% maximum voluntary isometric contraction (MVIC)) and high levels of gluteus medius activation (41-60% MVIC).[15] The patient mastered the step up with proper form after the first week so we increased the box size to 12, then 16 inches and added a posterior resistance at the hips using a resistance band and PT force. With the resistance band at the hip we were also able to apply a small amount of rotational force that the patient has to correct in order to perform a proper step up. The hydrant and step up were performed in front of a TV and cameras to make it easier for the patient to correct her body mechanics. On the TV she was able to see a front view and side view of her step up as she executed the exercise.

Table 6. Phase 3

Phase 3: Single Leg Static		
Goals	Exercises	
1. Perform a Step-Up exercise with good form for 10-20 repetitions determined by PT 2. Perform a Standing Hydrant exercise with good form for 30 seconds, each side, blue band	Step Up	20-30 times, goal 8 inch step
	Standing Hydrant	Three holds each leg, goal 30 second hold, blue band
	Hamstring curl on ball - SL	2 sets, 10-15 reps
	Foam roll	Hip flexors, Quadriceps, Hamstrings, Glute, Calves
	Hip Flexor stretch	3 sets, 20 second hold, no pain

Phase 4: Weeks 2.5-4

Phase 4 was started close to three weeks into her physical therapy treatment and was centered on double limb dynamic exercises. By this point she reported no pain at rest or with physical therapy exercises. In this phase it was important to start her on a 6-day per week cardio and strengthening routine. We also only planned to see her once a week to check on her progress and form in this phase. She was doing the majority of her lifting program, which we prepared, with her high school athletic trainer and strength coach. Phase 4 goals and exercises are located in Table 7.

Phase 4's purpose was to get the patient started and compliant with a good lifting and cardio program with the correct form. The patient was not allowed to do any of the exercises on her own unless physical therapy gave her permission. During this phase, we also stayed in close contact with the patients athletic trainer at her school to ensure everything was going smoothly.

When the patient was in the clinic, we utilized the video feedback and corrected any movement issues we saw. Studies have shown that the single-limb deadlift exercise produces high levels of activation in the gluteus maximus and medius (41-60% MVIC), which makes this exercise important to the Phase 4 intervention.[15]

Table 7. Phase 4

Phase 4: Double Limb Dynamic		
Goals	Exercises- Strength	
1. Perform Resisted Squat exercise with good form	Resisted Squats	3 sets of 6-10 reps
2. Perform a Forward Walking Lunge with chest forward and good form	Forward Walking Lunge	3 sets of 10 reps
3. Perform Band Walk progressions with good hip strategy and form in all directions using blue band	Romanian Dead Lift (RDL)	3 sets of 10 reps
4. Show understanding and compliance with 6 day/week program a. 3 days/week strength b. 3 days/week movement and cardiovascular training	Band walks: Lateral Diagonal forward Diagonal backward Reverse-Pivot	20-30 steps each leg with blue band
	Leg press (double leg)	3 sets of 10 reps
	Hip Extension	3 sets of 10 reps
	Hamstring curls	3 sets of 10 reps
	Planks (see Phase 2)	
	Exercises- Cardio	
	Stationary Bike Elliptical Treadmill- Incline Walking	45-60 minutes of cross-training, maintain a mild forward trunk lean with all exercises, 60%-80% of Heart Rate max, NO RUNNING

Phase 5: Weeks 4-6

After about two weeks in Phase 4, we started the patient on Phase 5. Phase 5, single leg dynamic, focused on the pelvic drop due to weak abductors and extensors. In this phase we continued the Phase 4 double limb strength program and added selected single leg exercises found in Table 8. Again, this is an important phase for a runner due to the amount of time runners spend on a single leg.

We started her with a simple hip hike progression to activate the proper muscles and then added some movement. During the physical therapy sessions we worked on taking steps forward, lateral and diagonal, balancing on one leg and evaluating form. Throughout the sessions, the patient learned to decipher between right and wrong movements and correct them herself using the video feedback. We taught her to have a slight bend in the knee, knee should align with big toes but not inside of the big toes and butt should be back, like sitting in a chair. In Phase 5, she was able to feel when her knees were caving in versus moving in proper alignment and she was able to correct the movement.

Single leg step down was another important exercise in Phase 5 because it required a good deal of strength and control to perform properly. The patient has to demonstrated a good gluteus maximus and medius contraction in order to perform this exercise with good form. This exercise took her a week and a half to master on an 8-inch step. The goals and exercises for Phase 5 are listed in Table 8.

By week 6, Phases 1, 2 and part of 3 became a warm up for the patient before she did any kind of activity. Phases 4 and 5 were combined into a 6 day/week strength and conditioning program that focused on muscle activation of the gluteus maximus and gluteus medius and

proper movement patterns. The patient will continue with this program for the rest of her athletic career.

Table 8. Phase 5

<table>
<tr><th colspan="3">Phase 5: Single Limb Dynamic</th></tr>
<tr><th>Goals</th><th colspan="2">Exercises- Strength</th></tr>
<tr><td rowspan="8">1. Perform 10 Step Downs each side off an 8-inch step with proper form:
a. No pelvic drop
b. No medial collapse
c. Forward trunk lean
d. Hip strategy of movement

2. Perform Standing Hydrant-Dynamic, Assisted Single SL, and RDL-SL exercise with proper use of hip strategy and form

3. Demonstrates compliance with 6 day/week program

4. Normalized hip and knee strength</td><td>Standing Hydrant Dynamic</td><td>3 sets of 10 reps</td></tr>
<tr><td>Assisted Single Leg Squat</td><td>3 sets of 10 reps</td></tr>
<tr><td>Step up - 12 inch box</td><td>2 sets of 10-15 reps, goal of 18 inch box</td></tr>
<tr><td>RDL-SL</td><td>3 sets of 10 reps</td></tr>
<tr><td>Bird Dog</td><td>10-15 times each side</td></tr>
<tr><td colspan="2">Exercises- Cardio</td></tr>
<tr><td>High Knee Step: Forward Lateral</td><td>20-30 reps without toe touch</td></tr>
<tr><td>High Knee Step: Forward Lateral</td><td>(Same as above, with resistance band)</td></tr>
<tr><td>Stationary Bike

Elliptical

Treadmill- Incline Walking</td><td>45-60 minutes of cross-training, maintain a mild forward trunk lean with all exercises, 60%-80% of Heart Rate max, NO RUNNING</td></tr>
</table>

**RDL= Romanian Dead Lift, SL= Single Leg*

Phase 6: Weeks 6-7

Phase 6 focused on double limb ballistic movement. Ballistic movements, or jumping, are good exercises to simulate the impact that running has on the joints of the body. If the patient can master proper movement with double and single limb ballistic exercises, the movement patterns will transfer into correct running form. Phases 1 through 5 had helped the patient develop the proper skills and movement patterns needed to be successful in phase 6 and 7. Table 9 describes Phase 6 goals and other exercises we performed in therapy and added to her strength and conditioning program.

Table 9. Phase 6

<table>
<tr><td colspan="3">Phase 6: Double Limb Ballistic</td></tr>
<tr><td>Goals</td><td colspan="2">Exercises- Plyometric/Strength</td></tr>
<tr><td rowspan="8">1. Perform Drop Jump off an 18-inch box with proper form including:
a. Forward lean
b. No pelvic drop
c. Shock absorption
d. Hip strategy
e. No medial collapse

2. Demonstrates compliance with 6 day/week program

3. Able to perform all double leg jumps/plyometrics without pain or avoidance behaviors</td><td>Stationary Jump</td><td>3 sets of 10 reps with a blue band around knees</td></tr>
<tr><td>Jump Up (8 in)
Jump Forward
Lateral Jump</td><td>20 jumps over a line, with blue band around knees</td></tr>
<tr><td>Jump Rope (side to side, forward back, increase speed)</td><td>50 jumps each exercise</td></tr>
<tr><td>Drop Jump</td><td>2 sets of 10 with blue band, 18-inch box</td></tr>
<tr><td>Forward Hurdle Jump</td><td>2 sets of 10 with blue band</td></tr>
<tr><td>Lateral Hurdle Jump</td><td>2 sets of 10 with blue band</td></tr>
<tr><td colspan="2">Exercises- Cardio</td></tr>
<tr><td>Runners prep- High knee hop</td><td>20-30 times each side without toe touch</td></tr>
<tr><td colspan="2">(Same as Phases 4 and 5)</td></tr>
</table>

The patient did very well in Phase 6 and became very good at cueing herself. At the start of Phase 6, she had been in physical therapy for about 6 weeks and pain had gone down significantly. In Phase 6, the patient was still unable to run and was getting very anxious to do more challenging activities. The patient was motivated and hardworking that it was difficult to slow her down and show her the importance of taking these phases slowly.

The drop jump is the main exercise we wanted the patient to master. The drop jump utilized everything the patient learned in Phase 2 with the squat hold but forced the body to be in the proper positioning on impact. We started the patient with a green thera-band around her legs, just above her knees for tactile cueing to push the knees out in line with the big toe when landing. With Phase 6 exercises, the patient responded well to tactile cues from the band or my hand, and visual feedback from the front and side cameras.

Phase 7: Weeks 7-8

The protocol is written with 8 phases, with the 8th phase being sports specific movements such as cutting and deceleration. The patient we were working with quit basketball and was only going to participate in cross-country and track, which obviously involves no cutting or quick deceleration. We decided that we would end her treatment with Phase 7, single leg ballistic exercises.

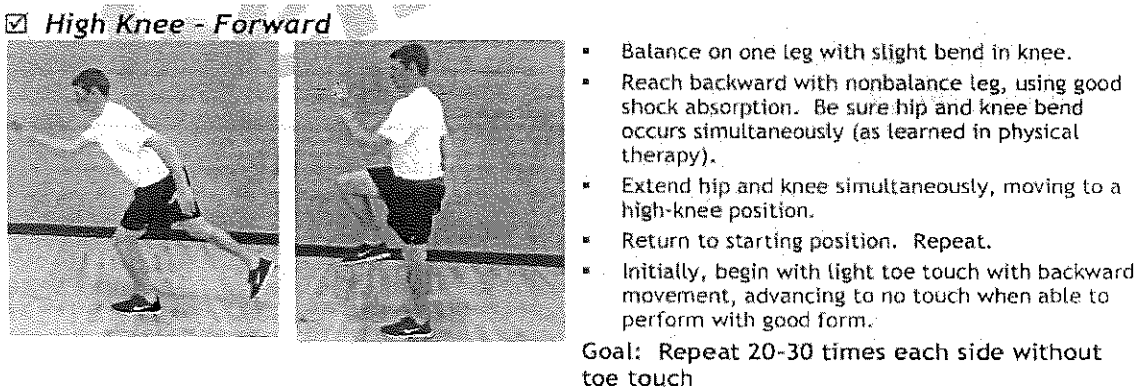


Figure 5. High knee forward[12]

Table 10. Phase 7

Phase 7: Single Leg Ballistic		
Goals	Exercises- Plyometric/Strength	
1. Perform Triple Hop with proper form including: a. Forward lean b. No pelvic drop c. Shock absorption d. Hip strategy e. No medial collapse 2. Demonstrates compliance with 6 day/week program 3. Able to perform all Double and Single leg jumps/plyometrics without pain or avoidance behaviors	Stationary Single Leg Hop	2 sets of 10 reps
	Single Leg Hop Up	2 sets of 10 reps bilaterally
	Bounding: Forward Lateral Diagonal	2 sets of 10 reps
	Split Squat	3 sets of 10 reps
	Single Leg hop over line: Forward Lateral Diagonal	15 jumps over line
	Exercises- Cardio	
	Treadmill: light jogging (only at PT or with athletic trainer)	Start at 5 mph for 5 min, progress to 30 min
	(Same as Phases 4 and 5)	

Like the other phases, the Phase 7 exercises are designed to help the patient progress her new skills in muscle activation and movement patterns in more challenging, real life situations. In the physical therapy gym, we were able to have her practice proper technique under a somewhat controlled environment and give her the visual, tactile and verbal cues she needed to execute the exercises correctly. The most important exercise in Phase 7 was the high knee forward in Figure 5. We treated this exercise as a runners prep and had the patient start in running form with legs split. The exercise was similar to a hop but we were focused on running form, hips back, forward lean, and absorption rather than the height of the hop. During this exercise, the patient struggled to keep her stance knee from caving in. With the use of tactile cues from my hand and the video feedback, after a week, the patient was able to perform three

hops in a row without any valgus from the stance knee. Once she mastered the hop on the ground, we progressed to single leg hop on to a box and over a line. Table 10 lists the goals and exercises performed in Phase 7.

All of the exercises we had the patient perform were aimed at correcting the muscle imbalance by focusing on the gluteus maximus and medius activation. The earlier phases concentrated on waking up the gluteus maximus and medius and reprogramming the muscles the body recruits to achieve a specific movement. It was really neat to see her progress though the phases and gain strength, balance and coordination. The patient made our job easy because she was so motivated to improve and return to running.

CHAPTER IV

Outcomes

Strength

Throughout her treatment, we occasionally Biodex tested her strength. Biodex testing her during her treatment was more for the patients psyche than anything else. It was good for us as physical therapists to make sure she was gaining strength, but we were able to see her improvement through the exercises. Every time we tested her we were able to see a gradual increase in strength in hip extension and abduction, which motivated the patient to work even harder. Once the patient was able to demonstrate Phase 7 exercises, such as the single leg hop and bounding, with good form and no pain, we strength tested her for the last time. Table 11 shows the patients strength assessment from the examination and evaluation day, and also her final strength test 8 weeks later.

Table 11. Biodex Measurements, Exam and Evaluation Day and Re-evaluation 8 Weeks Post Initial Treatment

	Average Peak Torque (ft lbs)		% Deficit	
Right Hip	Day 1	8 Weeks	Day 1	8 Weeks
Extension	111	115	-12.90%	-13.20%
Abduction	77.1	89.5	-13.80%	-14.90%
Left Hip				
Extension	51.8	111	47.30%	-12.90%
Abduction	57	82.1	15.90%	-14.10%

** Negative values in "% Deficit" represent a strength measurement above average norm*

The data above shows an enormous improvement in strength in the left hip. The patient was able to double the strength in her left hip extension torque and demonstrate above average strength in both extension and abduction in her left hip. Most importantly, we can see an improvement in the muscle imbalance from day one to 8 weeks into therapy treatment. When comparing extremities bilaterally, Davies[16] states that muscle weakness between 10-15% is considered to indicate significant asymmetry. The patient's physician and the overseeing PT consider anything between 1% and 10% difference in the percent deficit category to reflect that there is no significant difference between extremities. The strength test revealed almost equalized strength between the left and right hips in extension and abduction.

Pain

The patient's pain improved from a 5/10 to 0/10 with activity. During the treatment she had a few flare ups of pain but they diminished quickly and only lasted a day or two. During the last week and a half to two weeks, we started the patient on a light running program. A week into the program the patient had a minor flare up of pain but it subsided quickly.

Running Evaluation

To allow the patient adequate time to return to running, we waited two weeks after Phase 7 to do the running evaluation. At this point she had been in physical therapy for 8 weeks and had been running for 4 weeks (two weeks with physical therapy and two with her athletic trainer) including short sprints. The running evaluation was performed at 9.7 mph, no incline, and both frontal and lateral views. We decided to test her at a sprint for her post test to gain a more realistic look at her improvements and make the test more applicable to her track season. At this point the patient was able to sprint with no pain.

Test results showed reduced pelvic drop, a reduced crossover sign and a significant decrease in the degree of valgus on the left leg during initial contact. Figure 6 compares day one running evaluation to week 10. During the initial evaluation, the patient had 11.19° of valgus in the left knee on initial contact and when re-evaluated she showed 2.07° of valgus on initial contact. It was evident that the strengthening of her hips and abductors improved her ability to control her knee during running and she was using her quadriceps and glutes more equally. The practice with proper movement was also successful and transferred over to her running form.

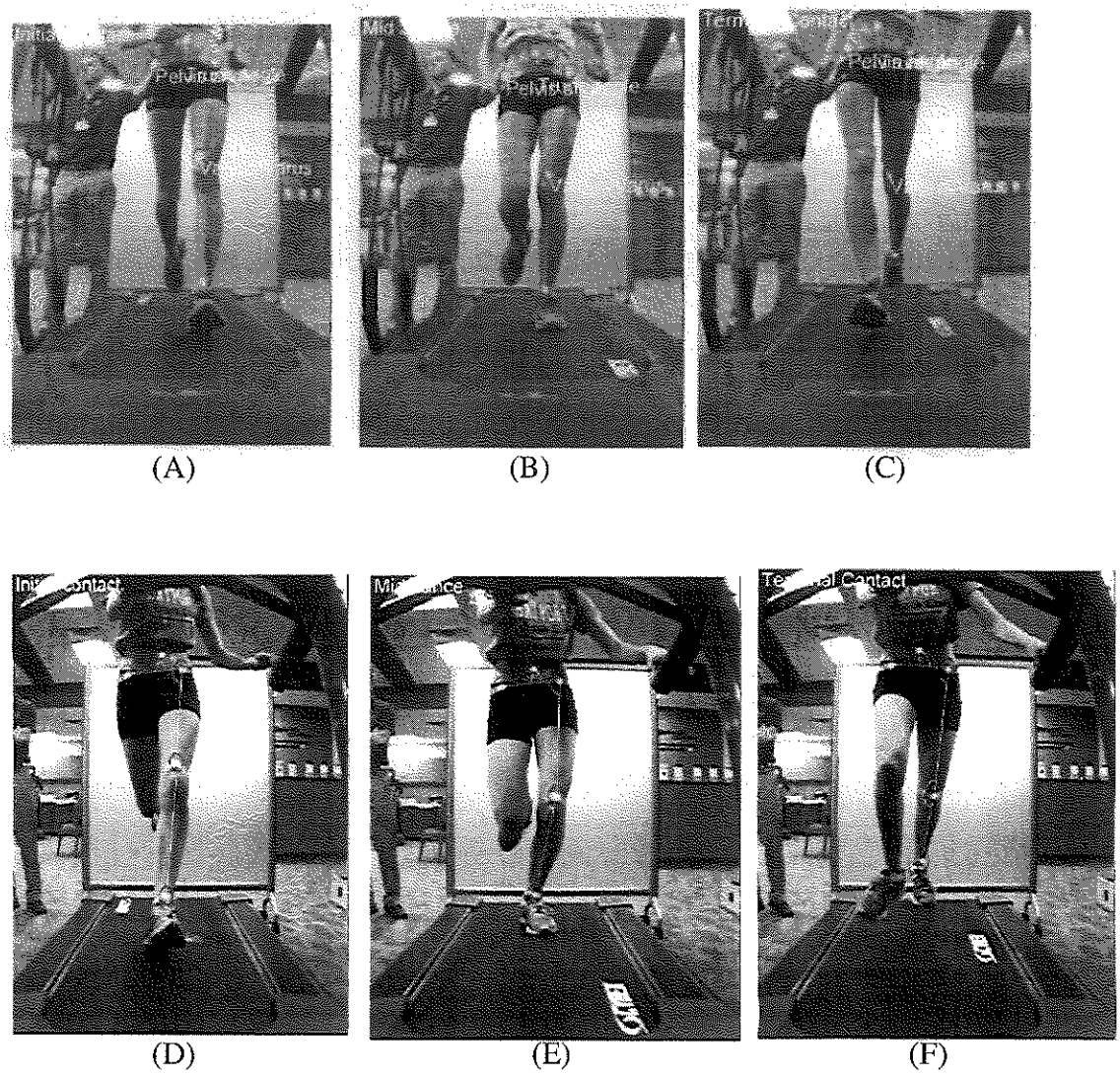


Figure 6. Running evaluation day one (A, B, C), treadmill at 5.3 mph, running evaluation week 10 (D, E, F), treadmill at 9.7 mph. Pictures (B) and (E) illustrate the change in knee valgus over ten weeks of intervention.

Education

The patient's motivation allowed her to be compliant with her home exercise program throughout therapy. The home exercise program in combination with therapy sessions provided her a good strength program routine to start with. She learned proper lifting technique and was able to demonstrate proper form on all of the exercises we worked on. The patient was also educated on the importance of a good stretching routine before and after her runs. The patient maintained her compliance to the strengthening and stretching routines throughout therapy and seemed motivated to continue after therapy.

CHAPTER V

Discussion

Overall, the patient had great results due to her motivation and willingness to adhere to the protocol, home exercise program and restrictions. The patient showed substantial strength gains, a reduction in pain and improved running mechanics. The patient was able to participate in therapy and gym class without any hip pain by the end of her treatment. The patient showed increased hip strength and safer lifting and running form. She was cleared by physical therapy to return to her sport after her 10 week checkup and the patient showed interest in having another running evaluation a week before she starts competition.

The protocol implemented is based on research by Chris Powers in Los Angeles, CA. Powers main focus of research is on the knee joint and the effect the hips have on the knees. By strengthening the hips we can control the movement of the knee and, in our patient's case, take force off of the pelvis and hip flexor/quadriceps by adding it to the glutes.[4] After reading Powers' research articles and seminar notes my clinical instructor provided me, it made sense to implement a strength and movement pattern focused intervention for this patient. As stated earlier, Studies suggest that strengthening alone may not be enough to correct abnormal running or movement patterns and neuromuscular reeducation can be an important component in treatment.[13] I believe the intervention encompassed both strengthening and neuromuscular reeducation exercises that PT adjusted specifically for this patient. The layout of the program made it easy for the patient to follow and the progression made sense from an evidence based, physical therapy standpoint.

With a lack of evidence on the reliability, specificity, and sensitivity of manual muscle testing, using the Biodex to assess the patient's strength was an appropriate examination technique. The Biodex has normative data that we can compare the patient to as well as good interrater reliability. According to an article in The Journal of Orthopedic and Sports Physical Therapy[6], the isokinetic concentric mode of the Biodex dynamometer was reliable for test-retest measures of peak torque and single repetition work. We used the Biodex in an isometic mode to test the lower extremity strength but the machine is run by computer and still has good interrater reliability. With the patient's pain, we were unable to get a good measurement of quadriceps and hip flexor strength which should have been assessed. Based on my clinical instructor's past experience, the patient's history and her exam results, he assumed the excess quadriceps strength. With the Biodex, we were able to see the muscle imbalance when comparing the right and left hip but not specifically compared to the quadriceps. It would have been beneficial to assess the quadriceps once the patient's pain was reduced even if it was two or more weeks into the intervention. Having a quadriceps strength measurement would have allowed us to confirm our assumptions and insured the correction of muscle imbalance. We were able to see a significant improvement in the muscle imbalance between the left and right hip strength.

Another thing I would have done differently is our discharge running evaluation. I agree with having the patient run at a faster pace to assess her ability to return to track, but it is difficult to compare the two evaluations when the patient is running at different speeds. We could have had her run at the same speed as her first test, assess the measurements and then have her do another test at a sprint.

Physical therapy and other health care professions would benefit from further research on manual muscle testing and Biodex testing. While searching for articles on strength

measurements, I was unable to find the information I was looking for on the reliability and validity of these measures. I can assume that Biodex testing would provide more reliable results because it is computer based and easy to repeat whereas manual muscle testing could give different results based on the examiner.

Hip strengthening, especially abductors, have become a large area of research. The gluteus maximus, gluteus medius and abductors are a very important group of muscles for both stability and trunk and lower extremity movement. I believe it would be beneficial to continue to research the importance of proper strength training and movement guided exercises on lower extremity health conditions including hip apophysitis.

Reflective Practice

This case was very educational for me. While working at the clinic, I learned the importance of hip and abductor strengthening in a variety of lower extremity pathologies. We received amazing outcomes from the patient in this case by focusing on hip strength and movement training. At the clinic, we used the same protocol guideline to treat a number of patients lower extremity pathologies from ankle sprains to total knees and received great outcomes.

If I had a patient with the same diagnosis of bilateral hip apophysitis, I would definitely assess hip strength and imbalances. I would use the same philosophy that we used with the patient in the case study. Hip strength is very important to body mechanics and movement of the lower extremity and I think many patients, young and old, can benefit from a proper hip and abductor strengthening program.

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