Pilates and the Effects on a Teenage Volleyball Player with Patellar Tendonitis

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Abstract

Volleyball players can develop a cluster of muscle imbalances that can lead to several injuries, including patellar tendonitis, or “jumper’s knee”. This affects at least 50% of volleyball players today(5). Jumper’s knee is an inflammation of the patellar tendon from repeated overuse. With repeated strain, micro-tears as well as collagen degeneration can also occur(4). The research presented focuses on a 14 year old female competitive volleyball player and the results of a 20 session BASI program. It was designed to address core strength, overall flexibility and to improve lower body imbalances. Studies show patellar tendonitis can be prevented by strengthening and conditioning muscles of the hip, hamstring and quadricep muscles as well as the gluteals. These muscle groups work together to absorb the “shock” to the knee during a jump. Ultimately, we will work to relieve pain, improve performance, restore optimal range of motion and establish body awareness, control and efficiency.
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Anatomy of the Knee

The knee, also known as the tibiofemoral joint, is a synovial hinge joint formed between three bones: the femur, tibia, and patella. Two rounded, convex processes (known as condyles) on the distal end of the femur meet two rounded, concave condyles at the proximal end of the tibia. The patella lies in front of the femur on the anterior surface of the knee with its smooth joint-forming processes on its posterior surface facing the femur.

The joint-forming surfaces of each bone are covered in a thin layer of hyaline cartilage that gives them an smooth surface and protects the bone from damage. Between the femur and tibia is a
figure-eight-shaped layer of tough, rubbery fibrocartilage known as the meniscus. The meniscus acts as a shock absorber inside the knee to prevent the collision of the leg bones during strenuous activities such as running and jumping.

A joint capsule surrounds the bones of the knee to provide strength and lubrication. The outer layer of the capsule is made of fibrous connective tissue continuous with the ligaments of the knee to hold the joint in place. Oily synovial fluid is produced by the synovial membrane that lines the joint capsule and fills the space between the bones, lubricating the knee to reduce friction and wear.

Many strong ligaments surround the joint capsule of the knee to reinforce its structure and hold its bones in the proper alignment\(^3\).

1. The Patellar Ligament extends from the inferior border of the patella to the tibial tuberosity of the tibia and holds the patella in place.
2. The Oblique Popliteal Ligament and Arcuate Popliteal Ligament join the femur to the tibia and fibula of the lower leg, posteriorly.
3. The Medial Collateral Ligament (MCL) connects the medial side of the femur to the tibia and prevents forces applied to the lateral side of the knee from moving the knee medially.
4. The Lateral Collateral Ligament (LCL) binds the lateral side of the femur to the fibula and prevents forces applied to the medial side of the knee from moving the knee laterally.
5. Two internal ligaments – the anterior and posterior cruciate ligaments – also help to maintain the proper alignment of the knee.
6. The Anterior Cruciate Ligament (ACL) is the most anterior of these internal ligaments and extends obliquely from the inner surface of the lateral condyle of the femur to the anterior intercondylar space of the tibia. The ACL plays an important role in preventing hyperextension of the knee by limiting the anterior movement of the tibia.

7. The Posterior Cruciate Ligament (PCL), is directly behind the ACL and extends obliquely from the inner surface of the medial condyle of the femur to the posterior intercondylar space of the tibia. The PCL prevents the posterior movement of the tibia relative to the femur\(^{(3)}\).
Anatomy and Function of the Patellar Tendon

The patellar tendon is a thick, organized band of tissue that attaches the patella to the tibia. The patella is the moveable bone on the front of the knee. It is wrapped inside a tendon that connects the quadriceps to the tibia, or lower leg bone. The tendon is composed of a highly organized arrangement of collagen that are organized longitudinally to resist flexible forces like a rope. During movement, the tendon slides in the groove between the femoral condyles, known as the “femoral groove”. It is important in transmitting forces generated by the quadriceps to the tibia, so the leg can straighten and support body weight when walking or jumping.

The quadriceps muscle is very large and ends in a tendon that inserts into the tibial tuberosity, which is a bony bump at the top of the tibia, just underneath the patella. The tendon and the patella are called the quadriceps mechanism. The mechanism has 2 separate tendons, the quadriceps tendon on top of the patella and the infrapatellar tendon or patellar tendon below the
patella. The role of the patellar tendon is to transfer force of the quadriceps muscle much like a rope and pulley, as the knee straightens.

The greatest level of stress through the patellar tendon is during jumping and landing activities. During jumping, the quadriceps muscles provide an explosive contraction, which straightens the knee and pushes you into the air. When landing, the quadricep muscle helps absorb the landing forces by allowing a small amount of controlled knee bend.

http://eorthopod.com/patellofemoral-problems/
Case Study

Samantha is a 14 year old elite club volleyball player with 5 years experience on the court. This year she began to experience pain in her left knee, just below the patella, eventually diagnosed with patellar tendonitis by a physical therapist. She uses KT tape and ice on a regular basis, which provides temporary relief. She wants to incorporate a pilates program into her training to strengthen her knee, hip and ankles and hopefully relieve the knee pain. In addition, she is looking for greater core strength, flexibility and mind/body connection which will improve her overall athletic performance. Since the goal is broad, I designed 2 programs that address lower body imbalances as well as abdominal/back extensor exercises, all of which progress in difficulty. I feel this program will give her a nice introduction to pilates, and move to achieve her goals.

BASI Pilates Program #1
Sessions 1-10

WARM UP - standing roll down, fundamental warm up (pelvic curl, spine twist supine, chest lift, chest lift with rotation). I can assess postural deviations and Samantha can establish mind/body connection.

FOOTWORK/CADILLAC - fundamental footwork (parallel heels, parallel toes, V toes, open V heel, open V toes, calf raises, prancing, single leg heels, single leg toes). We work slowly and carefully through this block, paying close attention to the knee, ankle dorsi flexion and how ankles, knees and hips track. Footwork on the cadillac can be a bit more advantageous to
Samantha as it takes potential damaging forces off of the knee and works in the “power range” of her knee flexion\(^1\). This means it is a smaller ROM when she jumps.

**ABDOMINALS/CADILLAC** - Fundamental work (roll up, mini roll up, mini roll up obliques). I like how the roll up focuses on abdominal muscle recruitment to begin, and the mini roll up adds the back extensors, then finally adding the spinal rotation in the mini roll up oblique. All of these strong, stable muscles are essential for a volleyball player.

**HIPWORK/CADILLAC** - Basic leg springs series (frog, circles down, circles up, walking, bicycle, bicycle reverse). Using the yellow springs, Samantha was again able to focus on each side of her body working together, yet using each leg individually. The cadillac provides stability while addressing lower body imbalances.

**STRETCHES/REFORMER** - Standing Lunge. Great for the hip flexors and tight hamstrings.

**FULL BODY INTEGRATION/REFORMER** - Reverse Knee Stretch. This exercise added shoulder stabilization to the intense abdominal work. Careful to do this in spinal flexion rather than neutral spine to protect the low back.

**ARMS/REFORMER** - Supine arm series (extension, adduction, circles down, circles up, triceps). The series focuses on several muscles needed for shoulder strength, flexibility and stabilization. Range of motion is essential for volleyball players.

**LEGWORK/JUMPBOARD** - Jumping Series (parallel position, v position, single leg parallel, changes) This is my favorite part of the entire workout as all 4 exercises are tailored for hip extensor control, knee extensor strength and plantar flexor strength. Foot articulation and pelvic lumbar stabilization are emphasized throughout. Samantha was able to make a very clear connection of her “landing” on the board as it relates to the volleyball court.
LATERAL FLEXION/REFORMER - Mermaid. Working spinal rotation as she “unwinds” and moves with a nice flow throughout the exercise.

BACK EXTENSION/REFORMER - Breaststroke Prep. Shoulders, arms and back extensors all work nicely together. This was interesting as Samantha had to work very hard for the shoulder flexibility to lift her head/chest on the 4-6th repetition.

**BASI Pilates Program #2**  
**Sessions 11-20**

WARM UP - Standing roll down, roll up, spine twist supine, double leg stretch, single leg stretch, criss cross.

FOOTWORK/REFORMER - fundamental footwork (parallel heels, parallel toes, V toes, open V heel, open V toes, calf raises, prancing, single leg heels, single leg toes). We work slowly and carefully through this block, paying close attention to the ankle dorsi flexion and how ankles, knees and hips track. The concentric and eccentric movement patterns in footwork are key to strengthening the quadriceps which will help with jumper’s knee. Single leg heels and toes are an excellent way for Samantha to see/feel the deviations on her right side.

ABDOMINALS/REFORMER - 100 prep and the Hundred. This emphasizes abdominals and shoulder extensors. I like this because we can make it harder with different leg positions as she continues to get stronger.

HIPWORK/CADILLAC - Single Leg Series. This is a natural progression from the last 10 sessions, requiring a very stable pelvic lumbar stabilization. Samantha is able to connect with each side of her lower body to address limitations on each side. *Noted improved strength and control on right side.*
SPINAL ARTICULATION/CADILLAC - Tower Prep. This focuses on abdominals and hamstrings.

STRETCHES/LADDER BARREL - Gluteal, Hamstring, Adductor and Quadricep Stretches.
We spend a good amount of time on all stretches, taking 3-5 deep inhale/exhales. After 4 sessions, noted improvement in flexibility. We also add shoulder stretch for sake of flow.

FULL BODY INTEGRATION/ CADILLAC - Sitting Forward and cat stretch. These exercises provide great stretches through Samantha’s lower back, moving her to neutral alignment. She is definitely feeling more balanced and stretched. She likes how her hamstrings and lower back feel after this block..

ARMS/CADILLAC - Standing Arm Series. Includes glute strength and core stabilization in the standing posture, keeping her balance throughout as she performs the series. These are also helpful in helping her connect upper body movement to scapular stabilization.

LEGWORK/CADILLAC - Squats. This exercise fits well here for the sake of flow, and works bicep and quadricep strength. Knee stabilization is an objective.

LATERAL FLEXION/CADILLAC - Butterfly. The spinal rotation and lateral flexion together with the abdominal strength is key.

BACK EXTENSION/CADILLAC - Prone 1. This works toward abdominal control with the back extensors and scapular stabilization...beautiful back extensor strength. Mind body connection.
Conclusion

The original purpose for this research was to assist Samantha in alleviating knee pain associated with patellar tendonitis and strengthen the surrounding muscles. This was accomplished by the stretching and strengthening exercises that corrected muscle imbalances. We also added eccentric strength training through jumpboard series. However, the bigger picture was the subject learning about pilates and how it positively affects her body and overall well being. According to Mary Ann Briggs of the Pilates for Teen Esteem program, “teens can express themselves without being being judged, move without being ridiculed and realize that being confident in one’s self is something no one can take away from them(8).” Pilates has provided Samantha with a new sense of confidence in her body and mind. It has taught her exercises to calm pain and inflammation, correct muscle imbalances and to improve her ankle, knee and hip alignment, which constitutes a better physiological action. Prevention of future injuries through patient education was a key component in this program. Ultimately, working on strength, balance, control and efficiency allows her body and mind to work in harmony.
BIBLIOGRAPHY


