Utilization of BASI Pilates for a dancer post patellar subluxation injury

Sutton Anker, MSc

September 2019

Course: 2019, Pilates Denver, Denver, Colorado
Abstract

Dance is a physically demanding sport requiring muscular strength in extreme ranges of motion (Quin, et al. p. 178; Russel, p. 199). The knee and hip joint work in tandem due their close proximity to various muscular attachments and biomechanical movement patterns. When dancing there is a great amount of force placed on the knee joint during extension, when jumping, and in a grand plié. Lateral subluxation of the patella occurs when the patella is pulled laterally out of its position in the femoral groove. This usually occurs when landing or turning on an unstable leg and a skewed pelvic alignment (Simmel, p. 110). If the dancer has a great Q-angle (Quadriceps angle) they are more at risk for patellar subluxation (Clippinger, p. 259; Simmel, p. 110). A 15-year-old female dancer recently had four separate incidents of patellar subluxation while dancing. After being released from physical therapy the dancer fully participates but experiences knee and hip pain. Training the dancer in a 12-week BASI Block Comprehensive program she will strengthen the muscles that attach at the knee and hip joint to better support the biomechanical movements of the knee joint when dancing. This strength development and intentional biomechanical tracking will support and reduce the risk of injury occurrence in their dance training.
Table of Contents

Abstract 2
Anatomical description of the hip 4
Anatomical description of the hip 5
Injury in Dance 8
    Patellar Subluxation 9
Case Study 9
BASI Block Comprehensive Program 11
Desired results and reasoning 12
Conclusion 14
References 15
Anatomical description

It is important to outline the anatomical description of the hip and knee joint when discussing the Q-angle (Quadriceps angle) and its link to patellar subluxation. Due to the multiple muscle attachments proximally and distally both joints must be understood in order for the knee’s alignment to be maintained.

Anatomical description of the hip joint

The hip joint, or the acetabulofemoral joint, is a synovial ball and socket joint and is considered the core for full body movement (Prentice, 270). The function of the hip joint is to allow the leg to move in all planes of motion (sagittal, frontal, and transverse) with hip adduction, abduction, external and internal rotation, flexion and extension, and to allow for weight transfer in locomotion.

The skeletal structure of the hip is the head of the femur placed deep inside of the acetabulum of the pelvis by suction of the synovial fluid and the strong ilofemoral ligaments (Clippinger, 158). Ligaments of the hip joint include the iliofemoral ligament attaching at the anterior inferior iliac spine to the head of the femur (crucial for joint stability), the pubofemoral ligament from the pubic bone to the lesser trochanter of the femur, and the ichiofemoral ligament on the posterior side of the hip from the ischium to the femoral neck.

Due to the vast ranges of motion (ROM) the muscular attachments at the hip joint are numerous and complex (Figure 1). The primary hip flexors are the iliacus and psoas major and minor as well as the quadriceps muscle group and sartorius. The primary hip extensors include hamstring muscle group and gluteus maximus. The gluteus
minimus/medius and tensor fascia lata (TFL which creates the iliotibial band) create hip abduction and internal rotation. Primary adductors of the hip are the gracilis, pectineus, adductor longus, adductor magnus, and adductor brevis. The muscles responsible for hip external rotation include the six deep outward rotators: piriformis, superior gemellus, inferior gemellus, obturator internus, obturator externus, and quadratus femoris.

**Figure 1:** Skeletal and muscular anatomy of the hip joint, anterior and posterior view.

**Anatomical description of the knee joint**

The knee joint is a synovial hinge joint with four bones: femur, patella, tibia, and fibula. The primary movements of the knee joint are flexion and extension, with small amount of rotation. Due to the tibia’s essential rotational function at the knee joint it is not a true hinge joint (Prentice, 252). The knees key function is to offer stability weight bearing and mobility in locomotion.
There are several ligament and muscle tendon attachments at the knee (Clippinger, 238). The four main stabilizing ligaments of the knee joint aiding in its function (particularly when extreme demands are placed upon the joint) and correct alignment are the medial collateral ligament, lateral collateral ligament, posterior cruciate ligament, and anterior cruciate ligament (Figure 2; Simmel, p. 102).

![Image](image_url)

**Figure 2:** Skeletal and ligament anatomy of the knee joint, anterior view.

In addition, the knee joint is the intersection and insertion point of the quadriceps group muscles and tendons (vastus intermedius, rectus femoris, vastus lateralis, vastus medialis oblique) (Simmel, p. 106). The quadriceps muscle group is responsible for the knee extension (Clippinger, 245). The hamstring group muscles are responsible for knee flexion and internal rotation, semitendinosus and semimembranosus, and the key role for the biceps femoris is knee flexion and internal rotation of the knee (Clippinger, 249; Simmel, p. 106). Other primary knee flexor muscles, gracilis and sartorius, intersect and insert at the medial side of the knee joint. All shown in Figure 3. The popliteus muscle runs behind the knee to externally rotate the femur and internally rotate the tibia (Figure 3). The lower limb muscles including the gastrocnemius, tibialis anterior, peroneus...
longus, extensor digitorum longus also have attachment points around the knee joint (specifically the upper part of the tibia) making this joint crucial to the stability and movement of the leg as a whole (Figure 4; Clippinger 312).

**Figure 3:** Muscular anatomy of the knee joint, medial view.

**Figure 4:** Muscular anatomy of the knee joint lateral view.
**Injury prevalence in dance**

Dance is an artistic sport that requires large ranges of motion with complex movement patterns and sequences (Ahearm Greene, & Lasner, p. 192 and Welsh, et al, p. 86). For the purpose of this paper the term “dancer” is defined as any individual who participates in formal dance technique lessons including but not limited to the following genres: ballet (en pointe), jazz, contemporary, modern, tap, ballroom, social dance, and hip-hop. These athletes must have adequate muscular strength, motor control, flexibility, and coordination to be successful in the sport (Russel, p. 199 and Welsh, et al, 86). The injury rate among dancers is high; with the hip, knee, and ankle as the most common injury locations on the dancer’s body (Hendry et al, p. 72; Quinn et al. p. 178; Russel, p. 206; Welsh, et al, p. 86).

The knee joint is often placed in vulnerable positions (hyper extension, landing forces, and rotational forces) in order to succeed the aesthetic demands of dance (Clippinger, p. 260; Hendry et al, p. 72; Winslow and Yoder, p. 18). Since there are various muscle attachments from the hip to the knee joint, as discussed previously, this causes interdependent relationship on the joints. When a dancer does not have proper alignment of the pelvis when landing from a jump or preparing for a turn, the knee joint can be negatively impacted (Winslow and Yoder, p. 18). When analyzing knee traction or alignment pelvis placement must be considered (Simmel, p. 108).
Patellar Subluxation

Patellar subluxation is an injury that occurs for dancers due to the complexity and quick movement patterns placed on the knee in addition to the extreme ranges of motion and muscular imbalances (Simmel, p. 109; Welsh et al. p. 86). Primary factors of patellar subluxation are extreme Q-angle and weakness in the surrounding knee joint muscles and tendons. The Q-angle is a static measurement from the ASIS (anterior superior iliac spine) to the patella relative to the center of the patella to the tibial tuberosity (Clippinger, p. 258 and Simmel p. 105). The rectus femoris is attached at the ASIS on the pelvis and the tibial tuberosity via the patellar tendon. The rectus femoris muscle pulls to make a straight line between its two attachment points causing the patella to be pulled laterally (Clippinger, p. 258). An individual with a more severe Q-angle tends to have more knee pain, a weaker knee joint, and more prone to knee injury (Clippinger, p. 258 & Prentice, p. 265). When the patella glides away from its position in the femoral groove this causes pain, stretches the supporting ligaments and tendons, and weakens the knee joint (Prentice, p 265). Common treatments of this injury include rest, strengthening of the knee and hip muscles (hip and knee extensors and flexors, along with adductors and abductors), and training with proper alignment and biomechanical movement patterns.

Case Study

The client is a 15-year-old female dancer, who will be referred to as Sara. She dances 12-15 hours per week in ballet, modern, contemporary, jazz, hip-hop, tap, and ballroom for a competitive dance team. Sara has a small frame with long limbs, and is hyper-mobile in her knee and hip joints. A year and a half ago Sara subluxed both of her
knees and often complains of hip pain. As Sara’s modern dance teacher it has become
evident she forces rotation from the knee joint, is not able to hold her leg in an extension
for more than a few seconds without fatiguing, and has an insufficient amount of strength
in her TA (transverse abdominus), back extensors, hip extensors, flexors, and adductors.
It is apparent in her technique that she does not track her knee and hip alignment
correctly indicating the muscular weakness and perhaps a lack of awareness. Since she
has subluxed her knees she wears a knee brace and has done physical therapy, but has not
participated in a formal treatment program in the eight months since her injury. When she
feels pain or discomfort in her knees or hip she reduces her ROM (range of motion) and
rests. To note, a physical therapist has cleared Sara to participate fully in dance classes
and competitions.

In her Pilates practice training it has been recommended for Sara to focus on
better understanding of the knee tracking in relation to the hip and to strengthen the
surrounding muscles of the knee to support her dance movement. Table 1 is the outline of
the exercises proposed in the Comprehensive BASI Block system (Isacowitz, 2010) over
a twelve-week program. The primary goal of the program is to strengthen knee extensors
and flexors and to strengthen hip flexors, extensors, adductors, abductors for general knee
and hip alignment support. The secondary goal of the program is to bring more awareness
to her alignment and train the recruitment of her abdominals to support the movement of
the leg.
**Table 1:** Comprehensive BASI Block 12-week program for dancer recovering from knee subluxation. * Indicates Blocks specifically discussed in following section.

<table>
<thead>
<tr>
<th>Block</th>
<th>Week 1-4</th>
<th>Week 5-8</th>
<th>Week 9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-Up</td>
<td>Pelvic curl</td>
<td>Pelvic curl Spine twist supine Chest lift Chest lift w/ rotation</td>
<td>Roll up Spine twist supine Double leg stretch</td>
</tr>
<tr>
<td></td>
<td>Spine twist supine Chest lift Chest lift w/ rotation</td>
<td>Roll up Spine twist supine Double leg stretch Single leg stretch Criss-cross</td>
<td></td>
</tr>
<tr>
<td>Foot Work</td>
<td>Reformer foot work series</td>
<td>Cadillac foot work series (Include Hip-Opener for alignment training and muscle recruitment)</td>
<td>Wunda Chair foot work series</td>
</tr>
<tr>
<td>Abdominal Work*</td>
<td>Avalon: Roll-up, Mini roll-up, Mini roll-up oblique Chair: Standing pike &amp; Pike sitting</td>
<td>Reformer: Hundred prep, Hundred, Coordination Cadillac: Bottom lift w/ Roll-up bar</td>
<td>Reformer: Teaser prep Cadillac: Teaser Chair: Torso Press sit</td>
</tr>
<tr>
<td>Hip Work*</td>
<td>Reformer series: frog, circles down, circles up, openings</td>
<td>Cadillac: Basic leg springs Step barrel: Supine leg series</td>
<td>Cadillac: Single leg side series</td>
</tr>
<tr>
<td>Spinal Articulation</td>
<td>Reformer: Bottom lift and Bottom lift w/ extension Chair: Pelvic curl</td>
<td>Reformer: Short spine Cadillac: Tower prep</td>
<td>Reformer: Long Spine Cadillac: Tower</td>
</tr>
<tr>
<td>Stretches</td>
<td>Standing Lunge</td>
<td>Kneeling lunge</td>
<td>Full lunge</td>
</tr>
<tr>
<td>Full Body Integration (F/I)*</td>
<td>Reformer: Round back, Flat back, Elephant, Scooter</td>
<td>Reformer: Stomach Massage round back, flat back, and reach, Down stretch Cadillac: Thigh Stretch w/ Roll up bar</td>
<td>Reformer: Up stretch 2, Up stretch 3, Long Stretch</td>
</tr>
<tr>
<td>Arm Work</td>
<td>Reformer: Sitting series Chair: Side kneeling arm (must hold pelvis stable with</td>
<td>Avalon: Arms sitting series</td>
<td>Cadillac: Arms standing series</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>oblique recruitment)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td><strong>Leg Work</strong></td>
<td>Chair: Leg press standing, hamstring curl, hip opener</td>
<td>Reformer: Split Cadillac: Squats</td>
<td>Reformer: Jumping series series</td>
</tr>
<tr>
<td></td>
<td>Reformer: Hamstring curl, Single leg skate</td>
<td>Chair: Frog front, Backward step down</td>
<td></td>
</tr>
<tr>
<td><strong>Lateral Flexion/Rotation</strong></td>
<td>Chair: Side Stretch</td>
<td>Cadillac: Side lift</td>
<td>Reformer: Side over on box</td>
</tr>
<tr>
<td></td>
<td>Reformer: Mermaid</td>
<td>Chair: Side Pike</td>
<td>Ladder Barrel: Side Overs</td>
</tr>
</tbody>
</table>

**Desired results**

The BASI Block system is designed to work the full body emphasizing particular muscle groups and movement patterns; each block equally important for overall functional training and movement. For dancers in general the entire block is highly beneficial for their training and strength development. In this particular case of a patellar subluxation injury recovery, four Blocks specific desired results will be discussed to focus on the programs goals.

For the Abdominal Work Block we will progress the exercises to first strengthen the abdominals, specifically the TA, and have her be more kinesthetically aware of recruiting the abdominal muscles concentrically and eccentrically before moving her legs. The Block progresses from her legs in a closed chain, stationary position to an open chain position in a movement sequence to relate the Pilates training to her dance training.
Cueing of a neutral pelvis and co-contraction of quadriceps and hamstrings will also assist in achieving the goals of the program.

In the Hip Work Block the series starts on the reformer to allow Sara to understand pelvic lumbar-stabilization while the legs are moving in ranges of motion, and engaging her hamstring muscles and hip adductors throughout. The step barrel series will require strength in the TA while finding eccentric length of the muscles and not exceeding her range of motion/mobility. This series will strengthen the hip flexors and extensors with more control and concentration in movements that are similar to dance. The single leg side series on the Cadillac permits Sara to find great ranges of motion but she must have strength in her hamstrings to extend the leg behind her and stay in control. The Hip Work Block will not only strengthen the targeted muscles, but also enhances Sara’s mindfulness of her movement.

The focus of the Full Body Integration Block is for Sara to build strength in her hip extensors and flexors, while maintaining control of the hip range of motion and torso. Stomach Massage Series is key to the goals of the program building knee extensor strength while focusing on stability of the pelvis by contracting the abdominals, and maintain proper tracking of the joints. The Block progresses to requiring full body stabilization in fluid movement with the focus on strength of hip extensors and flexors.

The Leg Work Block is a primary focus attributed to the exercises muscle focus and movement patterns. The block begins with increasing hamstring and quadriceps strength. It then progresses to more difficult movements requiring strength of the hip extensors and flexors while requiring the knee to track properly from the hip. Backward step down will require Sara to rely on her abdominal strength and hamstring work to
stabilize the standing leg without her knee tracking medially or laterally from the hip. Ending the block with the jumping series translates directly to Sara’s dance training. With focus, intention, and precision Sara will be able to control the movement of the knee using the hamstrings and abdominals to support the take off and landing of the jumps.

**Conclusion**

Dancers are athletes required to move gracefully, with conviction, in demanding physical movements. The movements require strength and proper alignment of the knee and hip joint. The knee and hip joint are interdependent of one another for proper tracking because of the muscular attachment points. Due to a high Q-angle some dancers become more prone to knee and hip injuries, including but limited to patellar subluxation. This injury causes the patella to pull laterally from the femoral groove can be an indicator to weak hamstring and quadriceps (hip flexors and extensors), which perpetuates poor knee alignment. For a dancer currently in a long post recovery from patellar subluxation the BASI Block Comprehensive 12-week program can be utilized to gain strength in the hip extensors, hip flexors, and abdominals while focusing on proper knee alignment. The strength development in the knee, hip, and abdominals will better support Sara’s biomechanical efficiency and the great ROM when dancing.
References


