The Rehabilitative Effects of Body Arts and Science
International™ Pilates Principles and Repertoire for Dancers with Genu Recurvatum

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ABSTRACT

Genu recurvatum means (L. genu, knee + re-curvous, bent back) “back-knee” as the knees curve backward in the sagittal plane. The knees extend “beyond straight”, creating a convexity of the legs posteriorly. It is more common in females than males. This hyperextension of the knees is thought by some to complement the aesthetic of the legs with pointed (plantar flexed) feet. In dancers, this often indicates a general predisposition towards ligamentous laxity.

Trouble arises when the dancer “locks” back in to his or her knees, or has an extreme amount of flexibility in the knee joint (looser ligaments equals a significant amount of hyperextension) and therefore places undue stress on the knee joints and lower legs rather than employing muscle strength for correct postural stance. Hyperextension of the knees can put excessive stress onto other structures in and around the knees, which can become painful, and/or create further injuries. The principals and repertoire of the BASI™ Pilates method can be used to create more stability and control of the muscles and ligaments surrounding the knees.
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ANATOMICAL DESCRIPTION OF THE KNEE JOINT

The knee joint is the largest joint of the human skeletal system and is a synovial hinge type joint. The entire weight-bearing load is transferred through the knee joints. The asymmetrical design of the condylar surfaces of the femur contributes to the complexity of joint motion as well as to the integrity of joint stability during load bearing. With six degrees of freedom, the motion of the knee joint is a combination of gliding and angular movement. The anatomical axis shifts orientation in all three perpendicular planes of reference during both swing and stance phases, although the primary joint motion occurs in the sagittal plane. The stability and strength of the knee joint, therefore, depends on the controlling ligaments to some extent but otherwise entirely upon the controlling muscles. Without good muscle control the knee is an unstable joint, heavily loaded by the body above and vulnerable to injury.

Bones and Articulations

When describing the knee, four bones and their articulations should be discussed: the femur, the tibia, the fibula, and the patella. Each articulation surface is covered with hyaline cartilage. The primary articulation of the knee is between the condyles of the femur and tibia. This articulation is separated by the medial and lateral menisci, which serve to deepen the articular surfaces and aid in lubrication and cushioning of the joint. Although not a part of the knee joint, the articulation of the tibia and fibula is significant due to its importance in weight bearing. The patellofemoral joint is a synovial gliding type joint. The patella is a sesamoid bone contained in the tendon of the quadriceps muscle. The articulation consists of the underside of the patella and the patellar groove of the femur. The gliding of the patella in the femoral groove allows for increased efficiency of the quadriceps muscle.
Musculature

Many muscles acting on the thigh have their insertions around the knee. Although not participating in gross knee movements these muscles are significant in the dynamic stabilization of the knee joint. Only the muscles specifically participating in knee flexion, extension, internal, and external rotation are discussed in this paper.

The anterior muscles of the knee act primarily as knee extensors. The quadriceps femoris muscle is the principle muscle involved in knee extension. This muscle can be divided into four distinct parts: the rectus femoris, vastus medialis, vastus lateralis, and the vastus intermedius. All four parts of this muscle come together to insert on the proximal edge of the patella, which then transfers their action, by way of the patellar tendon, to the tibia.

The principle muscles involved in knee flexion are the hamstring muscle group. This group is comprised of the biceps femoris, semitendinosus, and the semimembranosus muscles. Their insertion occurs on the proximal tibia and head of the fibula. The biceps femoris muscle has an additional action of externally rotating the tibia. While the semitendinosus and semimembranosus muscles also have an additional role of internally rotating the tibia. Other muscles participating in knee flexion and internal rotation are the sartorius, and gracilis muscles. The popliteus muscle also serves to internally rotate the knee in a non-weight bearing position. Additional muscles involved in isolated knee flexion include the gastrocnemius and plantaris muscles.
INTRODUCTION

Dancers are involved in the daily practice of movements that are extreme and repetitive. This makes dancers (and dance instructors) more susceptible to injury than the general population. Unlike their fellow athletes in most other sports, dancers seldom experience career-threatening acute injuries, but they do manifest a wide range of “micro-traumatic syndromes” or chronic injuries. Most dance injuries result from errors in technique or the repetitive application of techniques to bodies that are anatomically ill prepared to perform them, such as genu recurvatum (hyperextended knees).

Sagittal Views of Normal and Genu Recurvatum Knees

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SYMPTOMS / ASSOCIATED PROBLEMS

Hyperextension of the knees can put excessive stress onto other structures in and around the knee, which can become painful. The hamstrings activate the flexing of the knee; therefore, all the hamstring muscles have a two-joint action at the hip and knee, exposing them to increased chance of injury in movement. The actions of the quadriceps and the hamstrings are opposite in nature, and dance is fluid, the muscles work in concert, or co-contraction. Hamstrings are not postural muscles, i.e. slow twitch, tonic muscles. Hamstrings are fast twitch muscles, phasic muscles that accelerate and decelerate the hip and knee. To effectively strengthen the hamstrings, working the muscles for both flexion and extension involving concentric strengthening and eccentric strengthening is advised.

Common associated problems include:

- A muscle imbalance in the thigh, in which the quadriceps muscles can be overactive and the hamstrings subsequently are not as well developed.
- Patella displacement or subluxation can occur, due to poor quadriceps development or general ligamentous laxity.
- Inversions sprains of ankles and feet.
- The unusually high amount of loading placed on the lower leg can result in “shin splints” or even, in more severe cases, tibial stress fractures.
CASE STUDY

Name: Brete Martin
Age: 52
Limitations: None
History: Former dancer with genu recurvatum, currently teaching ballet to younger students, requiring repetitive demonstration. Increased generalized laxity and decreased ITB flexibility resulting in the following injuries:

- patella displacement of left knee
- Two inversion stress fractures of 5th metatarsal left foot
- inversion sprain of left ankle
- inversion sprain of right ankle

Treatment: Pilates and stretching exercises.

- Two private Pilates sessions with instructors working to strengthen surrounding muscles of the knees
- Three to four hours of self-practice Pilates repeating the exercises recommended by the instructors and the BASI™ Movement Analysis handbooks (using apparatus) targeting hamstring strength and control
- Stretching the quadriceps, TFL, and IT band with thera-bands and rollers daily

Measurement: Ms. Martin’s hamstrings are stronger as evidenced by the ability to perform exercises from the Pilates repertoire such as the Pelvic Curl, Footwork (particularly on the Reformer or Wunda Chair), Frog, Down/Up Circles, Long Spine, and Hamstring Curl that require hamstring strength and control with noticeable improvement. Applying the correct co-contraction of muscles learning during Pilates sessions and alternating sides of the body, while instructing ballet classes (especially for younger classes that involve repetitive demonstration) is much improved, as evidenced by decreased joint and muscular pain in the knees and surrounding muscles the following day. Other activities have benefited as well, including fitness classes requiring leg lunges and other unstable movements without fear of inversion sprains and other injuries.
REHABILITATIVE AND CONDITIONING PROGRAM

The varied associated problems of hyperextended knees require an assessment by a physician or clinician to determine where weaknesses may exist and which structures are consequently under stress. A dancer (or instructor) with genu recurvatum should also consider an analysis of technique and alignment during training (or teaching), as poor mechanics can aggravate injury. A dance instructor should always demonstrate exercises on both sides, and/or alternate demonstration to prevent “sidedness” asymmetry. A well-designed Pilates program focusing on to strengthen the hamstrings and surrounding muscles of the knees, and stretching the quadriceps, TFL, and IT band can be crucial in correcting and preventing reoccurrence of pain or sustaining an injury. Pilates combines isotonic and isometric contractions, making it a desirable form of rehabilitative exercise.

Utilizing repertoire from the BAST™ method, the following exercises are specifically targeted for strengthening the hamstrings and surrounding musculature to stabilize the hyperextended knee- for additional exercises, see Appendix II.

Warm Up: Pelvic Curl (mat) target the co-contraction of abdominals and the hamstrings

Foot Work: (Reformer, Wunda chair) All of the exercises target co-contraction the hamstrings and quadriceps – while focusing on the feet, the hamstrings must remain co-contracted to keep the knees from locking back into hyperextension. (The Cadillac’s focus is hip extensors.)

Abs: (Wunda chair) The Standing Pike utilizes the co-contraction between the abdominals and the hamstrings.

Hip Work: (Reformer, Cadillac) Frog, Down/Up Circles, Openings, Basic Spring and Single Leg Supine Series all focus on the co-contraction of the abdominals and hamstrings.

Spinal Articulation: (Reformer, Wunda chair) The Bottom Lift and Short/Long Spine, Pelvic Curl and Jack Knife also target the relationship between the abdominals and hamstrings.

Stretches: (Reformer) The Side Split targets the hip adductors, when strengthened provide additional support to the knees.

FBI 1: (Reformer, Cadillac) Stomach Massage Series if performed correctly, require the hamstrings engaged. The Thigh Stretch with RUB is an excellent quadriceps stretch.

Leg Work: (Reformer and Wunda chair) The Hamstring Curl and Single Leg Skating (strengthens the glut medius) on the Reformer and the Leg Press Standing, Forward Lunge, Backward Step Down, and Hamstring Curl on the Wunda Chair target the abdominal and hamstring co-contraction, as well as provide a measurement of the strength in the hamstrings, as evidenced in the execution, with assists or without.
These exercises are by no means a complete list. Numerous exercises within the BASI™ repertoire, if performed with precision and control, can contribute to the overall muscular strength and stability of hyperextended knees.

**CONCLUSION**

Early identification and treatment of knee joint deviations are indicated for prevention of injury. Genu recurvatum is a complex and debilitating structural deformity of the lower limb, and while aesthetically pleasing for dancers, efficient movement patterns must be superimposed to prevent sustaining an acute and/or chronic injury.

Pilates creates an awareness of the body—specifically in this instance, an awareness of the prevention of hyperextension, and the ability to control the muscles to reduce the amount of ligamentous laxity. Pilates must be performed with concentration to be in control of one’s body and to enable the ability to understand and maintain the proper form, alignment, and work from the center with efficiency of effort during the session. Understanding the proper form, breath, and placement creates precise body mechanics. Precision is the end product which creates flow and harmony to the movement—thus, creating a balance of both mind and body to the individual practitioner.

The principals and repertoire of the BASI™ Pilates method provide the necessary stability and control of the muscles and ligaments surrounding the knees to prevent injury therefore, extend the career of the dancer or instructor.
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