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## Common Foot, Ankle, and Knee Problems in Professional Dancers

### Orthopaedic and Physical Therapy Evaluation and Care

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Professional dancers develop more problems and injuries in the foot, ankle, and knee than any other area.<sup>10, 15, 18</sup> Because of the special demands on the foot and ankle in certain dance forms, especially ballet, the dancer's foot and ankle are prone to unique mechanisms of injury that are not commonly seen in the general population. Most of the injuries are caused by overuse or technique dysfunctions.<sup>19, 20</sup> Acute injuries constitute a much smaller demographic of injury type seen<sup>19, 20</sup> by the performing arts medicine specialists in the foot and ankle. The professional dancer is subjected to the same type of acute knee injuries as the professional athlete. Acute or overuse injuries may need surgical intervention depending on the severity of the problem.<sup>5, 6, 7, 8, 9, 21</sup>

To evaluate and treat the professional dancer, it is imperative to have a firm understanding of the most common ailments in the dancer's foot, ankle, and knee. The ability of dancers to perform their daily activities (walking, taking class, and performing) also is a deciding

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factor in the treatment by the physician, physical therapist, and dancer. The types of injuries discussed in this article are limited to the dancer's foot, ankle, and knee. The most common and important ones include lateral ankle sprains, anterior and posterior impingement syndromes of the ankle, flexor hallucis longus tendinitis, Achilles' tendinitis, metatarsal fractures, meniscus tears, ligament injuries, dislocation of the patella, patellar tendinitis, prepatellar bursitis, and patellofemoral pain syndrome. The rehabilitation programs that the performing arts medicine team uses either preoperatively or postoperatively again depend on the type and severity of the injury presented.

Although most young dance students have acquired basic motor skills, many of them learn dance-specific skills before they have achieved a mature understanding of these basic techniques. As a result, immature patterns are being carried into dance training and may become a habitual part of the student's skill in performing dance-specific patterns. The resulting compensations can lead to many of the dysfunctional technique patterns that cause injuries seen in the more mature dancer as well as in the dance student.

Certain forms and styles of dance require different demands on the body to achieve a look and feel desired by the choreographer or artistic director. Many structural differences found in the lower extremities may not cause problems for the average person until later in life; however, for the dancer, these problems manifest at a much earlier age because of the repetitive nature and high load demands of most dance forms. Abnormal joint arthrokinematics and osteokinematics cause a faster wearing away of articular cartilage as well as the development of bony spurs around the joint.

Dancers spend numerous hours performing the same or similar movement patterns, every day for several years. Consequently, proper technique, alignment, and motor patterning are some of the most important considerations in developing a rehabilitation program for the dancer. Whether the injury results from dysfunctional alignment, proprioceptive or muscle imbalance, or movement dysfunctions in a joint, the whole kinetic chain should be considered when treating a foot or ankle injury.

The kinematic chain of the lower extremity has greater than 25 degrees of freedom from the foot to the hip, thus allowing compensations to occur easily, including restriction of joints or structural anomalies, while performing dance-specific movement patterns. Over time, these compensations may also be the cause of hypermobility, instability, and pain in the compensating joints.<sup>12</sup>

Loss of or inability to gain rotation in the hip may be compensated for in the low back, knee, or foot. The following structural abnormalities, although not found in the foot, can cause problems in this area because of specific requirements in dance technique: anteversion or retroversion

of the hip, an increase or decrease in the angle of inclination, coxa valga, and coxa vara. These abnormalities represent the main concern of the performing arts therapist who treats foot and ankle problems. Thus, the degree of anteversion or retroversion is an important evaluation component when looking at any dancer with lower extremity injuries.<sup>14</sup> Specific movement patterns required in the dancer's form and style of dance (form being modern, ballet, or jazz and style being Cunningham, Balanchine, or Luigi) should also be assessed. An imbalance in any of these factors may be the cause of chronic overuse and thus a precipitating factor in acute injuries.

### SPRAINED ANKLE

Ankle sprains are perhaps the most common foot and ankle injury in the athletic population as well as the most common injury in the dancer's ankle. The typical sprain involves injury to the lateral structures of the ankle. There are three primary ligaments along the lateral aspect of the ankle that serve to stabilize the ankle against inversion forces. These include the anterior talofibular, posterior talofibular, and calcaneofibular ligaments. The anterior talofibular and calcaneofibular ligaments are critical to the stability of the ankle. The combination of a complete tear of both ligaments presents a major injury for a dancer. The common classification system for ankle sprains divides these injuries into three grades. A grade I injury involves a partial tear of the anterior talofibular ligament only. A grade II injury involves a complete tear of the anterior talofibular ligament only. A grade III tear involves a complete tear of the anterior talofibular ligament and calcaneofibular ligament.<sup>6</sup>

The dancer's history is usually quite clear. A lateral ankle ligament injury occurs as a result of an inversion stress. The injury usually occurs in plantar flexion when the dancer is landing from a jump. The ankle becomes stiff and swollen quite rapidly following the injury and is often accompanied by significant pain.

Examination of the acutely sprained ankle is sometimes difficult because there is significant swelling and pain present. Although the injury may be quite obvious by inspection, the degree and grade of ligament injury are difficult to assess once swelling and pain have developed. The anterior drawer sign is the most important clinical test for determination of the grade of injury. The foot and ankle are held in a slightly plantar flexed position, and an anteriorly directed force is placed on the heel while the tibia is stabilized. The grade of injury is impossible to ascertain if the patient guards because of pain or has significant swelling. The anterior drawer should be repeated with the foot in a neutral or slightly dorsiflexed position to check the calcaneo-

fibular ligament as well. When the foot is dorsiflexed, the anterior talofibular ligament is not under stress, and the calcaneofibular ligament can be isolated for testing. In a similar fashion, when the foot is slightly plantar flexed, the calcaneofibular ligament is relaxed, and the anterior drawer can be isolated for testing.<sup>6</sup>

Associated injuries, including fractures, must be excluded. It is therefore important to obtain x-ray films of the ankle as well as of the involved foot because a fracture of the base of the fifth metatarsal or calcaneal beak may be associated with lateral ankle sprains.

Initial treatment for most ankle sprains includes rest, ice, compression, and elevation. Pneumatic ankle braces are useful for stabilizing the ankle and decreasing the pain when weight bearing.

Grade III sprains, or complete tears of the anterior talofibular and calcaneofibular ligament, are serious injuries for the professional dancer. Operative intervention is often recommended initially in treatment of these injuries because the likelihood of a good result with nonoperative treatment is low, especially for the female ballet dancer, as residual instability is often noted on pointe.<sup>6,8</sup> When a professional dancer has a grade III lateral ligament sprain, the surgical treatment recommended is a repair of the ligaments and reinforcement using the lateral aspect of the extensor retinaculum. This procedure, the modified Broström procedure, has been used with a success rate of greater than 95%. It is the procedure of choice for several reasons: It provides a more anatomic reconstruction; the extensor retinaculum reinforcement helps to stabilize the subtalar joint and reinforces the calcaneofibular ligament; and it allows for full, unrestricted range of motion of the ankle without sacrifice of the peroneal tendons.<sup>4,8</sup>

The dancer-specific exercise program should progress from foot on the floor to demipointe and then to pointe work (for ballet dancers), allowing the motor patterns to be integrated in a less stressful manner, which gives the dancer an optimal experience for learning. Having the dancer do specific exercises for finding and then holding the position of joint neutral is also supported by Freeman and Wyke's work.<sup>3</sup> They found mechanoreceptors in the joint ligaments and capsule that have been shown to work in relation to the tension prevailing in the part of the joint tissue in which they are located. They also suggest that these mechanoreceptors are involved in the normal reflex coordination of muscle tone in posture and movement. Thus, training the dancer in specific joint placement with a dynamic understanding of the kinetic chain that is directly related to the joint injured or joints compensating for the injury is relative in treatment. This type of retraining is of great benefit to the dancer, whether the injury is acute or chronic in nature. It is necessary not only for joint placement, but also because muscle imbalances develop secondary to the injury.

The muscle reflex imbalances are caused by mechanoreceptor dysfunction in capsular lesions. As stated by Wyke,<sup>22</sup> ". . . articular mechanoreceptors are of considerable importance in the circumstances of everyday life—not only in respect of their potent contribution to perceptual awareness of joint position and movement, but also in respect of their powerful reciprocal reflex regulation of muscle tone in posture and movement."

## POSTERIOR IMPINGEMENT SYNDROME

To pointe the foot fully, the dorsal surface of the foot should be parallel to the long axis of the leg. Extreme plantar flexion of the ankle is required to dance on full pointe. As a result, the posterior structures of the ankle joint occasionally become inflamed and painful from impingement of the talus against the tibia. The condition is often associated with an accessory bone at the posterior border of the ankle joint, the os trigonum. Pressure from the os trigonum against the soft tissue and capsule of the ankle joint when the foot is plantar flexed leads to pinching or posterior impingement. This process may also be precipitated by an enlarged trigonal process along the posterior border of the talus. The os trigonum is present in 7% to 10% of the population and is usually unilateral. The accessory bone forms during skeletal growth and may result from failure of fusion of the apophysis on the posterior aspect of the talus.<sup>9,11,17,21</sup>

The dancer who presents with posterior impingement syndrome complains of pain, particularly during relevés, demipointe, or full pointe. Most commonly, the pain is perceived behind the lateral malleolus, but may be experienced occasionally posteromedially.<sup>7,9,11</sup>

Examination of the foot and ankle often reveals tenderness to deep palpation posterior to the lateral malleolus in the area of the impingement. The classic sign on physical examination is the *plantar flexion sign*. Full, passive plantar flexion by the examiner reproduces the dancer's symptoms. Radiographs are important in the evaluation of posterior impingement, because the differential diagnosis may include stress fractures of the posterior talus (Shepherd's fracture), an os trigonum, a cyst, or bone tumor.<sup>9</sup> Radiographs may be obtained in a fully plantar flexed position to demonstrate bony impingement. An injection test is invaluable in diagnosing and confirming posterior impingement and may be used therapeutically for symptomatic relief. A small amount of 1% lidocaine (Xylocaine) without epinephrine can be injected posterolaterally into the area around the os trigonum, and after the anesthetic has taken effect, the dancer's symptoms are usually completely relieved temporarily and the plantar flexion becomes negative. If successful, a

small amount of cortisone can be injected in the same area to relieve the inflammation.<sup>7,9</sup>

When conservative measures fail, surgical excision of the os trigonum or trigonal process is indicated. For isolated posterior impingement syndrome, the surgical approach is usually posterolateral. The procedure can be performed as an outpatient with a regional anesthetic. The recovery period varies significantly, and complete recovery can take more than 3 months, but usually a ballet dancer can return to a barre within 3 to 4 weeks.<sup>4,7,11</sup>

Proprioceptive retraining is one of the most important considerations in the rehabilitation of the foot and ankle. Mechanoreceptor reflexes in the joint are affected when injury occurs. Normal reflex coordination of muscle tone in posture and movement may also become disordered when injury occurs to the joint capsule.<sup>14</sup> This disordering may be retrained with exercises directed at working the different joints of the foot and ankle to allow for positional understanding and awareness for each joint.<sup>1</sup> In addition, connecting joints up the kinetic chain should be addressed to allow for a stable equilibrium. Dancers spend much of their time on pointe (females in ballet) or demipointe (ballet, modern, and theater), a position that is considered a small base of support by most standards. As a result, a high level of center-of-gravity training is required to provide a stable equilibrium in the kinetic chain. Stability is efficiently maintained if the center of gravity projects within the base of support,<sup>12</sup> which, again, is quite small in the dancer.

The higher the center of gravity, the narrower the base of support, the more mobility the body has, and the less stability the person has while dancing.<sup>12</sup> This is the daily battle of the dancer. Having control of the body while being extremely mobile is a juxtaposition that requires the most efficient alignment, motor control, and functional placement of the kinetic chain, more than any sport or other activity. The ability to overcome an unstable equilibrium is best achieved by dynamic functional exercises that consider bony alignment, neural input, endurance, strength, and technique requirements.

### **FLEXOR HALLUCIS LONGUS (DANCER'S TENDINITIS)**

In various styles of dance, and especially in ballet, the foot and toes are forcefully plantar flexed to *pointe* the foot. To dance *sur les pointes*, the female ballet dancer must have a strong flexor hallucis longus. Because of the frequent strain placed on the flexor hallucis longus tendon, dancers occasionally develop tendinitis. Frequently, they continue to dance with this problem and develop chronic inflammation of the tenosynovium and stenosis of the flexor hallucis longus tendon

sheath (stenosing tenosynovitis). When the tenosynovitis becomes severe and the stenosis becomes marked, the dancer may experience triggering, or catching, of the tendon.<sup>5,7,9,21</sup>

The dancer usually complains of pain posterior to the medial malleolus, in the area of greatest tendinitis and stenosis. There may be associated posterior impingement symptoms, including pain posterolaterally. The examination reveals tenderness over the flexor hallucis tendon, posterior to the medial malleolus. There is usually associated pain with plantar flexion of the hallux. The pathognomonic finding, Tomasen's sign, is performed by passively dorsiflexing the ankle and hallux simultaneously. This causes pain posterior to the medial malleolus in a patient with flexor hallucis longus tendinitis. *Hallux saltans* is another finding, usually present only in severe and chronic cases. This sign, similar to *triggering* in the hand and fingers, is produced by placing gentle pressure on the flexor hallucis longus tendon sheath, posterior to the medial malleolus, while the toe is plantar flexed and dorsiflexed. The hallux becomes fixed and triggers in the area where the tendon is most thickened.

Initial treatment for flexor hallucis tendinitis includes rest and nonsteroidal anti-inflammatory drugs (NSAIDs) as well as physical therapy. Surgical treatment is reserved for those dancers who fail to improve with 3 to 6 months of conservative treatment. Surgical release of the flexor hallucis longus tendon and tenolysis is accomplished through a posterior medial incision. The fibro-osseous tunnel of the flexor hallucis longus tendon is incised, and the stenotic area is released. Debridement of the tenosynovitis should also be performed. The tendon should be checked carefully for longitudinal splits and the flap tears, and these should be excised or repaired depending on the size. The tendon sheath is not repaired; because of the pull of the flexor hallucis muscle proximally, the tendon does not sublux over the medial malleolus. A soft compressive dressing is usually applied, and physical therapy begins after the first dressing change.<sup>9</sup>

### **ANTERIOR IMPINGEMENT SYNDROME**

Most forms of dance require maximal dorsiflexion of the ankle. It is not surprising, therefore, that anterior impingement of the ankle constitutes a problem that is common to all types of dancers.

The dancer with anterior impingement usually presents with a history of pain along the anterior lateral aspect of the ankle and loss of the plié. These symptoms may have followed a recent ankle sprain but more commonly occur without a specific injury, and the ankle is painful with full passive dorsiflexion. Most dancers are aware of the association between the pain and full passive dorsiflexion; occasionally a dancer



may also complain of pain anterolaterally with full plantar flexion. This is most likely the result of a chronic inflammation and synovitis of the anterior ankle joint, which leads to pain with passive stretching, such as with plantar flexion of the ankle. In ballet, dancers notice pain with full, deep pliés because the ankle must dorsiflex maximally in a plié. Dancers may also notice the symptoms when landing from a jump, as the ankle *bottoms out* and is forced into maximum dorsiflexion.<sup>13, 16, 21</sup>

The examination of the ankle with anterior impingement usually reveals tenderness over the anterolateral ankle joint. A bony prominence, or osteophyte, along the anterior lateral tibia or talus can often be appreciated by palpation. Manual, passive dorsiflexion often causes pain, but a more reliable test of anterior impingement is to ask the dancer to stand and perform a plié or passively dorsiflex the ankle maximally by performing a calf stretch while standing and leaning against a wall. This usually reproduces the pain associated with anterior impingement.

Radiographs are an essential component of the evaluation. A lateral view of the ankle often confirms osteophytes present on the anterior lateral aspect of the tibia, adjacent to the joint, and often a corresponding osteophyte along the dorsal neck of the talus. A lateral view in maximum dorsiflexion can be obtained that demonstrates bony impingement and *kissing osteophytes*. Loose bodies occasionally are noted by x-ray, and, rarely, one may note a bone tumor.

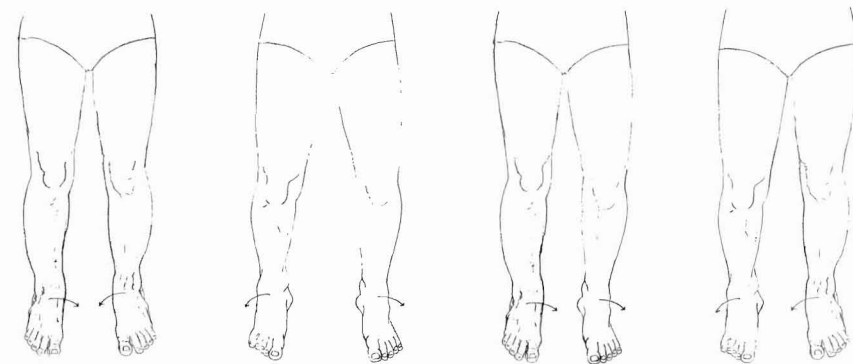
When there is no evidence of bone impingement or osteophytes, other differential diagnoses include a so-called symptomatic Bassett's ligament. The structure is an accessory ligament of the inferior-anterior tibiofibular ligament.<sup>2</sup> It often becomes inflamed and symptomatic following an ankle sprain and mimics anterior impingement. The initial treatment for anterior impingement syndrome includes avoiding forceful dorsiflexion of the ankle and ice as well as NSAIDs. Temporary use of a heel lift or a shoe with a higher heel alleviates the symptoms in daily activities because there is less ankle dorsiflexion in a shoe with a high heel. Should conservative measures fail to relieve the symptoms, surgical treatment includes excision of the osteophytes on the anterior aspect of the tibia as well as on the talus and debridement of the synovitis. If symptoms are due to a Bassett's ligament, this structure is also excised. The surgery can be performed arthroscopically or via a small incision medial to the tibialis anterior. Both approaches can yield excellent results; however, the authors generally prefer the open approach because large osteophytes are more rapidly and easily removed by way of this approach.<sup>13, 16</sup>

Every joint has the potential to be perturbed because of faulty posture. Because functional synergies are important to the development of posture, the authors' rehabilitation program for the foot and ankle

begins with specific proprioception exercises for finding a functional neutral joint position. It then progresses to multijoint coupled exercise because these are more complicated to understand and perform. It is important to note that muscles are able to transfer their power from one segment to another, resulting in a muscle imbalance. This problem can lead to other muscle and joint imbalances from abnormal proprioceptive or muscle patterning. Lastly, functional closed chain variable resistance exercises using an elastic band (e.g., Theraband) are discussed. This orchestration of intersegmental dynamics can make the difference in helping the dancer change destructive patterns and return to dancing without pain. It also helps to ensure that structural problems will no longer inhibit the dancer's career (unpublished data). For finding functional neutral for the lower kinetic chain, the dancer uses pronation and supination of the feet and lower extremity together and in opposition while focusing on the internal model (Fig. 1). This proprioceptive input facilitates the desired placement when repeated daily.

#### FOOT AND ANKLE NEUTRAL EXERCISES IN STANDING

This exercise should be first performed in parallel position with the feet mirroring each other (see Fig. 1). Once in this position, the dancer should first note weight placement between the feet and within each foot. This should be rechecked at the end of the exercise. Then, while keeping the toes and heels on the floor, the dancer should pronate and supinate the feet to comfortable end ranges. The dancer does this three to five times, then the dancer starts to stop in the midrange of the



**Figure 1** Finding functional neutral for the lower Kinetic Chain. The dancer uses pronation and supination together and in opposition while focusing on his or her internal model. This proprioceptive input facilitates the desired placement if repeated daily.

movement. Next the dancer supinates one foot while simultaneously pronating the other foot and then stops in the midrange of the movement (see Fig. 1). The dancer should notice if one foot is different from the other and if so have each foot try to imitate the movement available to its partner. Then the dancer makes a conscious mental image of the position that is the midrange of the joints of the foot and ankle. This allows for learning to take place and over time can become the dancer's position of choice when standing. Then the dancer performs the same exercise in first, second, third, fourth, and fifth positions. Also, other foot placement positions that may be required by the form or style of dance being studied should be included. In the third, fourth, and fifth positions, the dancer should do the exercises with the right foot in front and then repeat the exercise with the left foot in front to ensure that all typical positions are retrained. Correlating a different day of the week with each of the five positions maximizes dancer's compliance as well as being time efficient.

### ACUTE KNEE INJURIES

Generally, acute knee injuries are treated the same way for dancers and athletes. Severe knee injuries with associated ligament tears should be treated promptly. Initial treatment may include cold compresses, a knee immobilizer, or crutches. Physical examination should be directed at detecting ligament or capsular injury as well as injury to the meniscus. After appropriate radiographs, a magnetic resonance imaging scan is almost always recommended.

Decision making for the treatment of a knee injury can be complex. For example, a dancer with a small meniscus tear may be able to work on rehabilitation and postpone surgery if the choreography is less demanding. Meniscus tears should be repaired when possible or excised if not possible. Often the professional dancer's schedule needs to be considered, and timing of a surgical procedure may need to be adjusted if the problem is relatively minor. If there is a combined meniscus tear and anterior cruciate ligament (ACL) tear, surgical reconstruction of the ACL is usually recommended at the time of the meniscus repair. If the meniscus tear is excised and the dancer's choreography less demanding, ACL reconstruction may be postponed, and the dancer may be able to work on rehabilitation of the knee through physical therapy in an effort to postpone the surgery because the recovery period following ACL reconstruction can be as long as a year. If there is a combined ligament injury and meniscus tear (i.e., ACL and medial collateral ligament [MCL] and meniscus), surgical reconstruction is recommended as soon as swelling has subsided and range of motion approaches 90 degrees.

Other controversies revolve about the choice of graft for an ACL reconstruction in the professional dancer. The gold standard is the patellar tendon graft with bone blocks harvested from the patella and the tibial tubercle. Other options include cadaveric grafts and semitendinosus/gracilis grafts. If the semitendinosus/gracilis graft is doubled, strength of the graft can exceed the standard 10-mm patellar tendon graft. These grafts, however, obviously sacrifice some of the strength of the medial hamstrings. Disadvantages of the patellar tendon graft include postoperative problems ranging from patellofemoral pain to patellar fractures.

It is clear that the professional dancer with an ACL tear and instability, who cannot continue to dance at a high level (i.e., one that requires rapid lateral movements, jumps, and pivoting on the involved leg), requires surgical reconstruction of the ACL. Rehabilitation alone does not completely protect against instability in ACL tears. Derotational braces, sometimes worn by athletes, cannot usually be worn by performing dancers.

### KNEE NEUTRAL EXERCISES IN STANDING

The dancer repeats the pronation and supination exercise as previously while being aware of the movement at the knees. Does the movement take the knees up and down or in and out during its excursion? Once the dancer understands that the movement of the knees is in and out, have the dancer repeat the midrange program as in the foot and ankle program. This exercise should be repeated in all functional positions, same as with the foot.

### PREPATELLAR BURSITIS

Prepatellar bursitis is a problem that especially afflicts the modern dancer. Specific modern dance styles, such as Graham, require substantial floor work and the constant friction between the floor and the knee may lead to a bursitis, despite the appropriate knee pads. Initial treatment should be oriented toward reducing inflammation by a combination of rest, NSAIDs, cold, compresses, and physical therapy geared to look at the kinetic chain to help decrease the friction at the knee. If there is no improvement, aspiration and injection with a small amount of cortisone into the bursa may effectively relieve the swelling and pain. Should the bursitis become chronic, surgical excision may become necessary.

### PATELLAR TENDINITIS

Patellar tendinitis is another common problem in professional dancers, especially in forms that require repetitive jumps and pliés (i.e., ballet).

The symptoms are usually quite localized, and typically there is tenderness just below the patellar tendon origin on the patella. Patellar tendinitis generally heals slowly, and the dancer is always under pressure to return to work as soon as possible. Patellar tendinitis should be treated with NSAIDs; ice; and a progressive physical therapy program that includes stretching, alignment reeducation, and a balanced strengthening program such as the Pilates method of body conditioning. Braces or taping is occasionally helpful in relieving symptoms and stress on the inflamed area. If the patellar tendinitis becomes chronic and the symptoms severe, magnetic resonance imaging is often helpful in evaluating the integrity of the patellar tendon. In chronic cases, there is often a relatively large area of degeneration of the patellar tendon origin, and surgical debridement and repair may become necessary. The recovery from this type of procedure is long, and the dancer should be warned that it may take 3 to 6 months before return to full dancing is possible.

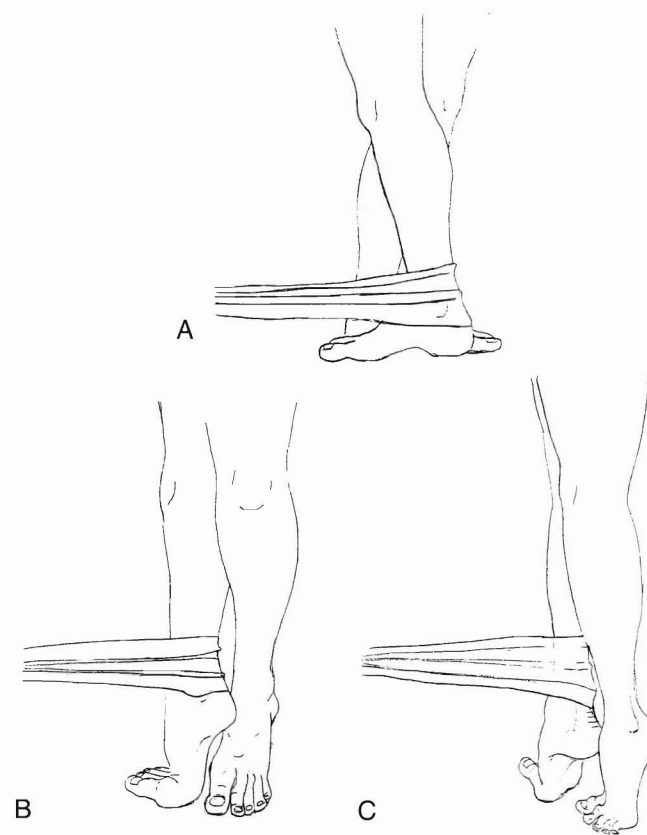
Patellar dislocation and patellofemoral pain syndrome are usually due to the combination of underlying malalignment, repetitive pliés, and forcing *turnout* through the knees and feet. These two problems usually respond well to alignment reeducation and soft tissue work in the lower extremity.

### HIP NEUTRAL EXERCISES IN STANDING

The dancer places the hands on both greater trochanters so he or she can assess the movement available at the hip joints. Once the dancer can feel the movement at the hips, he or she repeats the functional neutral joint exercises as outlined for the foot and knee. When these exercises are completed and understood, the performing arts physical therapist can then demonstrate that forcing the foot in turnout is in direct opposition to the normal closed chain kinetic mechanics of the lower extremity.

In the closed position when pronated, the hip and knee are naturally pulled into internal rotation. If the dancer is trying to turn out, a torquing motion has to be produced in the knee, ankle, or foot for the movement to occur. This causes stress to the joint structures as well as feeds into abnormal synergistic muscle patterns that can lead to soft tissue injuries.

By doing the exercises listed previously, the dancer can be trained to appreciate the tension created in these abnormal positions as compared to the less stressful neutral positions. These types of exercises can help maintain reflex and proprioception connections. The importance of updating the internal model of the body by way of proprioceptive input can thus be represented by the mechanical properties and conscious manipulation of the limbs.<sup>1</sup> Figure 2 is an example of Thera-



**Figure 2** An example of Theraband relevé in functional positions (fifth position in ballet is used here). The dancer then changes spatial orientation eight times. A, Fifth position. B, One-eighth turn. C, Second one-eighth turn, and so forth.

band relevé in functional positions (fifth position in ballet is used here). The dancer then changes spatial orientation eight times.

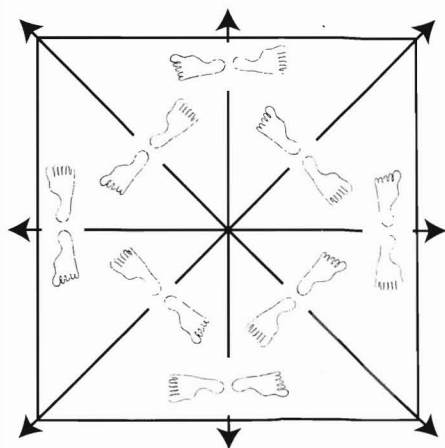
### VARIABLE RESISTANCE EXERCISES IN DANCE-SPECIFIC PATTERNS

Functional closed chain Theraband exercises for the lower extremity allow the dancer to increase strength and endurance while maintaining alignment. The first exercise is done with the feet in parallel, and the Theraband is tied to something so that it can make a loop. One foot is placed in the loop so the Theraband is around the arch of the dancer's foot. The dancer then steps away from where the Theraband is tied until he or she reaches the level of resistance at which he or she is able

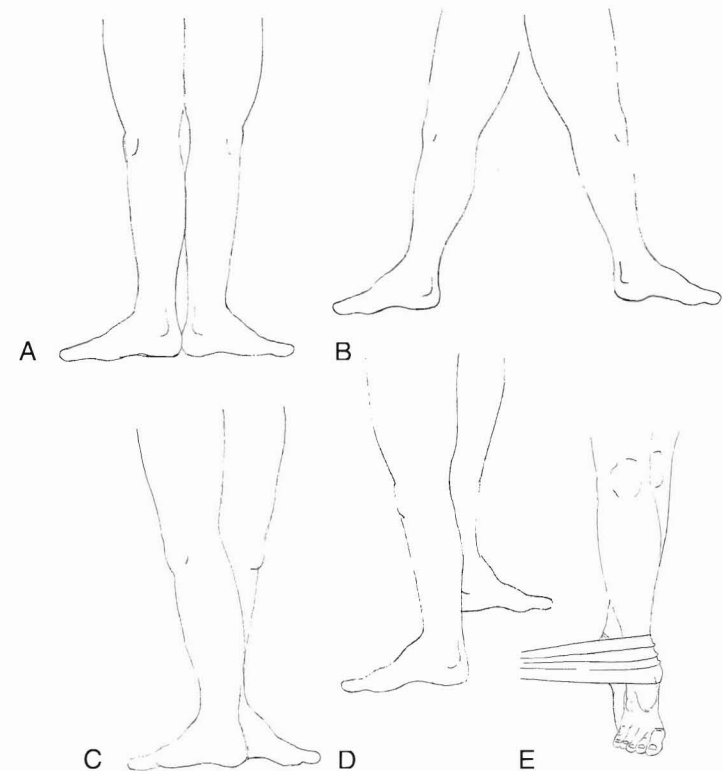
to exercise with control. The dancer then does a relevé in parallel position three times, making sure that the arch, ankle, knee, and hip are all in the same neutral alignment throughout the movement. Then the dancer makes an eighth of a turn and repeats for three relevés (see Fig. 2). This is done until the dancer returns to the starting position (Fig. 3), then the whole series is repeated on the opposite foot. A total of 48 relevés establishes a baseline strength and endurance program for one session. Figure 3 has diagrammatic representations of foot positions for Theraband resistance program and line of pull.

It is suggested that each of the pertinent positions of dance that the particular performer is studying be incorporated into the warm-up with this Theraband program. In ballet, there are five basic foot positions (Fig. 4) plus parallel position. The authors' basic protocol includes performing Theraband exercise in a different position every day of the week. For example, on Monday, the dancer performs the exercises in parallel; on Tuesday, in first position; on Wednesday, second position; on Thursday, third position; on Friday, fourth position; and on Saturday, in the fifth position, repeating the exercise with each foot in front. This format enables the dancer to strengthen functionally, in all the positions that are required for the dancer's particular style and form of dance with proper technique and placement.

Other variations include having the Theraband placed just above the ankle, just below the knee, just above the knee, and just below the hip. It can also be wrapped around different parts of the torso. When this is done, it helps the dancer understand that control and placement come from all different parts of the chain. It allows the dancer to gain strength and control functionally from each of these places. Thus, the dancer is reeducated in dynamic triplane activities, incorporating Ther-



**Figure 3** Diagrammatic representation of foot positions for Theraband resistance program and line of pull.



**Figure 4** The basic foot positions for ballet. A, First position. B, Second position. C, Third position. D, Fourth position. E, Fifth position using Theraband resistance.

aband, dance-specific foot placements with spatial orientation. All three elements are relevant because they pertain to the work required of the dancer on a daily basis.

The main purpose of this program is to give dancers core exercises that allow them to discover new ways to exercise, while improving their technique and placement. Many of the dancers' problems stem from faulty technique or placement (or both). Integrating this program or similar programs into the dancers' class or warm-up should help to decrease the current problems seen most often by performing arts physical therapists.

The body's architecture of the bones and soft tissue make up the dynamic musculoskeletal apparatus. This unique combination represents patterns of proprioceptive feedback that is connected by way of reflex circuits, unique to the muscle actions of the dancer. This arrangement of muscle, bone, and neural circuitry is not simply the



means by which body parts move. Rather, it represents one part of a dynamic integration of the mind and body in which the dancer is using his or her whole being to perform the art form. The unique actions required of the dancers are performed in multiple planes. Thus, muscle and reflex responses need to be trained in each of these planes to prevent injury from occurring and to ensure performances at peak levels. Repeating these patterns on a daily basis helps to maintain the proprioceptive reflex connections that provide the dancer with the most body control. This balance, acquired through joint awareness and reciprocal inhibition reflex, helps to stabilize the joints and therefore increase joint control.

Coordination dynamics is an integral aspect of proper dance training because it allows the dancer to perform consistently while training at the elite level. Being able to assess the movement at different joints allows the performing arts physical therapist to see the dancer's body as the sum of the dynamic whole. This complex system of body movements is a group of multidetermined actions that require repetition to allow for fine-tuning and consistency. Learning to understand and see these basic principles then gives the therapist an insight into the dancer's body that few are able to achieve. Only then will dancers know that the therapist understands their art form and, consequently, trust their corrections, comments, and exercises. To acquire skill, the dancer needs to have control of his or her goals, timing, and load.

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