Insights into the Position of the Ankle and Foot in Female Ballet Dancers En Pointe

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Ballet en pointe requires an extreme amount of motion in the ankle when a female dancer points her foot to stand in maximum plantar flexion. (Plantar flexion is the motion of pointing one's foot.) The anatomy of these regions and the demands of the pointe position must be clearly understood by those who work with dancers in this genre. Magnetic resonance imaging (MRI) and x-rays are two techniques that offer a look inside the body and help us understand the positioning of the structures in the foot and ankle. Using images from these tools to illustrate, this article presents an anatomical overview of the ankle and foot en pointe.

The ankle and foot comprise an incredibly important area as it marks the connection between a dancer's body and the floor. The ankle is a modified hinge joint that provides motion between the leg (and, therefore, the rest of the body) and the foot. The foot's structure, with its many bones intricately fitting together, provides a dynamic platform on which to support the body. The foot's adaptability to the floor or ground, regardless of whether or not it is encased in a shoe, is what starts the process of pushing off the floor, absorbing shock when landing from a jump, changing direction in turns, and providing a surface on which to spin, to name a few of the foot's functions important to dance. Knowing the demands that are placed on the structures of the ankle and foot is very important for the dancer and dance educator.

No ankle and foot position in dance is more extreme than that required to stand en pointe.[1] There are a number of crucial considerations about this position that dancers and dance teachers should understand. Just the ability to bear weight en pointe should be a marvel in itself because of what we know from research such as that done with MRI.[2,3] The magnetic resonance images in Figure 1 give an overview of the ankle and foot in both typical standing and the en pointe positions. Note the relative positioning of the bones of the ankle and foot compared to the tibia (shin bone) in order to gain an appreciation for how remarkable it is that bal-

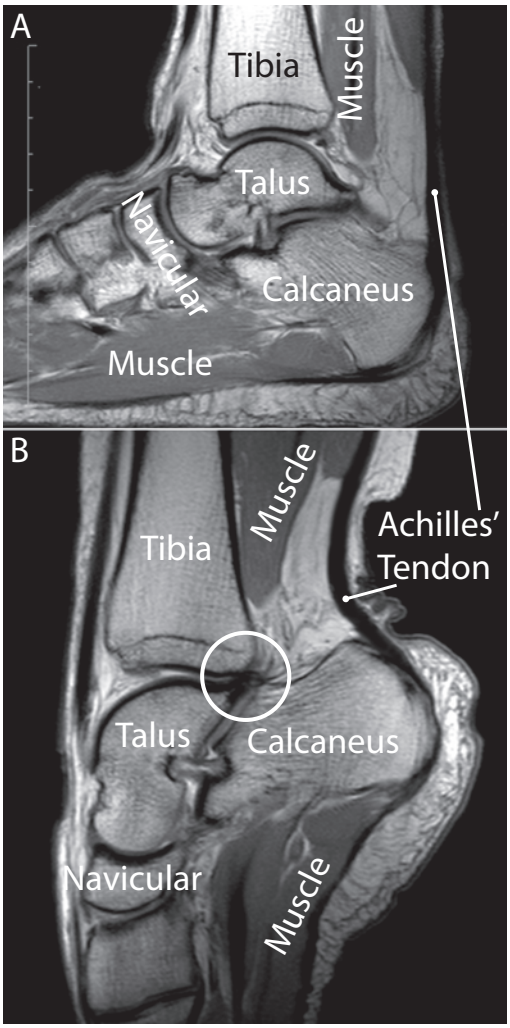

Figure 1 Magnetic resonance images of a ballet dancer in [**A**] a neutral standing position and [**B**] en pointe. Important anatomical structures are marked for an appreciation of how these structures are positioned when a dancer stands en pointe. Note the circled area in 'B' where the tibia (shin bone), talus (top bone in the foot), and calcaneus (heel bone) come together, thus forming a weightbearing situation that should be recognized in dancers.

let dancers can achieve this and succeed in their pointe choreography.

In a study designed to explore the ankle en pointe while dancers were standing in this position,[3] several bony and soft tissue contours were noted across all or most of the participants. These included the convergence of the tibia, talus, and calcaneus (seen in the circled area of Figure 1B), a position of the bones that helps with stability of the ankle in the pointe position because the three bones are "locked," i.e., firmly compressed together, when they contact one another.[4-5]

The anatomy of the foot and the positioning of its array of bones is important to the motion required to stand en pointe because the mobility of these bones helps provide movement that is not possible purely from the ankle joint. In order for that much pointing of the foot (plantar flexion) to occur, there also must be some motion of the foot bones. This was evaluated in ballet dancers using x-rays;[6] the study suggested that more than 25% of the foot's ability to point occurred between three pair of foot bones. Figure 2 shows this principle pictorially, with angle θ representing the motion that must come from somewhere other than the ankle joint. That is, to stand on full pointe the foot bones must move downward into more plantar flexion along with the ankle.

When dancers are en pointe, proper alignment in the sagittal plane is essential. This plane divides the body into right and left portions. There must be enough plantar flexion to situate the metatarsals of the foot (the five bones found in the middle part of the foot to which the toes are attached) underneath the shaft of the tibia (shin bone) for proper support. However, there should not be so much plantar flexion that "going over" occurs, a position that can over-lengthen the ligaments and tendons of the feet. Again looking at Figure 2, if the dancer did not have enough strength or muscular control to limit "going over," one can easily imagine that the joints indicated by black arrowheads would open farther and thus create a position of the foot that is less stable because the muscles, tendons, and ligaments have to work extra hard to control it. Also, a pointe dancer's technical ability is improved when the leg, ankle, and foot are lined up properly. Improving one's ability to correctly hold the ankle and foot en pointe is why strengthening of both the extrinsic muscles (located in the leg with tendons extending into the foot and creating movement there) and intrinsic muscles (muscles and tendons located completely in the foot) is essential in pointe dancers.

Alignment in the frontal plane is also important in pointe dancing. This plane divides the body into front and back, or anterior and posterior portions. Faulty foot posture in this plane is often called sickling if the forefoot (the forward portion of the foot from approximately the instep, including the toes) is positioned inward, or medially, so the outer, or lateral, portion of the shoe's platform is where the dancer bears most of the weight. Winging is the term used if the forefoot is directed toward the outside (laterally) and the majority of weight is borne on the inner, or medial, edge of the platform. Once again, sufficient foot strength and proper technical training are necessary to counteract a dancer's tendency toward one of these alignment issues.

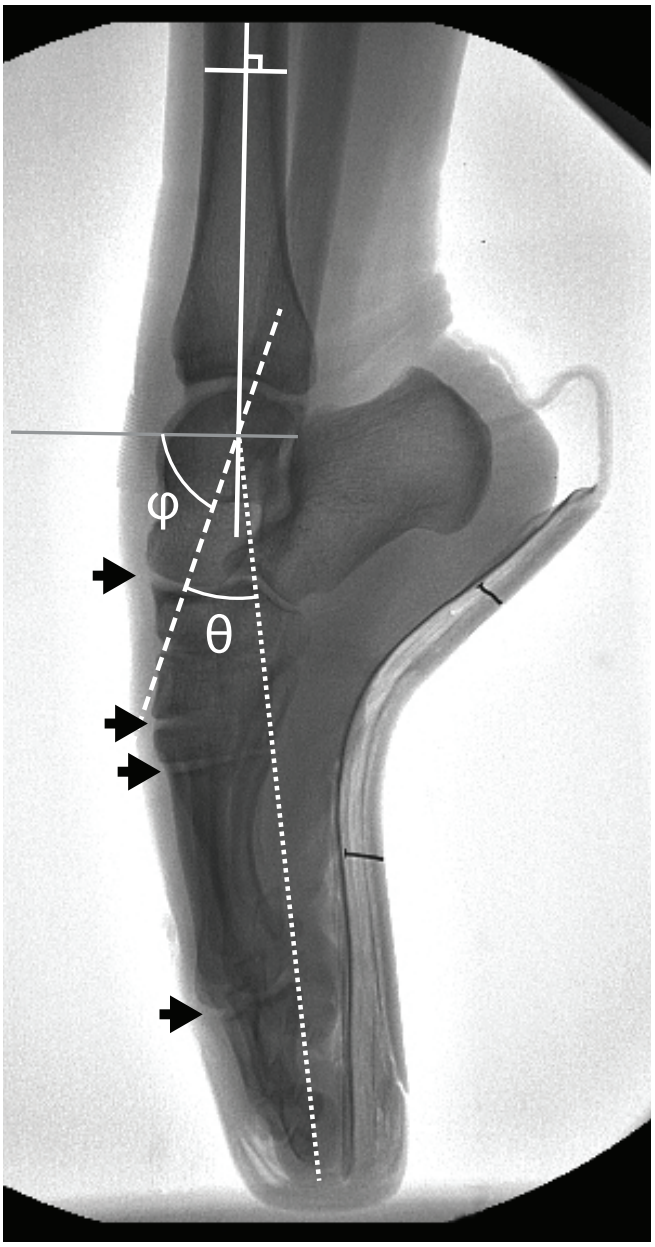

Figure 2 An x-ray of a dancer standing en pointe used to demonstrate that both ankle and foot motion are required to achieve this position. The solid line represents the shaft of the tibia (shin bone), and the gray line, perpendicular to it, is used as a line of reference. The dashed line is the long axis of the talus (bone at the top of the foot); thus, angle φ represents motion of the ankle joint. The dotted line is the amount of total plantar flexion (pointing the foot) that appears to occur. Angle θ, then, shows that motion occurs among the foot bones in addition to the motion based in the ankle joint. This comes from the joints marked by the black arrowheads. Note that this is a conceptual visualization in a single dancer, rather than an exact measurement of her plantar flexion.

A Special Note About Young Dancers

Observing the architecture of the bones comprising the ankle should especially inform the initial stages of en pointe training for young ballet dancers. Most notably, placing adolescent ankles and feet in this position should be done only after careful assessment of a dancer's readiness to assume its demands. Excellent resources are available to help ensure a healthy transition to pointe work.[7-9] While a child's foray into the world of pointe comes with much anticipation and excitement, teachers and parents must become familiar with the principles of pointe readiness in order to allow young dancers to have an enjoyable, safe, and productive experience.

Chronological age alone is not a satisfactory criterion for advancing to pointe dancing.[8,9] All in all, an effective process of a pointe teacher carefully guiding dancers through learning the skills and developing the strength necessary to dance en pointe is essential. Important factors to success in beginning pointe work are:

- Strong lower extremities (legs, ankles, and feet) to help develop the mechanical function needed to stand en pointe
- Sufficient, but not too much, flexibility and motion in the ankles and feet
- Strong "core" muscles (trunk and hips) to provide support to the body
- Good balance and alignment of the legs and torso
- Adequate preparatory ballet work (at least two sessions per week is suggested).[9]

Conclusions and Applications

In summary, dancing en pointe is a remarkable, beautiful part of ballet. This position places great demands on the ankle and foot as their joints plantar flex to move into the pointe position. Dancers and dance teachers should be familiar with the anatomy of the ankle and foot as it pertains to working en pointe so they can appreciate how good technique and the mechanics of anatomical function lead to success. This will also help them work together toward a positive experience for dancers. In addition, strengthening of the musculature of the foot, ankle, leg, thigh, hips, and trunk is important for ensuring that ballet dancers can participate en pointe effectively.

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