Fast-pitch softball has become increasingly popular. Over the past two decades, participation in Little League softball in the U.S. has dramatically increased from 259,080 players in 1990 to 349,065 players in 2009. The Amateur Softball Association reports over 83,000 youth girls fast-pitch softball teams, comprising over 1.2 million girls. Softball is similar to baseball, but a higher injury rate has been reported for girls participating in softball than for boys participating in baseball. When compared to baseball, fast-pitch softball exhibits some important differences: (a) pitching surface, (b) pitching distance to home plate, and (c) number of pitches delivered by one pitcher within a short period of time. In baseball, pitches are delivered from an elevated mound (approximately 10 inches), whereas softball pitches are delivered from a flat surface. The distance from the pitching rubber to home plate in baseball is 18.4 meters, whereas the corresponding distance in softball is 12.2 meters. Softball pitchers may pitch in as many as 10 games during a weekend, which equates to approximately 1,500 to 2,000 pitches within a three-day period. Because there is no pitch count restriction in softball, teams typically have a smaller number of pitchers on their rosters than baseball teams, which ultimately results in more innings being pitched per athlete. Because the softball pitcher throws from flat ground, rather than an elevated mound, the effect of gravity assistance to the pitch follow-through is absent. Instead of a controlled fall off a mound during the follow-through, the softball pitcher displays an abrupt stop, or posting mechanism, by the stride leg upon ball release. Ground reaction force experienced during the windmill softball pitch has been reported to be similar or greater than that experienced by baseball pitchers. Softball pitchers have been reported to have a high incidence of lower extremity injuries, which may be related to the high ground reaction force that results from posting of the stride leg at ball release. There are many similarities between softball and baseball. Although the windmill pitching motion is widely perceived to be more natural and less stressful to the shoulder than the overhand baseball pitch, the distraction force at the shoulder while performing the windmill softball pitch has been reported to be similar to that of a baseball pitch. The torques acting on the shoulder and the elbow have been reported to be comparable for both types of pitching, or even greater for the softball pitch. Powell and Barber-Foss reported that softball play-
ers had a 27% higher injury incidence than baseball players. Although severe injuries rarely occur,10 less serious overuse injuries are common.11 Loss of playing time has been reported for 45% of softball injuries, and 45% of the time-loss injuries involved the shoulder or the elbow.11 A study of 180 college pitchers found that 72.8% had sustained an injury during the previous year. Among 131 injuries that were reported, 36 were acute, 92 resulted from chronic overuse, and 3 were had an unspecified onset.11 Greater attention needs to be given to prevention of injury to softball pitchers.

Movement efficiency has been associated with a proximal to distal muscle activation sequence.12 Kibler13 has estimated that the lower extremity contributes 50–55% of the total energy generated by the body during performance of an upper extremity task. To transfer energy through the kinetic chain from the lower extremity to the upper extremity, a softball pitcher must have good neuromuscular control of the lower extremity.13,14 Traditionally, analysis of pitching performance and injury susceptibility has been focused on the function of the upper extremity; however, movement of the hips directs movement of the pelvis, which directs movement of the torso, the scapula, and the shoulder.15 The pelvis has been described as the platform for the scapula, and the scapula has been described as a platform for the shoulder.14,16 To serve as a platform, the pelvis must exhibit stability during functional movement, just as the scapula must maintain stability for the humerus to be effectively elevated.

Although some studies have analyzed the softball pitching motion,4,6,7,18,19 the available information is far less than that for baseball pitching. Understanding of the pathomechanics of common overuse syndromes is limited by a relative lack of quantitative information about the joint displacements and the corresponding muscle activation patterns that occur during the softball pitching motion. On the basis of available evidence,4,6,11 a description of the softball pitching motion is provided, with a recommended approach to injury prevention.

**Phases of the Pitch**

Maffet et al20 described the windmill pitching motion in terms of six phases that correspond to intervals on a clock. For a lateral view of a right-handed pitcher (Figure 1), Phase 1 (wind-up) consists of counter-clockwise downward movement to a 6 o'clock position. Phase 2 corresponds to upward movement from 6 o'clock to 3 o'clock, phase 3 corresponds to upward movement from 3 o'clock to 12 o'clock, phase 4 corresponds to downward movement from 12 o'clock to 9 o'clock, phase 5 corresponds to movement from 9 o'clock to ball release, and phase 6 corresponds to movement from ball release to completion of the follow-through motion.

During phase 1, the pitcher is generating momentum. Pitchers will often internally rotate the throwing arm and shift weight to the ipsilateral leg. Many pitchers display very unique wind-up motions, some of which involve extraneous movements. The wind-up should be a continuous motion that provides an efficient energy transfer from phase 1 to phase 2. When the pitcher displays an interruption in the movement from phase 1 to phase 2, potentially injurious stress may be created.

During phase 2, the contralateral stride leg undergoes hip flexion and knee extension and the ipsilateral gluteal muscle contracts to stabilize the pelvis.19 Also