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A functional model to describe the action of the adductor muscles at the hip in the transverse plane

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Anatomical texts agree on most muscle actions, with a notable exception being the action of the adductors of the hip in the transverse plane. Some texts list an action of the adductor brevis (AB), adductor longus (AL), and/or adductor magnus (AM) as internal rotation, whereas others list an action of external rotation. The purpose of this article is to present a functional model in support of the action of external rotation. Transverse plane motion of the femur at the hip during normal gait is driven by subtalar joint motion during the loading response, terminal stance, and preswing phases. During the loading response, the subtalar joint pronates, and the talus adducts. This talar adduction results in the lower leg, and subsequently the femur, internally rotating. During terminal stance and preswing, the opposite occurs; the subtalar joint supinates as the talus abducts in response to forces generated from the lower extremity and in the forefoot. Electromyographic (EMG) studies indicate varied activity in the AB, AL, and AM during the loading response, terminal stance, and preswing phases of the gait cycle. A careful analysis of EMG activity and kinematics during gait suggests that, in the transverse plane, the adductors may be eccentrically controlling internal rotation of the femur at the hip during the loading response, rather than the previously reported role as concentric internal rotators. In addition, these muscles may also concentrically produce external rotation of the femur at the hip during terminal stance and preswing. Physical therapists should consider this important function of the hip adductors during gait when evaluating a patient and designing an intervention program. Anatomical texts should consider listing the concentric action of external rotation of the femur at the hip as one action of the AB, AL, and AM, particularly when starting from the anatomic position.

Introduction

Knowledge of normal muscular anatomy is essential for the physical therapist in the examination, evaluation, diagnosis, and development of intervention programs for his or her patients (APTA, 2001). Beyond anatomical knowledge, the therapist must also be aware of the contributions of each muscle as the patient functions by interacting with the environment. Generally, a therapist will find agreement on human anatomical structure in the literature. However, the action of one muscle group—the hip adductors—has been the subject of disagreement. Authors agree that the hip adductor muscle group, consisting of the adductor longus (AL), adductor brevis (AB), and adductor magnus (AM), adduct the femur in relation to the pelvis along the frontal plane. Furthermore, some authors describe the AL, the AB, and the anterior (superior) fibers of the AM as acting along the sagittal plane by flexing the femur in relation to the pelvis, and the posterior (inferior) fibers of the AM as extending the femur in relation to the pelvis. For motion along the frontal and sagittal planes, then, there is no

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disagreement about the actions of the hip adductors (Basmajian, 1975, 1982, 1989; Grant, 1958, 1971; Hislop and Montgomery, 1995; Kapandji, 1988; Lindner, 1989).

There is not universal agreement, however, about the action of these muscles along the transverse plane. Some authors describe the action as internal rotation (Basmajian, 1982; Basmajian and DeLuca, 1985; Basmajian and Slonecker, 1989; Hislop and Montgomery, 1995), whereas others describe the action as external rotation (Grant, 1958; Grant and Basmajian, 1971; Kapandji, 1988). Still others describe actions of both internal and external rotation (Guy, 1998; Lindner, 1989).

Upon initial observation, the anatomical arrangement of the hip adductor muscles would seem to indicate an action of external rotation of the femur on the pelvis in the transverse plane (Figures 1 and 2). The adductors originate proximally from the inferior aspect of the body and ramus of the pubis and the inferior ramus of the ischium and all three muscles insert distally on the femur from a point beginning on the posterior aspect of the femur proximal to the linea aspera, along the linea aspera, to the adductor tubercle (Basmajian, 1982; Grant and Basmajian, 1971; Grant, 1958; Guy, 1998; Lindner, 1989). From the anatomical standing position and with a fixed pelvis, an active concentric contraction of these muscles would appear to rotate the posterior aspect of the femur medially. This would result in the entire femur rotating around the vertical mechanical axis in a direction that, by definition, is external rotation.

There is little scientific evidence to support an action of the three adductors of either internal or external rotation at the hip. Of the anatomy texts cited for this review, none provide a specific reference to support the action of the hip adductors. Some texts provide general references or a reading list at the end of the chapters. John Basmajian (1985) has been a proponent of an action of internal rotation, which he has supported in his classic text *Muscles Alive: Their Functions Revealed by Electromyography*. In this text, Basmajian cites an abstract published in 1966 by deSousa and Vitti (1966) in the *Archives of Mexican Anatomy*, in which deSousa and Vitti conclude that the AL and AM act as internal rotators of the hip. Other texts authored by Basmajian (Basmajian, 1982; Basmajian and Slonecker, 1989) also describe the hip adductors as internal rotators. Basmajian's position on the issue is clearly demonstrated as one follows the hip adductors through the editions of *Grant's Anatomy*. The sixth edition of *Grant's Anatomy*, authored by Grant (1958), and the eighth edition, authored by Grant and Basmajian (1971), describe an action of external rotation. However, the ninth edition of *Grant's Anatomy*, authored by Basmajian alone (1975), describes the adductor action as internal rotation.

The abstract by deSousa and Vitti (1966) led to the publication of an article in 1967 (de Sousa and Vitti, 1967). Although deSousa and Vitti conclude that the hip adductors are internal rotators, the evidence presented in their article may not support such a conclusion. These authors studied the electromyographic (EMG) activity of the AL and AM as their subjects actively internally and externally rotated the lower extremity while supine and while standing. When reviewing the method of data collection for the standing trials, it is equally reasonable to conclude an action of external rotation if one were to consider the function of eccentric contractions. For example, deSousa and Vitti had the subjects internally rotate the hip while standing and weight bearing, noting the EMG activity that this motion produced. The conclusion, therefore, was that since the hip was internally rotating when the muscles were electrically active, then the action of the muscles must be internal rotation. These results and conclusions are similar to those of Williams and Wesley (1951). However, if these authors considered an eccentric action to control the internal rotation in standing, then the conclusions could have been that the adductors may actually function as external rotators.

By citing only the abstract of the article, Basmajian was unable to critically analyze the methods of de Sousa and Vitti, and it may be possible that Basmajian (Basmajian, 1975, 1982; Basmajian and De Luca, 1985; Basmajian and Slonecker, 1989) has incorrectly described the action of the hip adductors as internal rotation.

de Sousa and Vitti and Williams and Wesley also had the subjects internally and externally rotate the hip while lying supine. These data should also be questioned because the authors do not explain if or how the supine hip rotation

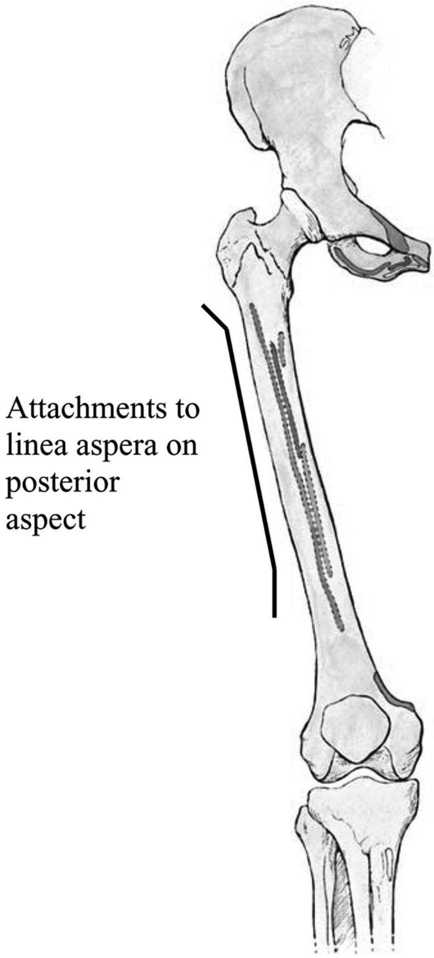

Figure 1. Hip adductor muscle attachments, anterior view. Green = adductor brevis; blue = adductor longus; and red = adductor magnus. With permission from *Life-Art, Grant's Atlas 3*, Lippincott Williams & Wilkins.

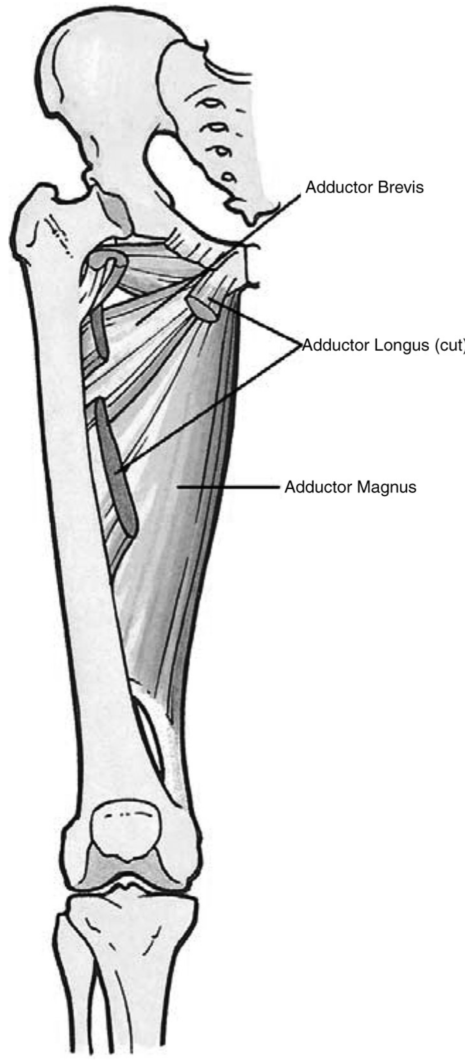

Figure 2. Hip adductor musculature, anterior view (see Figure 1 for posterior insertions on the femur). With permission from *Life-Art, Grant's Atlas 3*, Lippincott Williams & Wilkins.

motions were done in isolation of other hip motions. If the subjects were allowed to adduct and/or flex the hip, any EMG activity could not be conclusively attributed to the rotation seen.

A number of biomechanical models have been proposed to study muscle actions. Inman (1947) used wires and x-ray to represent the action lines of muscles. This early investigation came to be known as the straight-line method of describing muscle action, in which a straight line is taken from origin to insertion, and the muscle's action line is considered to fall along this line. The relationship of the action line to the axis of rotation determines the action of the muscle. Authors have advocated for the straight-line method as a reasonably simple way to determine the action line of any given muscle (Degutis, 1971; Dostal and Andrews, 1981; Dostal, Soderberg, and Andrews, 1986). Dostal and colleagues determined the straight-line vector for the adductor muscles and concluded that the moment arm of all three adductors was too small to suggest functional significance of these muscles as rotators of the hip (Dostal, Soderberg, and Andrews, 1986).

Mansour and Pereira (1987) described several "serious limitations" to studies using the straight-line method, particularly in situations in which a muscle curves around a joint. In their study of functional anatomy of the lower extremity during gait, these authors found anatomically incorrect action lines for some muscles of the lower extremity.

Jensen and Davy (1975) and Jensen and Metcalf (1975) also described several limitations to the straight-line method and suggested that the type and geometry of the muscles should also be considered. Many skeletal muscles follow a curved path, rather than a straight line, from origin to insertion. The curved path is a result of the muscle wrapping around a bony prominence or other muscles. The muscle's action line, therefore, should follow the same curved path. On the basis of this theory, Jensen and colleagues proposed the centroid-line method.

The centroid-line method describes a muscle's action line based on "the locus of the centroid of its transverse cross section" (Jensen and Davy, 1975). Although the centroid-line method has not been computed for the hip adductors, it would be reasonable to consider that because of the large muscle bulk on the medial aspect of the thigh that the centroid of these muscles is deflected posterior to the mechanical axis, creating a significant external rotation moment arm for the hip adductors.

Garner and Pandy (2000) described limitations of both the straight-line and the centroid-line methods. These authors state that the straight-line method is unlikely to yield meaningful results when the muscle follows a curved path, and the centroid-line method, although more realistic, is limited by the difficulty of obtaining centroid paths of a muscle through changing joint positions. Garner and Pandy propose a new approach, the obstacle-set method. In this method, the general concepts of centroid lines are used to produce vectors around known anatomical obstacles to produce a model of the muscle's actions for all configurations of a joint.

Lengsfeld, Pressel, and Stammberger (1997) applied this concept when constructing their model to estimate rotational lever arms for major hip muscles. Their model used "wrapping surface coordinates" to describe a muscle's path of action. Using this model, they report that the AM has an external rotation lever arm when the hip is positioned in a neutral position. The authors further state that to maximally lengthen the AM, the hip must be flexed, abducted, and internally rotated.

In the absence of definitive scientific data to confirm the rotary action of the hip adductors, the purpose of this article is to describe a functional model supporting an action of the hip adductors as external rotators of the femur in relation to the pelvis in the transverse plane.

Functional model

This functional model is based on the kinematics and kinetics of the hip in the transverse plane during human gait, along with the muscle activity of the three adductors during gait.

Hip kinematics in the transverse plane during walking

During normal gait, the foot is on the ground 60% of the time and is off the ground 40% of the time (Perry, 1992). When the foot is in contact with the ground, the lower extremity is functioning as a closed kinematic chain, in which motion at one joint influences the motion and function of other joints in the chain. When the foot is off the ground, the lower extremity is functioning in an open chain, in which motion at one joint may influence, but not necessarily dictate, the motion or function at other joints in the chain (Levangie and Norkin, 2001). This is an important concept in understanding the influence of the subtalar joint on the hip during gait.

During the stance phase of the gait cycle, transverse plane motion at the hip is closely related to the motion of the subtalar joint. At initial contact, the foot is turned out approximately seven degrees from the line of progression (Bruckner, 1998), and the femur is aligned in a neutral position in the transverse plane (Perry, 1992). During the loading response phase of the gait cycle, the subtalar joint performs the triplanar motion of pronation (Bruckner, 1998; Perry, 1992), with the talus plantar flexing relative to the calcaneus in the sagittal plane and adducting relative to the calcaneus in the transverse plane, while the calcaneus everts relative to the talus in the frontal plane (Rockar, 1995; Rodgers, 1995) (Figure 3). Because the transverse plane component motion of talar adduction is unable to be fully absorbed in the talo-crural joint (Perry, 1992; Rockar, 1995) or knee joint (Perry, 1992), the lower leg (Perry, 1992; Rockar, 1995; Rodgers, 1995) and the femur (Perry, 1992) internally rotate in relation to the ground and the foot (Figure 4). During the midstance phase, the pronated position is maintained, and then the subtalar joint begins triplanar supination late in terminal stance and through preswing (Bruckner, 1998; Perry, 1992). This supination of the subtalar joint is likely powered in part by external rotation of

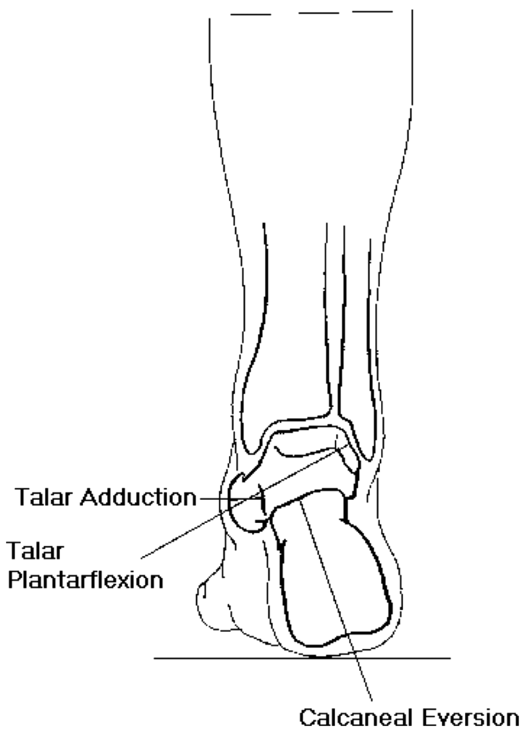

Figure 3. Subtalar pronation in weight bearing, consisting of the three component motions of calcaneal eversion, talar plantarflexion, and talar adduction. Drawing by Brian R. Hoke, PT, SCS with permission from American Physical Rehabilitation Network, © 1984.

Figure 4. Thigh internal rotation and subtalar pronation during weight bearing. Line indicates position of center of the femur, marked at the superior pole of the patella, in relation to the foot. Note that the alignment of the center of the thigh is medial to the foot.

the lower extremity, with the external rotators of the hip assisting in creating this external rotation force. As the lower leg externally rotates, the talus abducts along the transverse plane and dorsiflexes along the sagittal plane, as the calcaneus inverts along the frontal plane (Rockar, 1995; Rodgers, 1995) (Figures 5 and 6). When considering the kinematics of the subtalar joint, it becomes apparent how much this joint complex influences and is influenced by hip motion.

While the transverse plane motions of the subtalar joint and hip joint are closely related during the stance phase of the gait cycle (Perry, 1992), the pelvis is also moving along the transverse plane at the hip joint on the stance side. Keeping the reference foot as the stance foot, as this foot reaches forward at initial contact, the contralateral side of the pelvis is rotated posteriorly in the transverse plane (Bruckner, 1998; Inman, 1993; Perry, 1992) (Figure 7A). During the loading response, the contralateral side of the pelvis begins to rotate anteriorly in

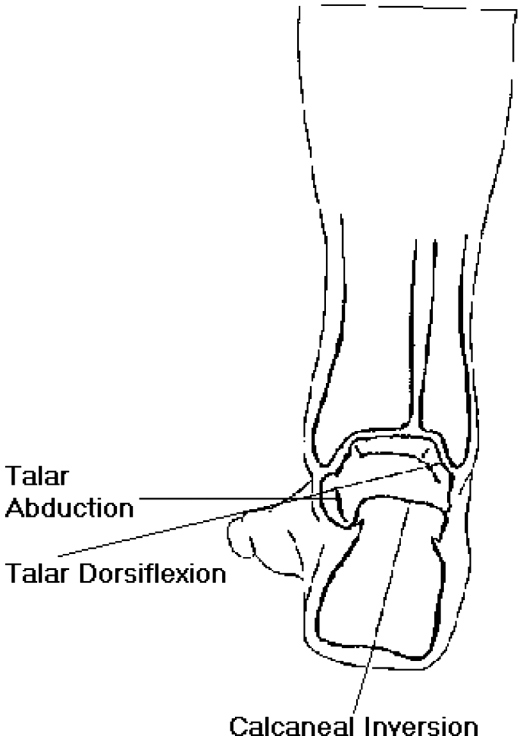

Figure 5. Subtalar supination in weight bearing, consisting of the three component motions of calcaneal inversion, talar dorsiflexion, and talar abduction. Drawing by Brian R. Hoke, PT, SCS with permission from American Physical Rehabilitation Network, © 1984.

Figure 6. Thigh external rotation and subtalar supination during weight bearing. Line indicates position of center of the femur, marked at the superior pole of the patella, in relation to the foot. Note that the alignment of the center of the thigh is along the lateral aspect of the foot.

the transverse plane (Perry, 1992) and reaches a neutral position by mid stance (Figure 7B). This anterior movement of the contralateral (swing) side of the pelvis is occurring concomitantly with the internal rotation movement of the ipsilateral (stance) femur as described above. This combined motion of both bony segments of the hip produces a very rapid internal rotation at the hip joint during the loading response. As the step proceeds through midstance and into early terminal stance, the contralateral side of the pelvis continues to rotate anteriorly past neutral (Bruckner, 1998; Inman, 1993; Perry, 1992), causing further internal rotation at the stance hip, even while the femur is relatively stationary in the transverse plane. Beginning in late terminal stance and through preswing, the contralateral side of the pelvis continues to rotate anteriorly in the transverse plane (Bruckner, 1998; Inman, 1993; Perry, 1992) (Figure 7C). Now, however, the femur is moving into external rotation, perhaps partly due to passive insufficiency in the posterior hip muscles, which eventually causes subtalar joint (STJ) supination. Because both bony segments of the hip are now moving in relatively the same direction, the external rotation at the hip joint may now be negligible as the amount of anterior pelvic rotation (5°) is equal to the amount of femoral external rotation (5°) (Perry, 1992).

In summary, the transverse plane motion occurring at the hip joint during stance is a rapid internal rotation during loading, a continuing and less rapid internal rotation during midstance and early terminal stance, and minimal, if any, transverse plane motion during late terminal stance and through preswing. During swing, the hip joint externally rotates to return to its starting position in preparation for initial contact.

Figure 7. The photographs show the rotation of the pelvis along the transverse plane at three phases of the gait cycle. A: At initial contact on the right, the contralateral aspect of the pelvis is rotated posteriorly along the transverse plane. B: At mid-stance on right, the pelvis is in a neutral position along the transverse plane. C: At preswing on the right, the contralateral aspect of the pelvis is rotated anteriorly along the transverse plane.

Hip kinetics in the transverse plane during walking

Perry described the primary goals of gait as propulsion, maintenance of upright stability, absorption of shock, and energy conservation (Perry, 1992). Gravity and momentum are the primary forces to be dealt with to achieve these goals. Once the foot contacts the ground to begin the stance phase of gait, gravity pulls the various anatomical components toward the ground. Because of the dynamic nature of the gait cycle, the body's interaction with the ground is constantly changing. This interaction of forces between the foot and the ground is referred to as the ground reaction force vector (GRFV) (Bruckner, 1998; Perry, 1992). The magnitude and direction of the GRFV determines how the body uses muscle force to maintain the goals of normal gait.

Although it may appear that motion of the femur in the transverse plane would not be influenced by gravity, when considering subtalar joint motion, it is apparent that gravity does drive internal rotation of the femur at the hip during the loading response. The GRFV lies lateral and posterior to the axis of the subtalar joint, and the line of gravity lies medial and anterior to the axis of the subtalar joint throughout the stance phase of the gait cycle (Perry, 1992) (Figure 8), thereby creating a force couple causing an eversion moment of the calcaneus in the frontal plane and a plantar flexion moment of the talus in the sagittal plane (Perry, 1992; Rodgers, 1995). Because these are component motions of normal subtalar joint pronation during weight bearing, the talus must also adduct in the transverse plane. During subtalar pronation, as eversion of the calcaneus and plantar flexion of the talus are driven by gravity, so too is the transverse plane component motion of talar adduction.

Beginning near the end of terminal stance and through preswing, the subtalar joint supinates to achieve a stable position of the foot for push-off. The component motions of supination are inversion of the calcaneus in the frontal plane, dorsiflexion of the talus in the sagittal plane, and abduction of the talus in the transverse plane. With the ground reaction force vector remaining lateral and posterior to the subtalar joint (Perry, 1992), all component motions of the subtalar joint supination are against gravity.

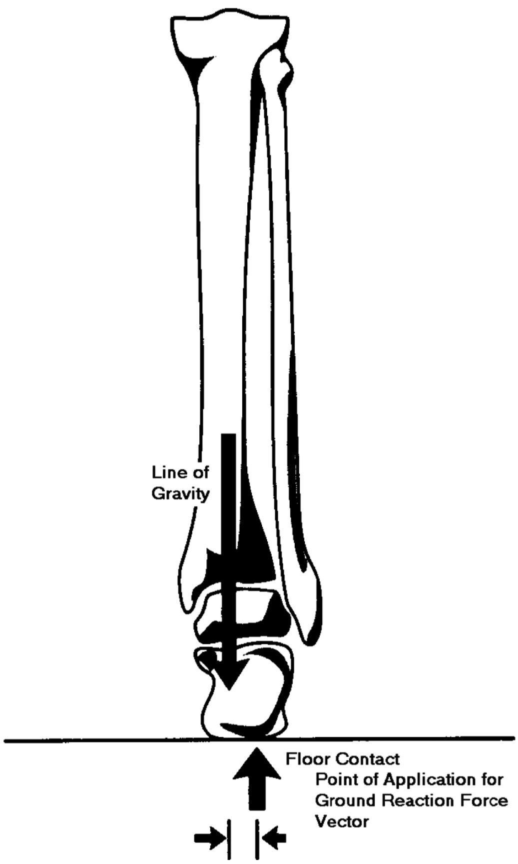

Figure 8. Ground reaction force vector at subtalar joint during initial contact, posterior view. The offset of the line of gravity and the ground reaction force results in a force couple, which produces rotation of the calcaneus into eversion, a component motion of subtalar pronation. Revised from Perry J, Ankle and Foot Complex, *Gait Analysis: Normal and Pathological Function*, 1992, with permission from SLACK Incorporated.

As gravity causes subtalar joint pronation and resists subtalar joint supination, the body must control the motion caused by gravity (pronation) and power the motion against gravity (supination). A variety of muscles are in anatomical position to function in this way at the ankle and foot. Because the lower leg and the femur are driven into internal rotation via the talar adduction, any muscle that externally rotates the lower leg at the knee or the femur at the hip will be able to assist in the functional task of controlling pronation and producing supination.

Adductor muscle function during initial contact and the loading response

At initial contact and during the loading response, the line of gravity force vector lies medial to the hip, producing an adduction moment at the hip (Perry, 1992) (Figure 9). It is well documented that contraction of the hip abductor muscles counteracts this moment (Perry, 1992). Because hip adductor muscles are not required to produce the hip adduction motion observed during the loading response, the activity of the adductors must be directed

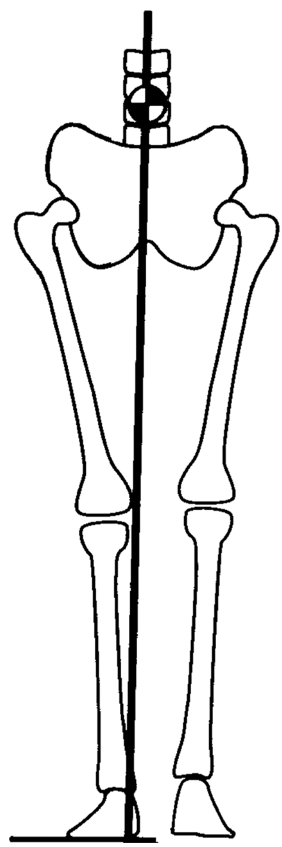

Figure 9. Ground reaction force vector at hip joint during initial contact, anterior view. The ground reaction force vector remains medial to the hip throughout the stance phase of the gait cycle, creating an adduction moment at the stance hip. Reprinted from Perry J, Hip, *Gait Analysis: Normal and Pathological Function*, 1992, with permission from SLACK Incorporated.

to either the transverse plane or to the sagittal plane.

EMG data indicate that the posterior portion of the AM is active during the loading response phase of gait. Because the posterior portion of the AM is a hip extensor, these fibers will help to resist the hip flexion load and will assist with the hip extension observed during the loading response (Green and Morris, 1970; Lyons et al, 1983; Perry, 1992). As the hip is also internally rotating during the loading response, the activity in the posterior portion of the AM would also be assisting in the control of this internal rotation via an eccentric contraction. Gans and Gaunt (1991) have suggested that muscles are compartmentalized, and differential activation within a muscle may result in changing functions. Depending on the individual amount and timing of the hip extension and internal rotation, the posterior portion of the AM would essentially be producing a nearly isometric contraction as the extension would tend to cause shortening (concentric) and the internal rotation would tend to cause lengthening (eccentric). Because human function tends to favor efficiency, the activity of the posterior portion of the AM will be effective for two hip motions. This concept of efficiency of muscular activity would also explain why the AL and AB are electrically silent during the loading response (Green and Morris, 1970; Perry, 1992). As hip flexors, activity in the AL and AB would be counter-productive to the functional task of extending the hip during the loading response. The AL and AB are more likely to play a functional role during the preswing phase of the gait cycle.

Also during the loading response, as the femur of the stance limb is moving at the hip in the transverse plane in response to subtalar joint motion and the force of gravity, the swing side of the pelvis is rotating anteriorly along the transverse plane (Perry, 1992) during preswing of the opposite extremity. The active posterior portion of the AM is also anatomically positioned to assist with controlling this motion of the pelvis on the femur at the hip.

The AB, AL, and AM are all electrically silent during midstance and early terminal stance (Green and Morris, 1970; Lyons et al, 1983; Perry, 1992).

Adductor muscle function during terminal stance and preswing

Beginning in late terminal stance and continuing through preswing, the AL (Green and Morris, 1970; Perry, 1992), AB (Perry, 1992), and anterior portion of the AM are active. As described previously, there is little, if any, transverse plane motion occurring at the hip joint because both the femur and the pelvis are moving in the same direction along the transverse plane and in the same amount. This results in a nearly isometric contraction of the adductors. If the forward rotation of the pelvis is being driven by the momentum of the swing leg, then this isometric contraction of the AB, AL, and anterior portion of the AM will pull the femur into the flexion and external rotation seen during this period of the gait cycle. Again, the muscles demonstrate efficiency by producing motion along two planes (sagittal and transverse) with a single isometric contraction. The posterior fibers of the AM are now silent (Green and Morris, 1970), because an extension force at this time would be counterproductive to the functional demand.

The external rotation force at the femur during late terminal stance and through preswing is an important force to be transferred down the lower kinetic chain, through the knee and into the lower leg. As the lower leg is forced to rotate externally, the talus is abducted and the subtalar joint supinates.

Clinical considerations

Several clinical scenarios involve the hip adductors, necessitating the therapist to have a thorough knowledge of the anatomy and function of the adductors to design appropriate intervention programs. Three typical clinical scenarios of running and jogging, groin strains, and the lower extremity kinematic chain are presented here. The reader is encouraged to consider a wide variety of other closed-chain lower extremity activities that will also involve function of the hip adductors in the transverse plane.

Running/jogging/sprinting: The hip adductors are important in everyday human function, as evidenced by the activity present during normal human walking. More strenuous activities, such as jogging, running, and other athletic endeavors, place an even higher functional demand on the adductors. During running, EMG data show the AM to have three peaks of activity; the highest peak occurs early in stance during the loading response (Montgomery, Pink, and Perry, 1994). The AL was found to be active during toe-off and into the early phase of swing and is more active during jogging as opposed to sprinting (Mann, Moran, and Dougherty, 1986). This pattern of activation is similar to that found during walking. Because of the increased demands placed on the hip adductors during jogging, running, and sprinting activities, it is important to adequately train these muscles to meet these increased functional demands. Proper transverse plane strengthening is essential to fully prepare the adductors. Both concentric and eccentric contractions while in weight bearing should be used as part of the training program.

Groin strains: The therapist involved in treating patients with orthopedic and/or sport-related injuries will likely treat patients with a diagnosis of groin strain, which most frequently involves strain of the hip adductors (Anderson, Strickland, and Warren, 2001; Morelli and Smith, 2001). During athletic activities, the normal femur and pelvic transverse plane motions seen during walking occur more rapidly and under an increased load. As described previously, the posterior fibers of AM are under a great functional demand during the loading response because both the pelvis and femur are moving in such a way to create very rapid internal rotation hip motion. During athletic activities, this motion will occur even quicker, causing the posterior fibers of the AM to respond with a very demanding eccentric contraction. Perhaps this excessive and quick eccentric load is a causative factor of groin strains. With the increased demands placed on the muscles during athletic events, combined with the hip motions and positions in which athletes place the hip, it is little wonder that the adductors are so frequently injured. In addition, if the athlete over-pronates at the subtalar joint during stance, the amount of femoral internal rotation will be increased, causing additional functional demands on the already overloaded adductors. For the therapist to effectively stretch and/or strengthen the adductors during treatment, it would be helpful to involve all planes of motion, including the transverse plane. The therapist may also be cued to carefully assess foot function with those athletes prone to groin strains.

Lower extremity kinematic chains: The efficiency of a kinematic chain is that the functional load is shared by all segments of the chain. If one segment is weak, then the load must be taken on by other links. It is this overloading of demand that can lead to injury. When considering the lower kinematic chain, many muscles contribute to decelerating subtalar pronation and accelerating subtalar supination. With the realization that the hip adductors contribute to this deceleration/acceleration function, the therapist is able to design an intervention program that will strengthen all links in the lower extremity chain with the desired outcome that the links will share the functional load and that excessive functional demands will not be placed on any one part of the chain.

Conclusion

Physical therapy is defined as a profession with "…clinical applications in the restoration, maintenance, and promotion of optimal physical function" (APTA, 2001). To fulfill this role, the therapist must have a full understanding of normal human anatomy and function. The hip adductors are problematic because the complete function of the adductors has been an area of differing opinion over several years. It is important to have this controversy resolved for the therapist to have a more complete understanding of human function.

It is understandable why the transverse plane function of the three hip adductors causes confusion. Although anatomically these muscles would seem to cause external rotation of the femur at the hip, a variety of sources report EMG activity in these muscles as the hip is rotating internally. Another complicating factor is the distinct likelihood that the adductor action changes in relation to the changes in hip position (Dostal, Soderberg, and Andrews, 1986). The model presented in this manuscript is based on the kinetics and kinematics of normal human gait. The reader is cautioned that extrapolation of this model to other activities in which hip position is widely variable is inappropriate.

This article has attempted to explain how a careful analysis of walking gait, combined with EMG findings during gait, suggests that the hip adductors are more likely functioning as eccentric controllers of hip internal rotation, and therefore, subtalar pronation and concentric producers of hip external rotation, and therefore, subtalar supination. Based on the theoretical function of the adductors during gait, the anatomical literature should reconsider the action the AB, AL, and AM as external rotation, rather than internal rotation.

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