

ABNORMAL TRANSTIBIAL GAIT

Sagittal Plane Analysis

Ordinarily, the knee on the prosthetic side should flex slightly in early stance and then move to nearly full extension at midstance, followed by slight flexion in late stance. The observer should view the prosthetic side.

Early Stance

- Insufficient knee flexion; the floor reaction passes anterior to the knee.
 - ⊠ Anatomic/physiologic causes include the following:
 - » Anterodistal pain—Patient who fears bending the knee may exaggerate knee extension, thus causing excessive pressure on the distal end of the tibia.
 - » Poor balance—Patient fears allowing the ipsilateral knee to flex.
 - » Extensor synergy, seen in patients who have cerebrovascular accident in addition to amputation.
 - » Knee extensor contracture.
 - » Knee extensor weakness—Patient compensates by forcing the knee posteriorly.
 - ⊠ Prosthetic causes include the following:
 - » Shoe that has a lower heel or a more resilient heel than that for which the prosthesis had been aligned.
 - » Prosthetic foot that has a heel cushion that is too resilient.
 - » Prosthetic foot malaligned in plantar flexion. Shank should be perpendicular to the floor in the sagittal and frontal planes.
 - » Socket malaligned in insufficient flexion.
 - » Socket malaligned posterior in relation to the prosthetic foot.
 - » Suspension that interferes with knee flexion.
- Excessive knee flexion (*buckling*); the floor reaction passes posterior to the knee.
 - ⊠ Anatomic/physiologic causes include the following:
 - » Knee extensor weakness.
 - » Knee flexor contracture.
 - ⊠ Prosthetic causes include the following:
 - » Shoe that has a higher heel or a firmer heel than that for which the prosthesis had been aligned.
 - » Prosthetic foot that has too firm a heel cushion.
 - » Prosthetic foot malaligned in dorsiflexion.

- » Socket malaligned in excessive flexion.
- » Socket malaligned anterior in relation to the prosthetic foot.
- » Suspension that causes knee flexion.
- » Prosthesis too long.

Late Stance

- Early knee flexion (*drop off*); floor reaction passes posterior to the knee.
 - ⊠ Anatomic, physiologic, and prosthetic causes include the following:
 - » Most of the factors identified with excessive knee flexion in early stance cause this late stance deviation. Height of the shoe heel and the resilience of the prosthetic heel cushion, however, are not relevant at late stance.
- Delayed knee flexion (*climbing the hill*); the floor reaction passes anterior to the knee.
 - ⊠ Anatomic, physiologic, and prosthetic causes include the following:
 - » Problems associated with insufficient flexion in early stance, except for the shoe heel and prosthetic heel cushion, can also cause this late stance abnormality.
- Step length discrepancy; prosthetic step is longer than step with sound foot.
 - ⊠ Anatomic/physiologic causes include the following:
 - » Hip and/or knee flexor contracture.
 - » Poor balance.
 - » Pain in amputation limb.
 - ⊠ Prosthetic causes include the following:
 - » Prosthesis too long.

Frontal Plane Analysis

Ordinarily, at midstance during single support on the prosthesis, the knee shifts slightly within the prosthesis. Shift is inevitable as the rigid portion of the socket compresses the soft tissues of the amputation limb. Movement of the prosthetic socket brim is known as *thrust*.

Usually, the prosthesis is aligned to position the floor reaction medial to the knee, increasing load on the pressure-tolerant proximomedial aspect of the amputation limb. If the patient walks with a cane, or if the prosthesis has an elastic sleeve, distal pin, or suction suspension, thrust will be less conspicuous.

The observer should stand behind the patient, noting the movement of the knee in relation to the socket during midstance on the prosthesis.