

**FIGURE 174-26** Leg length determination by computed tomography scout image in a 7-year-old boy with hemiplegia and leg length discrepancy. The left leg is shorter.

Mild leg length discrepancy does not warrant treatment. More severe discrepancies are treated. The type of treatment varies with the age of the child, the amount of projected growth remaining, the site of abnormality, and the degree of leg length discrepancy. With the Ilizarov procedure, bone on either side of a diaphyseal corticotomy is distracted slowly. New bone forms within the gap to add length.

**A leg length discrepancy of less than 1 cm is considered within normal limits; however, in most normal individuals, the legs are within 1 mm of each other in length.**

## *Feet*

Alignment disorders of the foot occur on an idiopathic basis or are due to a large number of underlying disorders. The standard method of radiologic evaluation of the foot involves weight-bearing or simulated weight-bearing anteroposterior (dorsoventral) and lateral views. The talus, which is more proximal, is considered fixed at the ankle

because it has no musculotendinous attachments of its own. The calcaneus, which is more distal, is linked to the midfoot and forefoot and moves as a unit with these structures relative to the talus. In a normal foot, on the anteroposterior view, the axis of the talus extends through the base of the first metatarsal (Fig. 174-27). With hindfoot varus, the more distal calcaneus is angulated inward, and the axis of the talus passes lateral to the base of the first metatarsal. With hindfoot valgus, the more distal calcaneus is angulated outward, and the axis of the talus passes medial to the base of the first metatarsal. The normal lateral talocalcaneal angle is approximately 45 degrees, decreasing to 30 degrees in older children and adults. With hindfoot varus, the lateral talocalcaneal angle is decreased, whereas with hindfoot valgus, the angle is increased. Normal elevation of the middle metatarsals relative to the fifth metatarsal reflects the transverse arch of the foot. The anterior calcaneus is slightly inclined upward. Accentuation of this upward inclination is called “calcaneus” position of the hindfoot. Equinus is downward inclination of the distal calcaneus. Normal calcaneal tilt and normal slight downward tilt of the distal metatarsals create slight longitudinal concavity in the osseous contour of the bottom of the foot.

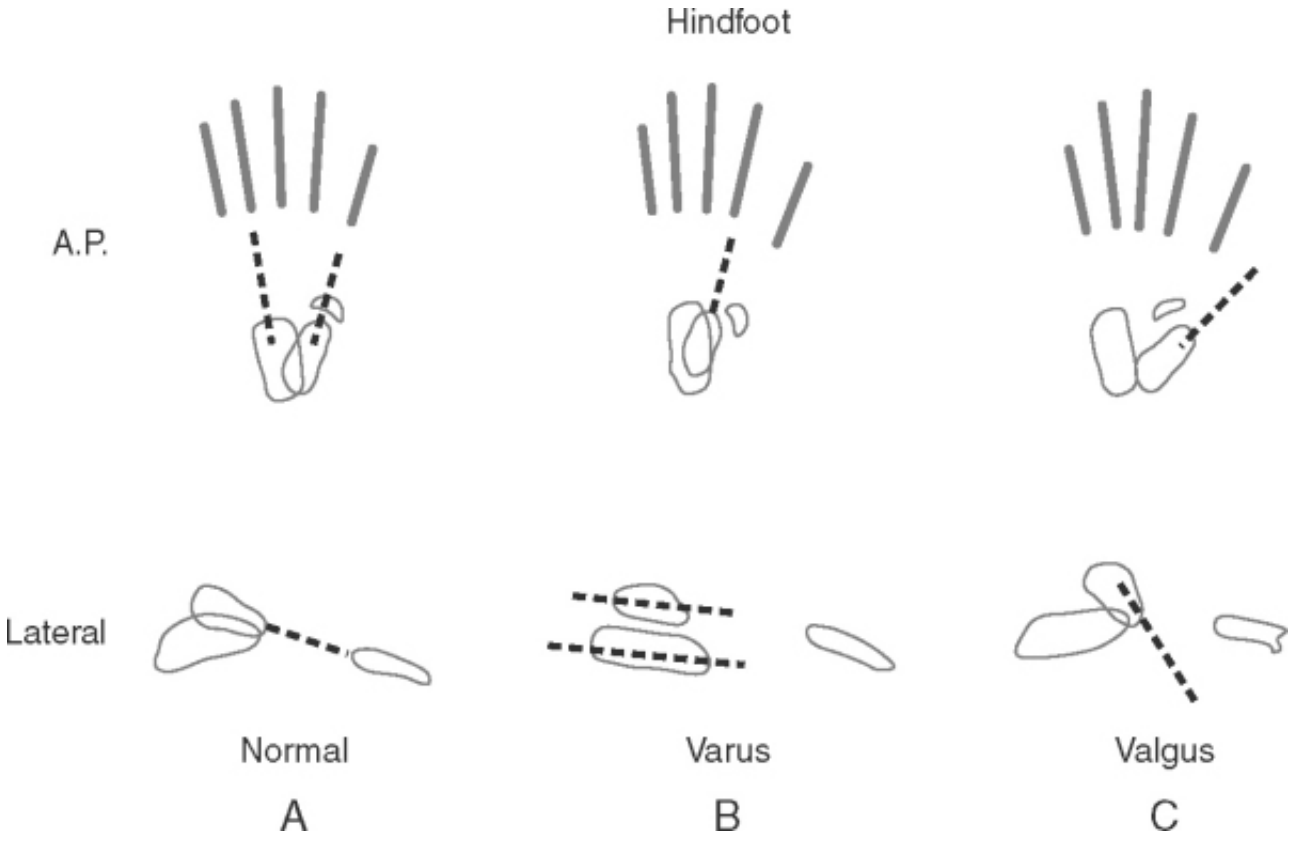


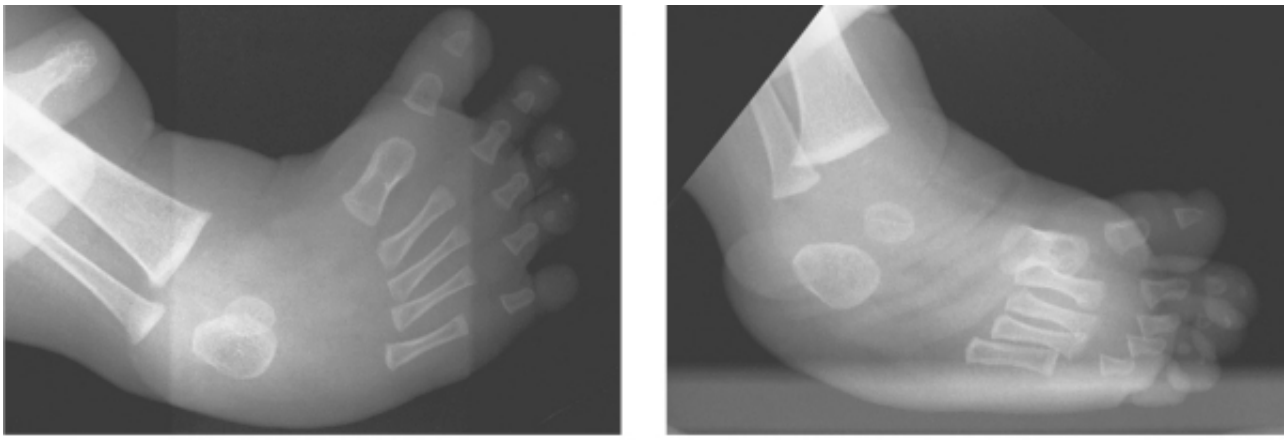

**FIGURE 174-27** Diagrammatic representation of hindfoot and forefoot relationships in the anteroposterior (A.P.) and lateral projections. **A,** Normal hindfoot. The talar axial line intersects or points slightly medial to the first metatarsal base. The navicular is situated directly opposite the head of the talus. The calcaneus points toward the fourth metatarsal base, forming a definable angle with the talus. On the lateral projection, the anterior portion of the talus is slightly plantarflexed, and the calcaneus is slightly dorsiflexed. The talar axial line points down the shaft of the first metatarsal. **B,** Hindfoot varus. The talocalcaneal angle is decreased, with these two bones more parallel to each other and actually superimposed. The navicular is medially displaced, and the axial talar line points lateral to the first metatarsal base. On lateral projection, the calcaneus and the talus are more horizontal and parallel to each other. **C,** Hindfoot valgus. The talocalcaneal angle is increased, with the navicular and other midfoot bones displaced lateral to the talus. The talar axial line passes medial to the first metatarsal base. On lateral projection, the talus is more vertical than normal.
*(Reprinted from Ozonoff MB: Pediatric Orthopedic Radiology, 2nd ed. Philadelphia, WB Saunders, 1992.)*

When foot deformity is assessed, the talus is proximal, and the calcaneus and the rest of the foot are distal. In varus, the calcaneus is angulated medial relative to the talus. In valgus, the calcaneus is angulated lateral relative to the talus.

## CLUBFOOT

Talipes (“talus” = ankle; “pes” = foot) equinovarus, or clubfoot, is a common congenital anomaly that is clinically obvious at birth. It is also commonly identified on prenatal sonography and MRI. The principal components of clubfoot

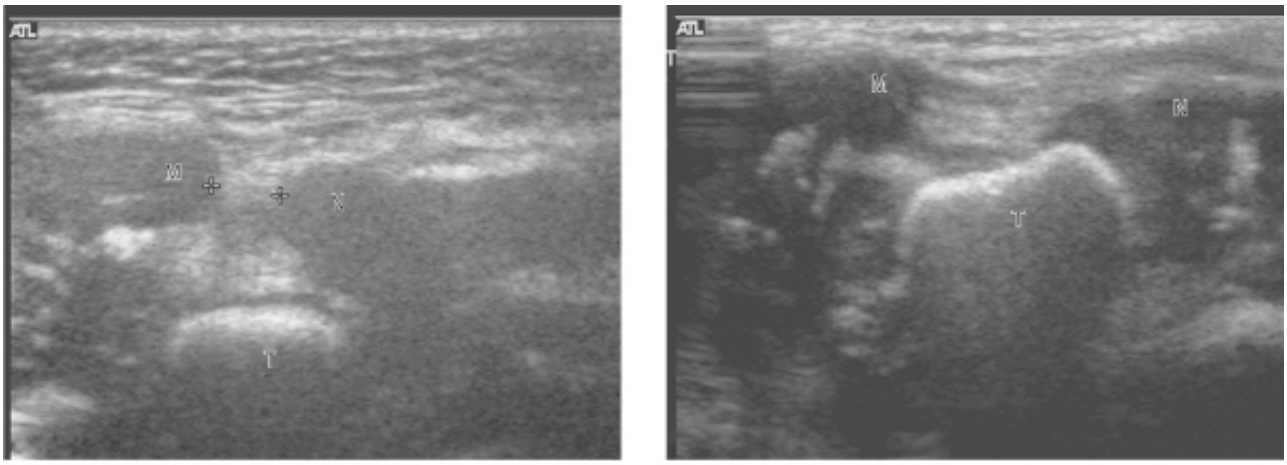
deformity include plantar flexion of the ankle (equinus), inversion of the heel (varus), and adduction of the forefoot (varus) (Fig. 174-28). Abnormal intrauterine pressures contribute to the development of clubfoot. Genetics also appears to play a role, with a higher than normal incidence of the deformity reported in first-degree relatives. Most congenital clubfeet are supple, and the condition is managed conservatively with serial casting. For very stiff, inflexible clubfeet and those that fail to respond to conservative treatment, operative reduction is required.



A B

**FIGURE 174-28** Radiographs of congenital clubfoot obtained with simulated weight bearing. **A,** Note inversion and forefoot adduction in the anteroposterior view. **B,** Inversion on the lateral view shows "laddering" of the metatarsals. Equinus of the hindfoot and parallelism of the talus and calcaneus are evident.

Anteroposterior and lateral views permit determination of talocalcaneal angulation, which is a commonly used method for grading the extent of deformity and monitoring treatment. An AP radiograph shows superimposition and parallelism of the talus on the calcaneus with the talar axis directed lateral to the first metatarsal (hindfoot varus). Parallelism of the talus and calcaneus is also seen on a lateral view. The lateral view shows plantarflexion of the calcaneus (equinus) and a step-ladder arrangement of the metatarsals, with the first metatarsal highest and the fifth metatarsal at the weight-bearing surface of the foot. Ultrasonography has been used in select centers to assess the flexibility of clubfoot and to guide therapeutic decision making (Fig. 174-29).



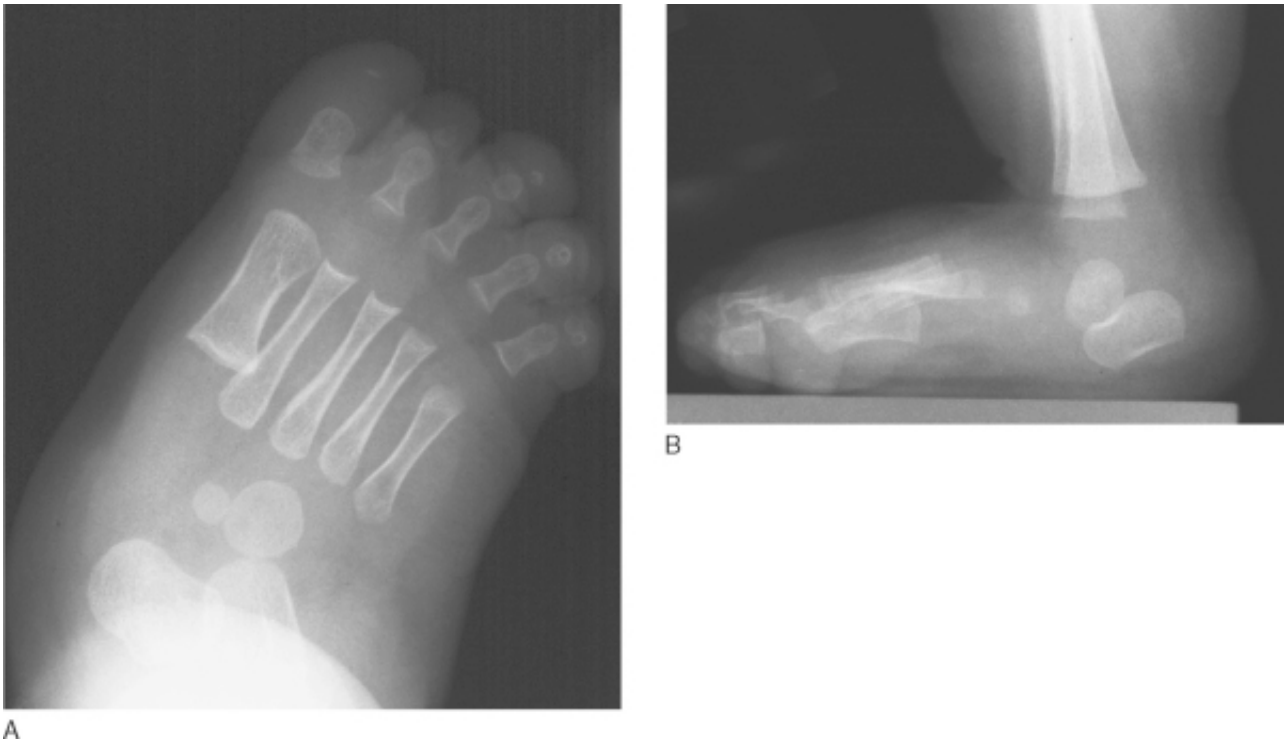
A B

**FIGURE 174-29** Ultrasonography of clubfoot in a 6-month-old girl: longitudinal scans at the medial aspect of the feet. **A,** In the clubfoot, the cartilaginous navicular (N) and the medial malleolus (M) are closely spaced *(cursors)*. These structures overlie the talus (T), which is ossified. **B,** In the normal foot, the navicular and the medial malleolus are widely spaced, and the talus is not covered. The distance between the navicular and the medial malleolus is an indicator of the severity of deformity and can be followed over time. Dynamic assessment reveals the flexibility of the deformed clubfoot.
*(Courtesy of Dr. M. A. DiPietro, Ann Arbor, MI.)*

Anatomic deformities persist after treatment of clubfoot and should be recognized as children grow. Many clubfeet have small, squared tali with flattened heads, decreased talocalcaneal angles, subtalar joint changes, and medial displacement of the navicular. Valgus deformity may result from overcorrection.

## CONGENITAL VERTICAL TALUS

Congenital vertical talus (congenital rigid flatfoot) may be an isolated condition or may be seen in association with various syndromes (e.g., trisomies) or other systemic abnormalities (i.e., central nervous system defects, arthrogryposis, and neurofibromatosis). The talus is almost completely vertical in this condition (parallel with the longitudinal axis of the tibia), and the calcaneus is fixed in plantarflexion (equinus) (Fig. 174-30). In the AP projection, the talar axis is medial to the base of the first metatarsal (valgus). The navicular dislocates dorsally, and clinically, a pronated rocker-bottom foot is present. After the navicular ossifies, its abnormal position helps to distinguish congenital vertical talus from severe planovalgus or flatfoot deformity. Prior to ossification, the position of the navicular can be determined by ultrasonography.



A B

**FIGURE 174-30** Congenital vertical talus in 7-month-old boy. **A,** In the anteroposterior view, the axis of the talus projects well medial to the base of the first metatarsal, consistent with hindfoot valgus. **B,** In the lateral view, the talus is nearly vertical in orientation, and the calcaneus is plantarflexed.

## METATARSUS VARUS (ADDUCTUS)

Metatarsus adductus is another cause of in-toeing that is usually seen in children younger than 5 years of age. Forefoot adduction differs from clubfoot in that midfoot and hindfoot relationships are normally maintained. This condition commonly disappears with normal maturation and no treatment. The affected foot has a C-shaped contour on examination. Forefoot adduction also can occur as a result of excessive internal tibial torsion or increased femoral neck anteversion. On AP (simulated) weight-bearing radiographs, the metatarsals are adducted and hindfoot alignment is normal.

## SKEWFOOT

In skewfoot (Z-foot; serpentine metatarsus adductus), the forefoot is adducted and the hindfoot is in valgus, resulting in a “Z”-like distortion of the bones of the foot (Fig. 174-31). Skewfoot is considered a severe form of metatarsus adductus. It is not congenital but develops in the young child. Skewfoot is common in otherwise normal children and also occurs in children with cerebral palsy.




**FIGURE 174-31** Bilateral skewfoot in a 4-year-old boy. The forefeet are abducted and the hindfeet are in valgus, resulting in a "Z"-like appearance of the feet.

## FLATFOOT (PES PLANUS)

Flatfoot (pes planus) is a descriptive term. The differential diagnosis of pes planus includes flexible planovalgus foot, peroneal spastic (rigid) flatfoot related to tarsal coalition, congenital vertical talus (congenital rigid flatfoot), and congenital calcaneovalgus (congenital flexible flatfoot).

The common flatfoot is a painless, flexible planovalgus foot. Variable degrees of hindfoot valgus, plantar arch flattening, and forefoot pronation occur. Pathology is thought to involve excess ligamentous laxity, which allows the calcaneus to shift into a valgus position under the talus. Abduction and eversion result from loss of calcaneal support. The AP projection shows the talocalcaneal angle to be increased as the result of abduction of the calcaneus. The midtalar line passes medial to the first metatarsal. On the lateral projection, hindfoot valgus causes the talus to be more vertical than normal. The navicular is normally located relative to the calcaneus. The calcaneus and metatarsals are horizontal longitudinally, and loss of the plantar arch is noted. Similar deformity may occur in some children with cerebral palsy (Fig. 174-32).

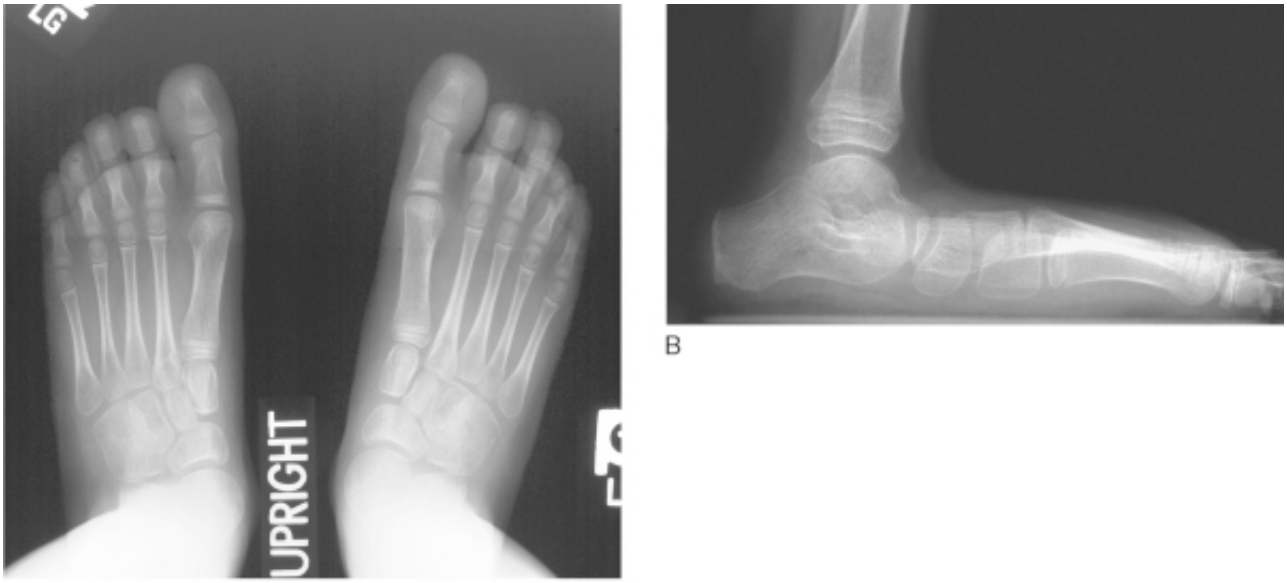



**FIGURE 174-32** Bilateral planovalgus feet in a 9-year-old with cerebral palsy. **A,** In the anteroposterior view, hindfoot valgus is symmetric. **B,** Lateral view of the right foot shows pes planus with a mild increase in the lateral talocalcaneal angle, also consistent with hindfoot valgus. The calcaneus is horizontal in orientation.

With rigid or painful flatfoot (peroneal spastic flatfoot), CT may be performed to detect subtalar coalition. Patients may develop peroneal muscle spasm and pain caused by irritation. Tarsal coalition is discussed in Chapter 164.

## CALCANEOVALGUS

Calcaneovalgus feet are reflective of intrauterine positioning. A total of 30% to 50% of newborns have mild calcaneovalgus deformity. In severe congenital calcaneovalgus, the foot is dorsiflexed against the talus. Radiographs show the hindfoot in severe valgus position with a plantarflexed talus. The navicular is not dislocated. The defect is flexible and correctable.

## ROCKER-BOTTOM FOOT

In rocker-bottom foot, the calcaneus is in equinus position and the metatarsals are dorsiflexed, producing a convex surface on the bottom of the foot. Rocker-bottom foot is seen with congenital vertical talus and severe cerebral palsy with hindfoot valgus, and it occurs as a complication of incorrectly treated clubfoot with persistent equinus.

## CAVUS FOOT

In pes cavus, the longitudinal plantar arch is deepened. The anterior calcaneus is abnormally dorsiflexed and the metatarsals are plantarflexed (Fig. 174-33). Although an idiopathic congenital form of cavus foot exists, more commonly the finding is related to neuromuscular abnormalities. MRI of the spinal cord or central nervous system may be indicated. Differential diagnoses include peroneal muscular atrophy (Charcot-Marie-Tooth disease), Friedreich ataxia, myelomeningocele, poliomyelitis, and other paralytic conditions.



**FIGURE 174-33** Marked pes cavus in an 11-year-old girl with Charcot-Marie-Tooth peroneal muscular atrophy. The talocalcaneal angle is increased, and the longitudinal arch is elevated. The metatarsophalangeal joints are extended, and the interphalangeal joints are flexed (hammertoe deformity).

## HALLUX VALGUS

Hallux valgus usually manifests during adulthood, but the deformity begins to develop and may occasionally present in childhood. Hallux valgus affects females 10 times as frequently as males. Patients present with pain and deformity that may interfere with proper shoe fitting. The upper normal limit of medial angulation of the proximal phalanx of the great toe to the first metatarsal is 14 to 16 degrees. Higher angles are considered hallux valgus (Fig. 174-34). With increasing angulation, the medial margin of the first metatarsal head may become more uncovered and protuberant.



**FIGURE 174-34** Hallux valgus in a 14-year-old girl. Slight sclerosis is present in the medial aspect of the first metatarsal head.

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