

THE YOUNG'S TENOSUSPENSION

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The Young's tenosuspension entails rerouting all or one-half of the tibialis anterior tendon through a slot fashioned in the navicular. The tendon is not detached from its insertion at the medial-plantar aspect of the medial cuneiform-first metatarsal base. Rather, it is slipped into the navicular keyhole slot by supinating the foot and stretching the tendon plantarly and posteriorly. The resulting position will create a new insertion for the tibialis anterior tendon into the dorsum of the navicular. The remainder of the tendon will function like a ligament to support the medial arch (Fig. 1).

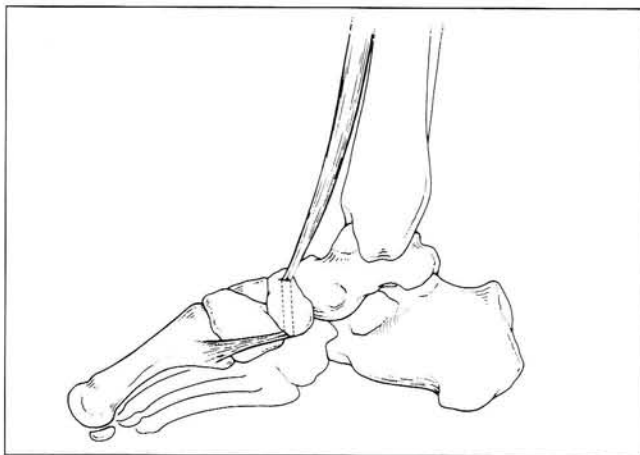


Figure 1. The Young's suspension reroutes the tibialis anterior through a keyhole slot in the navicular.

This will accomplish four functions: 1. The tibialis anterior will continue to be capable of inverting the foot around the longitudinal axis of the midtarsal joint (Fig. 2A). 2. The tibialis anterior will continue to function as one of the primary dorsiflexors of the foot at the ankle joint. (The extensor hallucis longus and the extensor digitorum longus are the other two primary dorsiflexors of the foot at the ankle joint)(Fig. 2B). 3. The distal portion of the tendon will become a strong ligament in the medial arch, running from the plantar aspect of the first metatarsal to the plantar aspect of the navicular (Fig. 2C). 4. Finally, the procedure removes the dorsiflexory force of the tibialis

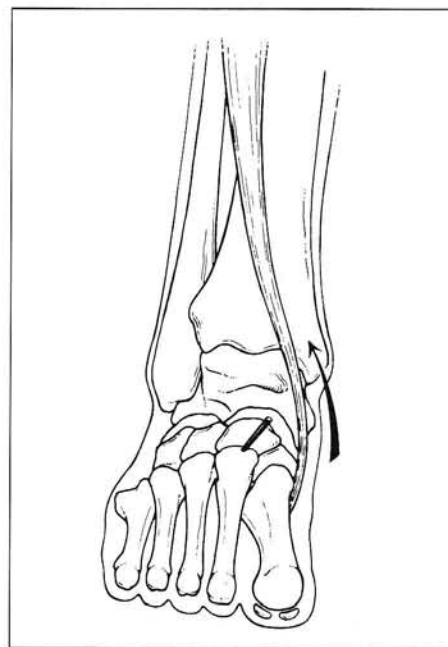


Figure 2A. The tibialis anterior has a supinatory (inverting) force around the longitudinal axis of the midtarsal joint.

anterior around the first ray axis (Fig. 2D). This allows a mechanical advantage to the plantar-flexory force of the peroneus longus (Fig. 2E). Most of the time, this loss of dorsiflexory power of the 1st ray during swing phase of gait does not lead to a cocked hallux, although this is theoretically possible.

In the early seventies, this procedure was used alone or in combination with a tendo-achilles lengthening for correction of flexible pes valgo planus foot deformities with good to satisfactory results. More commonly today, the Young's suspension is utilized with the Kidner tibialis posterior advancement as part of the medial arch reconstruction, with more effective results (Fig. 3). However, there are times when the Young's suspension is still utilized as an isolated procedure.

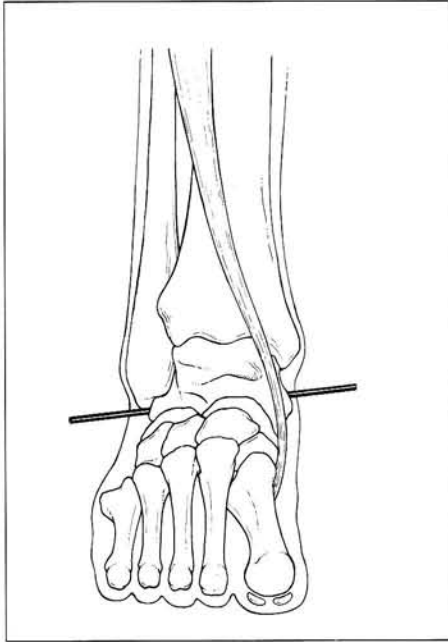


Figure 2B. The tibialis anterior has a dorsiflexory force across the ankle joint.

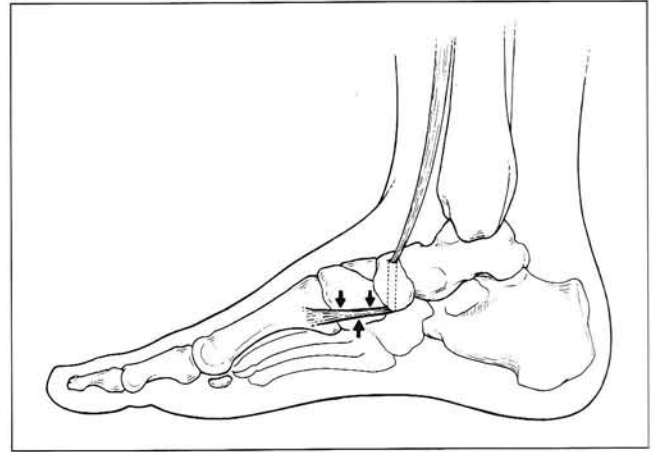


Figure 2C. The distal portion of the tibialis anterior tendon will become a ligament for the medial arch. The ligament extends from the base of the 1st metatarsal-1st cuneiform level to the navicular.

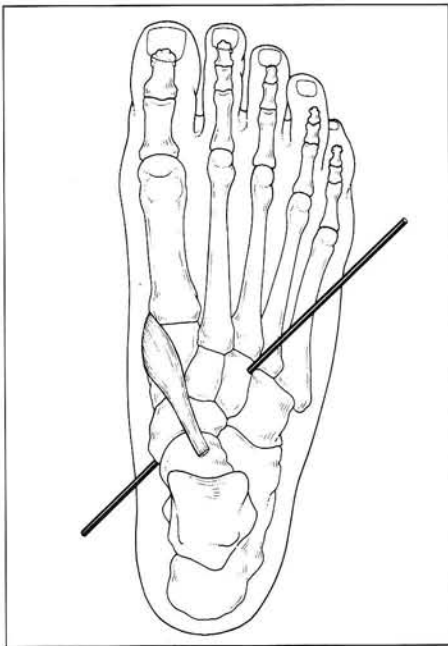


Figure 2D. The tibialis anterior has a dorsiflexory force around the 1st ray axis.

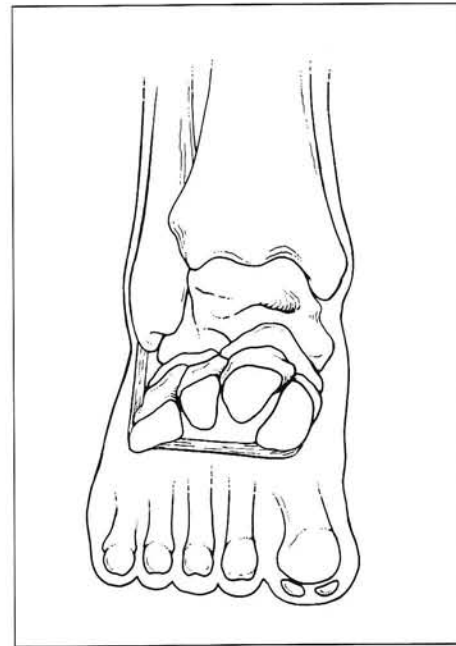


Figure 2E. The peroneus longus functions to plantarflex the 1st ray. It also resists dorsiflexion of the 1st ray.

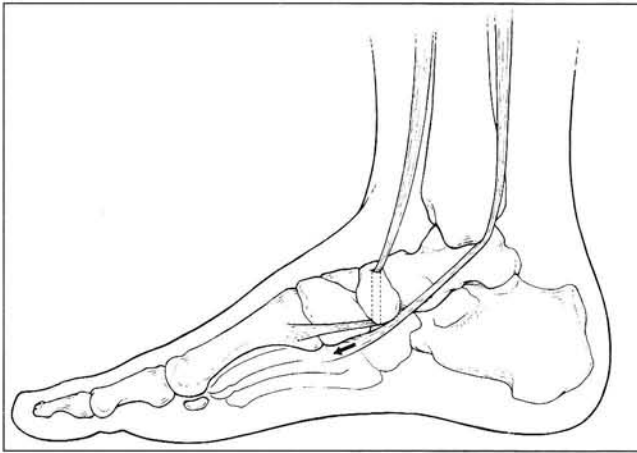


Figure 3. The medial arch reconstruction includes a combination of the Young's suspension and the medial advancement of the tibialis posterior (Kidner procedure).

CASE REPORT

J.J. is an 11-year old black male who had difficulty walking and frequently crawled. He had a dorsal prominence of his first metatarsal head and pain in the area. He was mentally abused by his father, and had a low self-esteem (Fig. 4A, 4B).

The patient's mother reported that her son had a history of a clubfoot as a young child. Early surgical correction was attempted, bilaterally. It is difficult to know what procedure was done to correct the clubfoot as an infant, as no records were available. There is a residual medial scar at the rearfoot and ankle area.

Examination revealed adequate range-of-motion of the subtalar, midtarsal, and ankle joints. There was limited eversion of the subtalar joint beyond perpendicular. The forefoot was inverted relative to the rearfoot in a neutral position, but flexible. There was a limited range of dorsiflexion at the first metatarsophalangeal joint, but 90 degrees of plantarflexion was available.

Although the peroneus longus appeared to be strong, the function of the foot resembled that which would be expected if the peroneus longus was weak. The patient walked with an interesting gait, with the foot in a supinated position contacting the ground with the lateral aspect of the foot, and with the hallux plantarflexed.

Radiographs demonstrated dorsal subluxation of the navicular on the talus. The foot was maximally pronated with occlusion of the sinus tarsi by the leading wall of the posterior facet of the talus (positive Kirby's sign). There was a low calcaneal

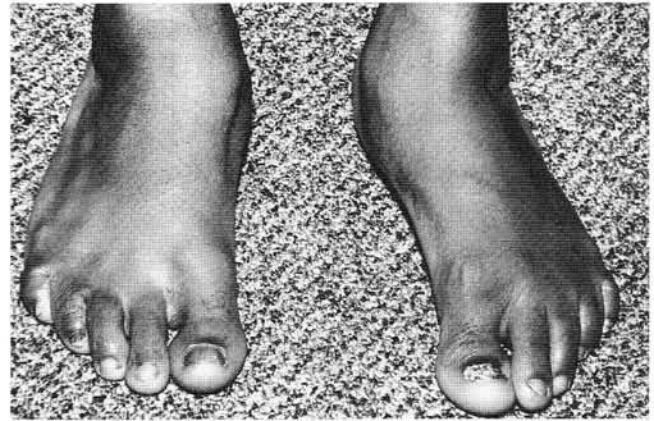


Figure 4A. Although the left foot is pronated, the forefoot is in a supinated attitude. The hallux is plantarflexed and the 1st ray is in elevatus. There is a dorsal prominence of the 1st metatarsal head.



Figure 4B. Lateral view.

inclination angle, with little superimposition of the lesser tarsals and the metatarsal bases on the lateral view. The hallux was plantarflexed with an obvious metatarsus primus elevatus (Fig. 5A).

A low talocalcaneal angle (Kite's angle) was noted on the dorsoplantar view. The cuboid abduction angle was increased. A normal metatarsus adductus angle with a low forefoot adductus angle also signified a pronated foot (Fig. 5B).



Figure 5A. The lateral x-ray:

- Dorsal subluxation of the navicular on the talus.
- Occlusion of the sinus tarsi by the leading wall of the talus (positive Kirby's sign) demonstrates pronation.
- A low calcaneal inclination angle is seen.
- Little superimposition of the lesser tarsus is noted.
- The hallux is plantarflexed.
- Metatarsus primus elevatus is obvious.



Figure 5B. The DP x-ray:

- A low talocalcaneal angle (Kite's angle) is present.
- The cuboid abduction angle is high.
- A low forefoot adductus angle in combination with a normal metatarsus adductus angle signifies a pronated foot.

The authors' initial impressions included hallux limitus, a significantly plantar-flexed hallux and metatarsus primus elevatus, and forefoot supinatus with a pronated foot. Conservative therapy and orthotics failed to reduce the symptoms and, therefore, surgical correction was considered. The specific surgical options included arthrodesis of the metatarsophalangeal joint, plantarflexory osteotomy of the first metatarsal, triple arthrodesis, and tendon transfers.

Although some limitation of eversion was present in the rearfoot, a Young's tenosuspension was recommended. There was a forefoot supinatus with metatarsus primus elevatus. The hallux was plantarflexed with limited range of motion of the first metatarsophalangeal joint. The tibialis anterior and peroneus longus tendons were both strong.

The Young's tenosuspension intends to decrease the force on the forefoot supinatus and the metatarsus primus elevatus. This will decrease the plantarflexory force on the hallux. The dorsiflexory force of the tibialis anterior at the ankle should be maintained, giving an advantage to the peroneus longus, and dynamically providing a force to reduce the supinatus and plantarflex the first ray. Gradually, this will allow increased range of dorsiflexion of the first metatarsophalangeal joint.

The Procedure

A dorsomedial curved incision is made from the base of the 1st metatarsal over the dorsal medial aspect of the medial cuneiform and navicular, and ends inferior to the medial malleolus (Fig. 6A). The

incision is carried deep in anatomic layers. The extensor retinaculum and deep fascia are incised, identifying the tibialis anterior tendon (Fig. 6B). A horizontal incision is made through the periosteum over the medial cuneiform and navicular bones. The periosteum is reflected plantarly to allow for routing of the tendon under these bones. A vertical "T" periosteal incision is made over the dorsomedial aspect of the navicular to provide exposure for a drill hole in the navicular. The hole is made from dorsal-proximal to plantar-distal (Fig. 6C). A slot is developed from the drill hole, medially and proximally (Fig. 6D). The plantar surface of the medial cuneiform and navicular is adequately exposed to allow for seating of the tibialis anterior tendon (Fig. 6E). Using two surgical drains or two moist umbilical tape sections, the tendon is pulled proximally and plantarly while the foot is held in full supination (Fig. 6F). A distal force applied to the proximal aspect of the tendon will facilitate seating of the tendon into the slot in the navicular (Fig. 6G). With the tendon locked in place, the periosteum is closed, reinforcing the tendon's new insertion into the dorsal navicular (Fig. 6H). The wound is then closed in anatomic layers, and the foot is dressed and casted in a mildly supinated position. A short-leg walking cast is kept in place for 4-6 weeks.

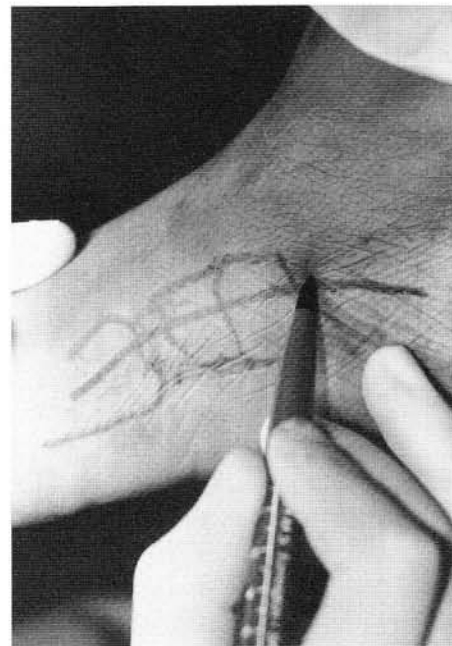


Figure 6A. The incision is made on the dorsal medial aspect of the foot, starting from the base of the 1st metatarsal and extending to a position inferior to the medial malleolus.

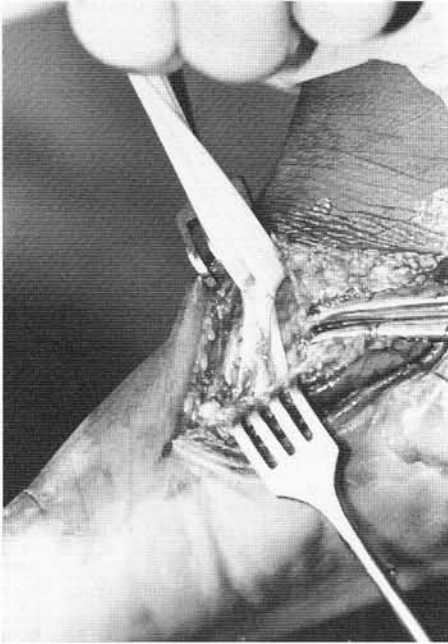


Figure 6B. The tibialis anterior is identified under the deep fascia and extensor retinaculum.



Figure 6C. A drill hole is made in the navicular from dorsal-proximal to plantar-distal.

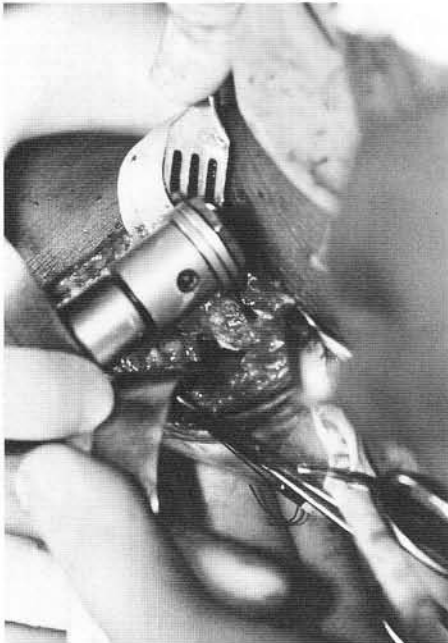


Figure 6D. A slot is directed from the drill hole medially and posteriorly in the navicular.

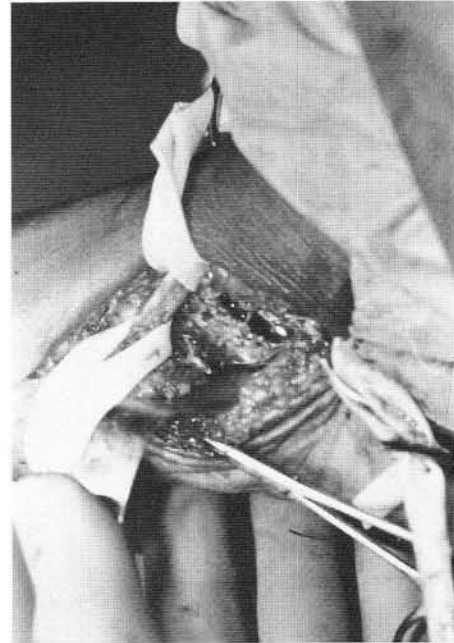


Figure 6E. Adequate periosteal reflection plantarly is necessary to allow the tibialis anterior tendon to seat under the cuneiform and the navicular.

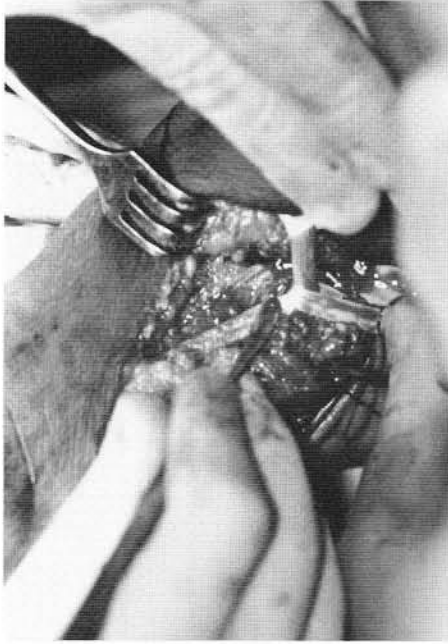


Figure 6F. The tibialis anterior is pulled posteriorly and inferiorly with the foot in supination, using two rubber drains.

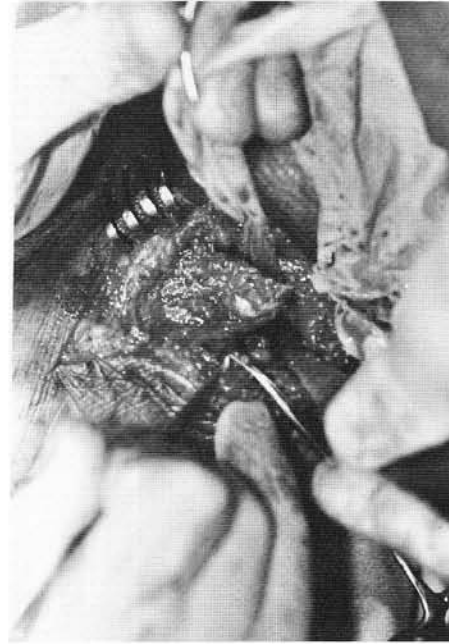


Figure 6G. Distal force applied to the proximal aspect of the tendon will snap the tendon into the slot of the navicular.

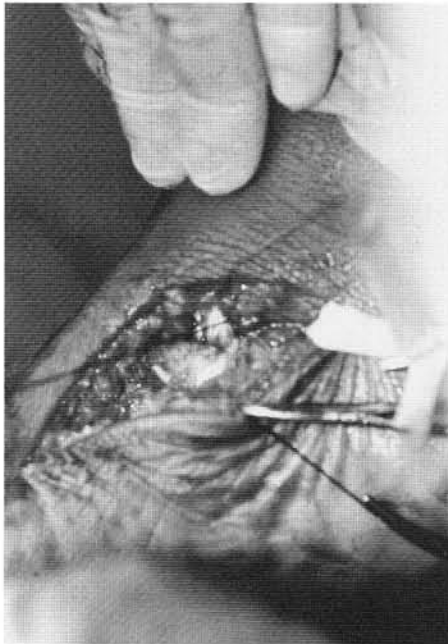


Figure 6H. With the tendon locked in place, the periosteum can be closed around it, reinforcing the tendon at the dorsal navicular area.

Although the Young's procedure is usually just a part of the medial arch reconstruction, in this patient, it was used as an isolated procedure. The Young's suspension tendon-balancing technique gives mechanical advantage to the peroneus longus tendon. This allows dynamic improvement of foot function to continue, even after the surgery has healed. Furthermore, it decreases the forefoot function of the tibialis anterior, while still allowing the normal ankle joint function of dorsiflexion. In this patient, the forefoot supinatus was reduced, there was an increased range of motion of the first metatarsophalangeal joint. The young man is now able to run and play, and is no longer crawling to get around (Figs. 7A, 7B).

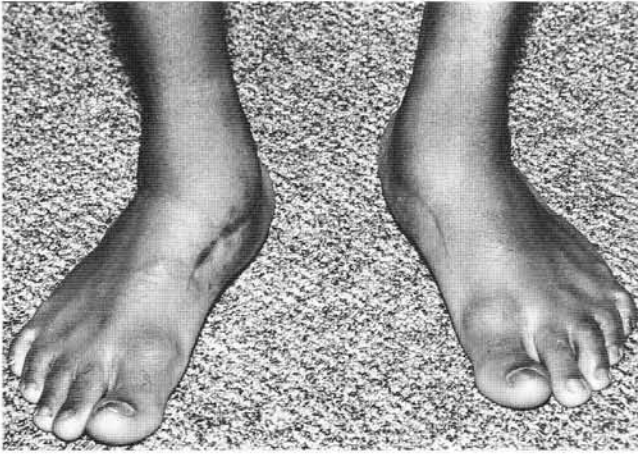


Figure 7A. Thirteen months postoperatively the forefoot supinatus has been reduced. The plantarflexed hallux and the metatarsus primus elevatus have been reduced. The foot is less pronated.

At 13 months postoperative, radiographs continued to demonstrate some subluxation of the navicular on the talus. There is no longer maximum pronation. Occlusion of the sinus tarsi by the leading wall of the posterior facet of the talus is no longer seen. The calcaneal inclination angle remains low, however superimposition of the lesser tarsus and the metatarsal bases on the lateral view is markedly increased from the preoperative films. The hallux is more parallel to the ground, and the metatarsus primus elevatus is markedly reduced (Fig. 8A).



Figure 8A. Lateral x-ray 13 months postoperatively:
 - The calcaneal inclination angle remains low.
 - Increased superimposition of the lesser tarsus and metatarsal base is noted.
 - The hallux is more parallel to the ground.
 - Metatarsus primus elevatus is significantly reduced.



Figure 7B. Thirteen months postoperative.

The talocalcaneal angle (Kite's angle) remains low on the dorsoplantar view. Although the cuboid abduction angle remains increased, the forefoot adductus angle has also increased. This also demonstrates less pronation postoperatively in the foot (Fig. 8B).

Although the criteria for utilization of the Young's suspension as an isolated procedure is very narrow, it can still be an effective procedure. The key to appropriate utilization is a thorough understanding of the biomechanics of foot function, and a specific appreciation of the function of the tibialis anterior tendon.



Figure 8B. Dorsal plantar x-ray 13 months postoperatively:
 - The talocalcaneal angle (Kite's angle) remains low.
 - The cuboid abduction angle remains increased.
 - The forefoot adductus angle is increased from preoperative values, demonstrating reduced pronation.