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The painful planovalgus foot-pressure studies and their implications

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The consequences of a severe progressive planovalgus deformity, specifically the role of hindfoot pathology in this condition causing alteration in the normal function of the forefoot, has not previously been described. The results of foot pressure studies in patients suffering from a progressive planovalgus foot is reported, demonstrating the breakdown of the normal compensation mechanisms. This causes an increase in pressure under the medial forefoot.

Thirty-three patients suffering from painful progressive planovalgus feet and 18 patients with rheumatoid arthritis and progressive flatfoot deformation have been studied. The age was 64 (40–82) years and 58 (38–79) years, respectively. The female to male ratio was approximately 7 to 1. Thirty-nine feet in the non-RA and 28 feet in the RA group were significantly affected. Foot pressures during the stance phase of gait were registered using a light glass plate contact method (Duckworth et al. 1983).

In both groups the progression to the center of pressure with time during the stance phase of gait was placed medially, and the rate of it longitudinally was also disturbed. In both groups the absolute pressures measured under the medial side of the foot (mean value 7.7 kg/cm²) as well as the first metatarsal peak pressures (8.2 kg/cm²) were high. Both of these figures were significantly raised compared with an age-matched group of normal subjects using an unpaired Student's *t*-test ($P < 0.001$).

This shows that abnormal pressures can be expected in the forefoot in progressive symptomatic flatfeet. This may be an important factor in the success or failure of conservative or operative treatment in this difficult group of patients. It seems likely that awareness of the breakdown of the normal compensation mechanisms for adjusting forefoot loads in these patients should improve the rational and success of treatment.

Reference

Duckworth T, Betts R. P, Frank C I, Burke J. The measurement of pressures under the foot. *Foot Ankle* 1983;3: 130–141.

Overuse injuries and other complaints from the lower extremities in children: Some aspects of the role of physical activity and foot structure

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In a retrospective study, 371 families answered questions about the complaints of the lower extremities and the physical activities of one of their children. The mean age of the children was 11 (7–16) years, and 61 percent were girls. The children were classified as passive (31 percent), as active (20 percent), or normal (49 percent). Of these children, 291 were examined clinically to establish possible correlations between the foot structure, physical activity, and disorders.

Of the children, 41 percent had had foot complaints, which sometimes disturbed physical activity, and 39 percent had had growing pains. The incidence of muscle tiredness of the lower extremity during physical activity was 15 percent, calcaneal pain 11 percent, undefined knee pain 11 percent, and pain in the tibial tubercle 7 percent. The active group had a slightly higher incidence of pain in the region of the tibial tubercle and the calcaneus. The symptoms of muscle tiredness were more common in the passive and active groups than in the normal group; the same applied to the incidence of Achilles pain. So-called growing pains had no correlation with physical activity or foot structure. Overpronation of the ankle joint correlated with flatfeet, with shin splint, and with symptoms of muscle tiredness lasting longer than 1 year. The passive dorsiflexion of the foot was less in children who had symptoms of muscle fatigue.

We conclude that certain complaints of the lower limbs in children have a correlation with the structure and mobility of the foot and ankle, and also with physical activity.

The kinematics of the talocalcaneal and talonavicular joints

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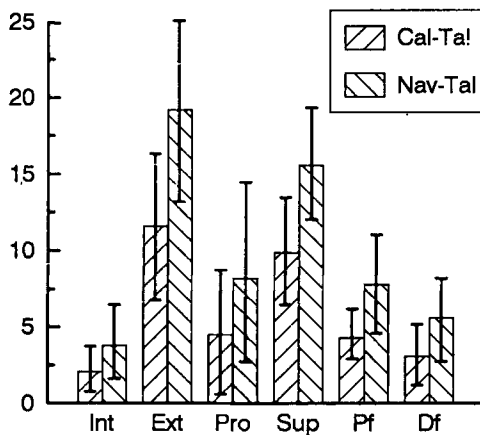
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To elucidate the kinematics of the subtalar joint complex, we performed roentgen stereophotogrammetric analysis of the talonavicular and talocalcaneal joints.

Patients and methods: Tantalum markers were introduced into the talus, the calcaneus, and the navicular in 8 healthy volunteers. Paired radiographs were taken in 10° increments of plantar flexion, dorsiflexion, pronation, and supination of the foot, as well as internal and external rotation of the leg. Joint helical axes and resulting rotations were calculated for each 10° increment, as well as for each arc (plantar flexion to neutral, neutral to dorsiflexion, etc.)

Results: Resulting rotations were larger in the talonavicular joint than the talocalcaneal joint in all input arcs (Figure 1). The joint axes for different input arcs were more parallel in the talocalcaneal joint. In the talonavicular joint, the joint axes observed in plantar flexion were more transverse than those seen in other input arcs.

Conclusions: The present investigation supports the view that the talonavicular joint is more mobile than the talocalcaneal joint, and that the orientation of its joint axis is more varying, indicating a ball-and-socket pattern of motion.



Some aspects of foot and ankle structure and mobility in children

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The structure and mobility of the foot and ankle (SMFA) in 308 school children (174 girls, mean age 10.5 years) were studied clinically and photographically. The following parameters were measured: (1) the size of the foot, (2) the pas-

sive mobility of the subtalar joint (STJ), (3) the Achilles tendon (β) angle, (4) the angle between the calcaneus and the ground (γ -angle), (5) the passive mobility of the talocrural joint (TCJ), (6) the footprint, and (7) the forward flexibility of the ankle joint (FFAJ) when bending the knees. The reproducibility of the tests was good.

The results of the combined values of the right and the left foot. The size of the variation was considerable: in 215–225-mm-long feet, the breadth of the distal foot varied from 74 to 95 mm and the height from 49 to 71 mm. The mean inversion and eversion of the STJ was $32^\circ \pm 6$ (13–55) $^\circ$ and $12^\circ \pm 5$ (0–30) $^\circ$, respectively. The mean dorsiflexion of the TCJ was $116^\circ \pm 7$ (94–142) $^\circ$ in a straight knee position and $130^\circ \pm 8$ (91–151) $^\circ$ with the knees bent 90 $^\circ$. The mean plantar flexion was $54^\circ \pm 7$ (23–74) $^\circ$. The mean β angle of the ankle was $187^\circ \pm 5$ (173–201) $^\circ$ and $192^\circ \pm 6$ (175–215) $^\circ$ when standing normally and with the knees maximally bent, respectively. Forty-five percent of the feet were evaluated as overpronating and 18 percent as underpronating. The mean FFAJ at the heel-off phase was $42^\circ \pm 8$ (16–63) $^\circ$. Flatfoot was found in 16 percent, lowered longitudinal arch in 24 percent, normal arch in 37 percent, and high arch in 23 percent of the feet.

We conclude that the SMFA varies greatly already in young children.

Radiologic pathology in the painful pronated hindfoot

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A study of the clinical and radiologic features of patients with painful valgus hindfeet was performed to demonstrate the pathologic lesions that gave rise to pain and deformity.

Patients and methods: Fifty-five adult patients (mean age 60 years) with 76 painful feet underwent clinical assessment, standard plain radiography, and computerized axial tomography. Note was taken of the site(s) of pain, the incidence of acute deformity, the degree of hindfoot valgus, and forefoot supination. The radiographs and scans were examined for degenerative changes in all hindfoot joints, soft tissue abnormalities, and fibulocalcaneal impingement.

Results: There were 22 patients with 33 rheumatoid affected feet and 33 patients (43 feet) with nonrheumatoid painful feet.

In the nonrheumatoid group, arthrosis was far less severe in the hindfoot than at the tarsometatarsal joints; unilateral tibialis posterior tendon ruptures were seen in 12 feet and impingement in 6 feet.

In the rheumatoid patients, bilateral disease was seen in half of the cases. Erosive joint disease was frequent, widely

spread, and severe. Additional symptoms arose from impingement and tibialis posterior tendon lesions in approximately half of the patients.

Conclusions: This study has demonstrated the variation in the sites, number, and extent of radiologic lesions in these feet. Appropriate management can be more easily selected on the basis of this more accurate diagnosis.

Shock absorption of the heel pad is correlated with the anatomic structure

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The human heel pad has a specialized anatomic structure developed to withstand the impact forces generated by the repetitive heel strikes in gait and running, i.e., of 1 to 3 times body weight. Deterioration of this structure has been related to overuse problems originating in the hindfoot.

Impact testing and the later dissection of six heel pads revealed a clear correlation between the anatomic structure and the shock-absorbing capacity. The heel pads with best shock absorption had a well-organized structure with a spindle-like fibrous framework, consisting of thicker septa, thicker internal heel cup, and thicker subcutis than the heel pads with lower shock absorberency.

Standardized anatomic dissection of 6 human heel pads revealed a not previously described ligament-like structure, which seems to be of importance for heel-pad shock absorberency—"the internal heel cup," which like a cup encircles the fat pad, with its characteristic system of well-defined fibrous septa, distended between "the internal heel cup" and the calcaneus to form fat chambers of different shapes. The 3-dimensional impression of the heel pad is comparable to that of a compressed onion.

Because the function of the heel pad depends on the anatomic structure, this should, by all means, be preserved

Comparisons of materials for insoles related to shock absorption during gait

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Individually made insoles are used to give better distribution of pressure to the skin and to make corrections of the foot dur-

ing standing and walking. They are made of foamy materials with different hardness and elasticity, and the results are better function of gait.

Shock absorption concerning the heel phase was analyzed in this study.

In 50 healthy volunteers the shock absorption of the heel phase was recorded on an AMTI force platform. The recording was performed without and with insoles of four different materials.

The insoles increased the shock absorption of different materials by 15–60 percent. PPI and Lunair Flex both had more than a 50 percent increase in shock absorption, whereas A-30 and Robabsop had only 25 percent and 15 percent, respectively.

Good adaptation of the insole around the heel increased the shock absorption by 15 percent. The best shock absorption was obtained at the speed of normal walking.

It is important to increase the shock absorption during sports by optimally distributing pressure to the entire heel surface, especially in cases with injuries to the fat tissue of the heel.

Often advertisements give information of high values of shock absorption, but measuring the insoles in vivo tests might show improvement of only 15–30 percent.

Postoperative evaluation of the outcome of different foot operations with the aid of the EMED gait analysis system

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We have used a computer-based gait analysis system for studies of the distribution of the load to the foot during walking.

A study was made 3–5 years postoperatively in 10 patients who had undergone arthrodesis of the first metatarsophalangeal joint, 10 patients treated with Keller's arthroplasty, and 10 patients with seropositive rheumatoid arthritis. Ten healthy subjects served as controls.

In the normal subjects the highest plantar pressures were distributed to the great toe, the head of the second metatarsal and the middle of the heel. Patients treated with arthrodesis had higher pressure over the medial part of the forefoot, whereas after Keller's arthroplasty the pressure was high laterally. Patients with rheumatoid arthritis formed a very heterogeneous group, and each individual patient had to be analyzed separately. It was common, however, that the metatarsal area was overloaded in these patients.

The method described gives useful information both for the planning of surgical and conservative treatment.

Gait function in patients after talocrural alloplasty

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During the period 1981–1988, a new endoprosthesis for the talocrural joint (Koføed) has been used at the Department of Orthopedics, Rigshospitalet, Copenhagen, Denmark. Gait analysis of these patients was done postoperatively.

Ten patients with unilateral arthrosis of the talocrural joints were analyzed 1–8 years after ankle replacement. The range of age was 27–81 years. The prosthesis of total type has a metal component for the trochlea tali and a plastic component for the tibia; both are fixed with bone cement. To prevent lateral movements, there is a sagittal crest on the talar component and a corresponding groove in the tibial one.

The gait analysis was performed on an AMTI force platform. The tests were carried out with the patients barefoot or in everyday shoes. Analysis included loads and vectors during gait for each leg separately.

The gait function was found to be satisfactory in all 10 patients, with close to normal gait, including the axes of movement in the ankle joint. Six of the patients showed a slight "rolling" gait due to a slight decrease of plantar flexion, which in turn was due to the restraining of rotation due to of the construction of the prosthesis.