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Effect of trauma and external support on shock absorbance in the human heel pad

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The heel pad is the most important shock absorber in the shoe/heel interaction at heel strike. The reduction of its shock-absorbing capacity has in some patients been associated with the development of overuse injuries.

In order to investigate the effect of trauma and external support on the heel-pad shock absorbance, drop tests were performed on 10 cadaver heel pads. Two of these were subsequently exposed to trauma and retested. Following this, rigid external support was provided to all the heel pads and the drop-test procedure repeated.

Trauma caused a significant decrease in the shock absorbance (24 percent). External support increased the shock absorbance significantly, with a higher fractional increase in the traumatized heel pads (49 percent) as compared with the nontraumatized heel pads (30 percent).

Our findings support the clinical observations that loss of heel-pad shock absorbance can be of significance for the body load at heel strike. External support is a possible way to increase the heel-pad shock absorbance.

Shock absorbance in shoes with and without heel support during walking and running

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The significance of shock absorption (SA) for the degree of body load in walking and running is commonly accepted. However, different shoe tests have been performed without attention to the condition of the heel pad, which is the most important shock absorber in the shoe-heel complex. The purpose of this study was to investigate whether the heel-pad status and/or the degree of heel support affects the SA during heel strike.

In the shoe drop test a soccer shoe had the lowest SA and a running shoe the highest. The impact forces in walking and simulated running at heel strike with these shoes (±the distal 2 cm of the heel counter) were measured on an AMTI(R) force platform in 12 subjects, 7 with normal heel pads and 5 with low SA.

The running shoe provided a significantly higher SA than the soccer shoe in both gait and simulated running. Heel support increased the SA in both shoes significantly. The subjects with low heel-pad shock absorbency had the highest fractional increase in shock absorbance with heel support.

The heel-pad SA and the degree of heel support should be considered when choosing, constructing, and testing shoes when an optimal shock absorbance is desired. This provides an additional possibility to optimize the SA in people at risk of developing, or with, overt overuse injuries.

Kinematic analysis of the foot in rheumatoid disease

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Destruction of the talocrural joint and the joints of the forefoot in rheumatoid arthritis is a well-known condition, whereas rheumatoid disease of the joints of the hindfoot/midfoot complex has only recently been met with increasing recognition.

In the present study, 2 patients fulfilling ARA criteria for definite rheumatoid arthritis and suffering from pain in the hindfoot/medial arch region have been examined using roentgen stereophotogrammetry. At least three 0.8-mm tantalum-marker beads were introduced into the tibia, fibula, talus, calcaneus, navicular, medial cuneiform, and first metatarsal bones of the most affected foot. The patients were examined standing on a platform that could be tilted about one anteroposterior axis and one transverse axis. Motion occurring between the neutral position and 10° increments of plantar flexion, dorsiflexion, pronation and supination tilt of the platform and internal and external rotation of the leg was recorded.

In the examined patients a marked decrease in pronation/supination and rotation of the talonavicular joint when compared with healthy subjects was noted. Pronation/supination of the naviculocuneiform joint was also reduced, whereas a compensatory increase in rotation about the vertical axis in the talocrural joint was recorded.

Foot-pressure recordings in the treatment of forefoot disorders

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Deviations in the distribution of load to the foot is closely associated with gait abnormalities. In order to study the distribution of load in disorders of the foot, a simplified method was developed.

Four pressure detectors (KISTLER, Switzerland) were placed at desired positions in a special insole. The load was recorded with the use of a normal EKG recorder. Two TV cameras and a video recorder were simultaneously recording the pressure of the walking patient. The results were compared with conventional gait analysis using Selspot recordings and a foot plate (The Enoch System, Sweden). Totally, 49 patients were examined with the simplified method and 10 patients were studied with both methods, both preoperatively and after surgery of the great toe.

Both methods demonstrated an increased load medially after osteotomy of the first metatarsal for hallux valgus. Partial proximal phalangectomy led to reduction of the load under the great toe, but the difference was not statistically significant compared with the preoperative finding.

We conclude that the method is useful for documentation and possibly also for preoperative planning.

Loads and shock absorption during walking and running

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The loads in the heel phase during walking and running were tested with a Philips' accelerometer, fixed to the medial malleolus. Investigations were also made with an AMTI force platform. Tests were made from 2.4–12.0 kilometers per hour (intervals 1.2 km per hour). Results were computerized.

Barefoot tests showed acceleration values from about 2 G to 8 G during walking and up to 24 G during running on hard surfaces. Under the same conditions the acceleration values were reduced through the skeleton by approximately 50 percent when measured on the top of the skull. When using different shoes, shock absorption values ranging from 30 to 65 percent were obtained. The best shoe (Lund Trim) has an EVA plate with a thickness of 1.5 cm in the sole construction. Measurements of the AMTI force platform showed differences in the loads in the heel phase when using different shoes. It is possible to eliminate nearly 100 percent of the shock waves in the heel phase.

Biomechanics of the child's foot

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During evolution the human foot has been shaped by two major events: the five rays of the prehensile foot have come together, and the inverted climbing foot has been changed to a plantigrade foot through a 90° pronation of the forefoot relative to the hindfoot. Through these rearrangements the foot has become a convex, elastic beam rather than an arch, which in mechanics is an unyielding structure. The beam has two functional modes, one with lesser elastic stiffness for shock absorption on the down beat and one with higher stiffness suited for propulsion. The change between the two modes is accomplished at each stand phase by a functional forefoot pronation in addition to the 90° structural pronation.

An incomplete structural pronation during development will lead to a flat foot with a consequent eversion of the subtalar joint when the foot is loaded and forced into its plantigrade position. The condition is corrected by a wedge under the head of the first metatarsal bone together with a slight elevation of the heel if correction is needed. Similarly, a forefoot pronation of more than

90° will lead to a cavus foot with inversion in the subtalar joint when the forefoot is loaded. This is corrected by a lateral wedge together with added padding under the metatarsal heads.

The foot consists of a postaxial or fibular set of bones comprising the calcaneus, the cuboid, the fourth and fifth rays, and a preaxial or tibial set comprising the talus, the navicular, the cuneiforms, and the first, second, and third rays. The two sets form a two-column sliding mechanism that is part of the elastic yielding of the foot. In the case of a coalitio calcaneonaviculare, a cartilaginous bridge spans the gap between the two columns and reduces their movements. The condition becomes painful at the age of 9–11 years when the apophyseal bridge ossifies. The fibular bones of the tarsus ossify during the first year, whereas the tibial ones forming the top of the beam ossify 2–3 years later, and the carrying part, the sustentaculum tarsi and the tuberosity of the navicular, as apophyses gain their bony structure at aged 8 or 9 years.

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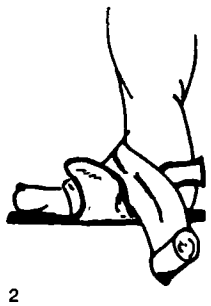

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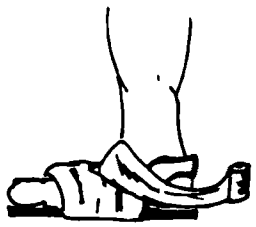

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Nonoperative treatment of pes metatarsovarus in infants

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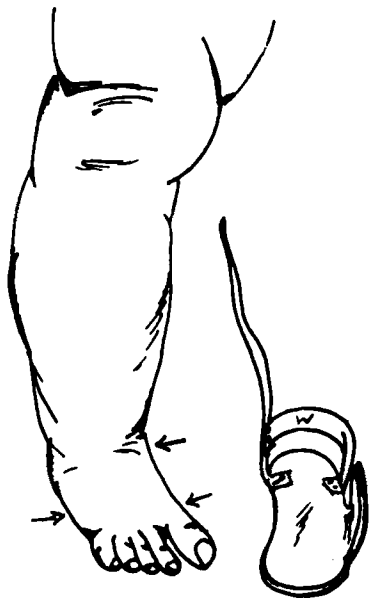
A presentation of the author's method of treatment of pes metatarsovarus.

The diagnosis is made at the maternity hospital. Treatment is started at the age of 1 week to 1 month. An AP radiograph is made and the diagnosis is explained to the mother. The mother is taught a redressing technique. The heel of the child's foot is kept stable with one hand while correcting stretching movements are made with the other hand. Putting on the brace using a special bandaging technique is then practiced (Figure). The mother is encouraged to do the redressing and to rebind the brace every time the diapers are changed. An initial examination is made 10 days later. Depending on how well the treatment is managed by the mother and on the severity of the malformation, a second examination is made 4–6 weeks later. In most cases, the varus angulation at that visit is corrected and treatment can be concluded.

All the cases, regardless of severity, have been treated. Out of the approximately 200 cases treated by me, no recurrences have been observed.



The pathomechanism of congenital foot deformities

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A special group of congenital foot deformities are characterized by an abnormal position of the foot. The mechanism by which these deformities may occur was analyzed based on clinical experience, pathologic findings, and experiments in stillborn infants.

Per equinovarus is a deformity in the direction of supination; however, the position corresponds to supination with subluxation in the hindfoot and midfoot. Changes in the bones and soft tissue may be secondary alterations.

Metatarsus varus is a deformity presumably arising with the hindfoot in a position of dorsiflexion followed by supination of the forefoot and subluxation in the same direction. This is supported by findings of changes in the bones and soft tissues.

Vertical talus is a deformity in the direction of pronation with subluxation in the midfoot and secondary changes of bones and soft tissues.

Pes calcaneovalgus differs from the others, for it is the only deformity without changes of the bone.

Equinovarus, metatarsus varus, and vertical talus belong to a group of congenital deformities with subluxations of unknown origin followed by secondary alterations of the bones and soft-tissue contractures. This contention is consistent with the response to treatment.

Nail matricectomy by phenol treatment

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See Abstract in "Proceedings of the Swedish Orthopedic Society," Helsingborg, June 1–2,1987, in this issue, p. 87.

Surgical treatment of chronic Achilles peritendinitis or partial rupture

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People active in sports and exercise often suffer from chronic overuse injuries of the Achilles tendon and/or paratenon. Despite conservative treatment including corrections of biomechanical faults, quite a few will be candidates for surgery. Surgery involves opening possibly closed compartments and improving blood circulation in paratenon, initiating a normal scarification.

In toto, 35 patients with chronic Achilles tendon disorder causing inability to exercise underwent surgical exploration of the Achilles tendinous region. The average age was 35 (19–62) years. Mean duration of symptoms was 3 years (4 months to 10 years). Running was the dominating sport. At surgery, 18 tendons with partial rupture had an excision of the tear and a side-to-side suture. There was an achillobursitis in 8 cases treated by a large resection of the upper dorsal corner of the calcaneus and extirpation of the bursa. Chronic peritendinitis was found in 15 cases and a tenolysis and fasciotomy were performed. Plaster was used for 4–6 weeks for the rupture cases, while the remaining patients were encouraged to undertake early movements. All were subjected to a physical rehabilitation program. Follow-up averaged 30 (12–67) months.

The results were excellent in 28/40 operated on tendons, with no pain during exercise. Among 8/40 tendons, transitory symptoms were reported in connection with activity and four tendons were still painful, causing restricted activity. In 24 cases, time for recovery was more than 6 months. Fifteen tendons were preoperatively examined with echography and signs of partial rupture were recorded in 12 cases – all with tears at surgery. In three tendons, no changes were discovered at echography, but partial ruptures at surgery were evident in two tendons. There were no major complications.

The results of this study indicate that surgery should be considered in chronic Achilles tendon injuries when conservative treatment fails.

Wound-healing disturbances after resection of metatarsal heads in rheumatoid arthritis

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Resection of the metatarsal heads I–V is used in rheumatoid arthritis as a treatment for forefoot arthritis causing pain and walking problems. Gschwend (1977) and Tillman (1979) reported more disturbances in wound healing after plantar than dorsal incisions. A plantar approach is nevertheless recommended because of better technical results.

During 1984–1987, 20 complete resections of metatarsal heads I–V were performed. All the patients had rheumatoid arthritis. Patients with vasculitis were not operated on. Local preparation of the operation field

was done with Hibitane washing and alcohol-soaked dressing the day and night before surgery. Metatarsal-head resection was done through a plantar incision including excision of the callosities. A separate incision was made for the first metatarsal head. The operation was performed with a tourniquet. The feet were bandaged for 14 days, using the techniques employed in hand surgery.

Of 20 operated on feet, seven had disturbed wound healing. Wound rupture with secondary infection occurred in three. Weight-bearing problems often remained for a long period in these cases. The feet with disturbed wound healing had in most cases considerable hyperkeratosis and callosities or cutaneous disease, such as psoriasis. Three had a severely contracted forefoot.

Resection of the metatarsal heads in rheumatoid arthritis is a beneficial procedure with good long-term results, but with considerable wound-healing problems. A longer time of preoperative preparation of the skin is recommended to diminish hyperkeratosis and inflammatory skin changes. Preoperative antibiotic prophylaxis might be beneficial, as well as delayed weight bearing after surgery.

The Arnoldi total alloplasty of the great toe

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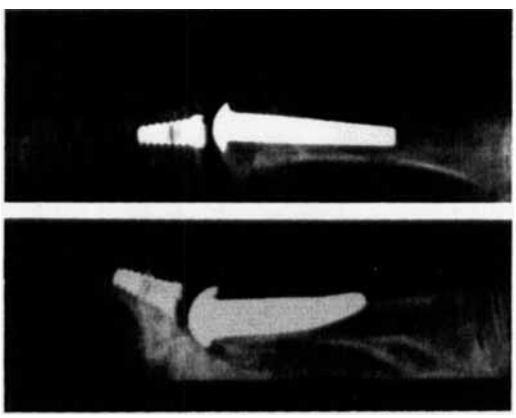
A noncemented titanium device for implantation in the first metatarsal bone and a titanium screw with a polyethylene top for implantation in the proximal phalanx of the great toe (Figure 1) were used in 12 patients, 5 with painful hallux rigidus and 7 with previous nonsatisfactory Keller procedures.



Initial complications were three dislocations in the Keller group, subsequently leading to extraction of the prosthesis in 2 cases.

At follow-up, 3–23 months postoperatively, of the remaining 10 prostheses, 2 patients had moderate pain on weight bearing. There were no radiographic signs of loosening in any of the cases.

With the present design, carefully balancing of the soft-tissue structures seems mandatory in order to obtain satisfying results.

Surgical treatment of forefoot deformities

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A prospective study of a consecutive series of patients who underwent surgical treatment for forefoot disorders was carried out.

In all, 582 operations were performed on 523 patients. In the majority, the diagnosis was hallux valgus, hallux rigidus, or metatarsalgia. Pain, function, and deformity were analyzed.

Ninety percent of the patients were women. The patients with metatarsalgia had more severe pain than any other group. The hallux valgus deformity was not correlated with the first intermetatarsal angle, but was correlated with deformities of the adjacent toes. The hallux valgus group was divided into six subgroups according to clinical and radiographic criteria, and the results of treatment were studied for each. Most of the patients were treated with metatarsal osteotomy, but resection of the first phalanx according to Keller or arthrodesis was also used.

The operation reduced problems with finding suitable shoes, but pain was also diminished, particularly in the least deformed cases. Ninety-seven percent of the patients with hallux valgus, 84 percent of those with hallux rigidus, and 96 percent of those with metatarsalgia were satisfied with the treatment.

Autoamputation – the salvage of the foot

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See Abstract No. 27 in "Proceedings of the Swedish Orthopedic Society," Helsingborg, June 1–2,1987, in this issue.

The mechanoreceptors of the sole of the foot and their clinical significance

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The mechanoreceptors of the sole of the foot furnish the central nervous system with information concerning pressure from, and structure of, the ground. Obviously, they thereby subserve an exteroceptive function. The question is whether they also have a proprioceptive function, i.e., if they are involved in the reflex-mediated activation of the postural muscles in walking and standing.

In a study of gait after immobilization of one leg by means of a plaster, we have shown that there can be a gait disturbance of long duration, which cannot be explained by pain, restricted joint movement, or weakness. This gait disturbance may have two components – a spastic component accompanied by enhanced tendon reflexes, and an atactic component, which is mainly characterized by the fact that the patient lifts the foot too much during the walking cycle, thus "treading on air." We found that the latter component correlated with a *lowered* threshold for perception of vibration in the skin of the sole of the foot.

When compared with data from animal experiments, the most likely explanation for the lowered vibration threshold after immobilization is enhanced synaptic function in the spinal cord.

In 2 healthy subjects the sole of one foot was anesthetized by infiltration of a local anesthetic around the distal part of the tibial nerve. This procedure resulted in a discrete atactic gait disturbance and moderately disturbed balance when the subject tried to stand on one leg. The ability to jump on one leg was severely disturbed.

Our conclusion is that impulses from the mechanoreceptors of the sole of the foot are involved in the central programming of the next step, i.e., these mechanoreceptors also subserve a proprioceptive function.

Working together for better foot care – a model developed by the Stockholm County Council

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There are approximately 30,000 diabetics in Stockholm County. Foot problems are a complication of diabetes, which make very high demands on resources. Foot sores and amputations alone accounted for 46,000 days of inpatient care in 1985, or a cost of approximately 80 million Swedish kronor. International studies have shown that the number of amputations can be halved if proper instruction, preventive foot care, and various kinds of medical treatment are provided. For all the patients to benefit fully from contemporary knowledge, all the links in the care chain must be strong.

With the help of questionnaires and foot examinations, a study was carried out in a sample of the diabetic population at primary health care centers. The state of the patients' feet was also documented photographically.

Two thirds of the patients had some form of foot problem, and one third needed specialized care by orthopedic surgeons or orthopedic technicians.

Foot problems are common among diabetics receiving primary health care. Existing procedures and forms of treatment are rarely organized in a coordinated way, and there are shortcomings in the development of, for example, foot beds. LUCD has therefore started a program of education, aimed at medical staff and chiropodists. Referral practices are being reorganized in such a way that the authority to prescribe foot beds is transferred to the primary-care sector. In addition, standardized procedures such as foot case records and group sessions with doctors, nurses, orthopedists, orthopedic technicians, and patients are being assessed. Patient teaching material and new referral systems have also been developed. This is aimed at achieving coordinated care for the diabetic with foot problems.