

# British Orthopaedic Foot Surgical Society

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## CONSERVATIVE MANAGEMENT OF PLANTAR FASCIITIS

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The aetiology and treatment of plantar fasciitis, the most common cause of inferior heel pain, are poorly understood. Our philosophy is that the condition is self-limiting and that only conservative measures should be used to either hasten recovery or allow enough time for the natural history to run its course. Our management plan consists of eliminating risk factors, advice on footwear, oral NSAID's, Achilles tendon exercises, orthoses, occasional night splints and very occasional steroid injections.

138 patients with 176 painful heels who have undergone the treatment regime outlined above have been reviewed. All but 4 patients with 5 painful heels were better by 12 months.

We believe that plantar fasciitis is a self-limiting condition and surgery should only be considered in those who have not improved after 12 months of appropriate treatment.

## REPLACEMENT ARTHROPLASTY OF THE FIRST METATARSOPHALANGEAL JOINT FOR HALLUX RIGIDUS

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We reviewed forty-six consecutive patients who had undergone silicone hinged joint replacement of the first metatarsophalangeal joint for hallux rigidus. (Dow Corning). Follow up was for a minimum of thirty-six months and an average of eight-six months (range thirty-six to one hundred and sixty-eight months). Both subjective and objective outcome measures were studied. Subjective measures showed seventy-two per cent of patients were completely satisfied, twenty-one were OK, whilst six and one half per cent were dissatisfied with the outcome of surgery. Pain, the most common pre-operative symptom was absent in eighty-two per cent of patients post operatively. Objective measures show the average range of motion of the first metatarsophalangeal joint post operatively was forty-nine degrees (average dorsiflexion injury thirty-three degrees, average plantar flexion sixteen degrees). Mechanical failure of the implant was determined radiologically, thirty-nine per cent of prosthesis loosened whilst six and one half per cent fractured. We found no association between subjective outcome and radiological evidence of mechanical failure.

The post operative complication rate was thirty-two per cent, with half of these patients having superficial wound infections. The revision rate with removal of the prosthesis was six and one half per cent - performed for persistent pain. We believed because of its success in relieving pre-operative symptoms, despite its high rate of mechanical failure demonstrated radiologically, the hinged silicone Implant Arthroplasty should continue to be used in patients with hallux rigidus.

## ISOLATED TIBIALIS ANTERIOR INSUFFICIENCY

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Isolated Tibialis Anterior Insufficiency is a rare condition. The clinical features of this condition are inaccurately or incompletely described in standard texts on foot surgery. We present video and photographic evidence of the physical signs present in two cases of isolated unilateral closed rupture of the tibialis anterior tendon.

On static examination the foot has a normal posture, both weight-bearing and non weight-bearing. On dorsiflexion there is pronation of the foot and also recruitment of EHL, causing a cocked up great toe. The range of dorsiflexion is normal if EHL recruitment occurs, but if the great toe is actively flexed, and EHL recruitment prevented, then the range of dorsiflexion is reduced. There is also EHL recruitment on heel standing. The most obvious observation on dynamic examination is the absence of foot drop.

Dynamic examination during the swing phase of gait shows EHL recruitment, and pronation of the whole foot. At the end of the swing phase test prior to heel strike, EHL recruitment is maximal, and there is maximal elevation of the medial arch of the foot. There is also a slight but audible foot tap. When observed from behind the pronation of the foot is obvious during the swing phase, and yet at heel strike the heel has returned to neutral, and the metatarsal heads load either concurrently (in one foot), or initially on the 5th metatarsal (in the other foot). This change from pronation to neutral, or mild supination, is achieved by a trick movement at the end of swing phase. This trick movement consists of internal rotation of the tibia, and foot, with maximal extension of the hallux, and elevation of the medial arch. The trick movement achieves neutral alignment of the heel and foot prior to heel strike.

## PLANTAR PRESSURES AND OUTCOME FOLLOWING NON-OPERATIVELY MANAGED CALCANEAL FRACTURES

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The aim of this study was to assess if there was a relationship between the functional outcome and plantar pressure profiles of patients with non-operatively managed calcaneal fractures.

The case notes, plain x-rays and computerised tomography scans of fifteen patients, with non-operatively managed intra-articular calcaneal fractures were assessed. Bohlers angle and the angle of Gissane were measured and the fractures classified using Essex-Lopresti's system from initial plain radiographs. CT scans were classified using Sanders, Atkins, Zwipp and Tscherne and Crosby and Fitzgibbons' methods. The functional outcome was assessed using the Bristol calcaneal fracture scoring system which measures pain, walking ability, use of walking aids and return to previous employment. Plantar pressure profiles of both feet were recorded using the Musgrave Foot-print® system.

There were 11 men and 4 women. The average age was

53.9 years (20-83). Patients were assessed an average of 38 months (range 23-58) post injury. The majority of fractures were the result of a fall from a height. Three patients had other associated orthopaedic injuries.

The majority were Essex-Lopresti joint depression type fractures. CT scans showed that most were Sanders two part, Atkins type 2, Crosby/Fitzgibbons type 2 and Zwipp/Tscherne four or five part fractures.

The median outcome score was 81 (range 10-100, maximum 100).

The duration of heel contact, foot flat, toe off and total contact time were calculated and the centre of load lines assessed from the averaged footprints of each patient. There was no difference in any of these measurements between the fractured and unfractured foot of each patient.

There was no relationship between any of the pressure profile measurements, the radiological classification of the fractures and the functional outcome scores of the patients.

**Conclusions:** The current classification systems for calcaneal fractures are mainly concerned with the subtalar joint and do not take into account the degree of displacement of the fracture fragments. There is no relationship between the plantar pressure profiles, radiological classification and functional outcome of patients following non-operatively treated calcaneal fractures.

## RUPTURE OF THE TENDON OF TIBIALIS POSTERIOR AND FOREFOOT DEFORMITY ? ANY ASSOCIATION

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Members of the Foot Surgery Society were asked for details of patients they had seen with rupture of the tendon of tibialis posterior in order to assess the proportion of patients who had co-existing deformity of the forefoot. At a previous meeting of the Society it had been suggested that toe deformities causing impairment of the windlass mechanism of the plantar fascia might put increased strain on tibialis posterior.

Eighty-one cases were reported. In many the clinical details as regards the condition of the forefoot were inadequate, but in 31 feet, forefoot deformity was described (24 severe hallux valgus, 5 hallux rigidus, 1 had a previous Keller's operation, and 1 had claw toes.) Only 4 feet were said to have no deformity.

The following surgical procedures were done in 40 patients but results not available: Cobb repair, with or without calcaneal osteotomy: 5  
FDL transfer with osteotomy or capsulorrhaphy of TN joint: 27

Reattachment of tendon: 1  
Composite procedure involving calcaneo-cuboid joint fusion and FDL transfer: 7

Members of the Society commented that they seemed to be seeing increasing numbers of patients with rupture of tibialis posterior.

In many cases the condition of the forefoot had not been recorded. Even so 38% definitely had significant forefoot

deformity and the true incidence is almost certainly higher.

**Conclusion:** There is probably an association between the development of a rupture of the tendon of tibialis posterior and the presence of forefoot deformity. Further observations are required.

#### THE POSSIBLE INCIDENCE OF FOREFOOT DEFORMITY IN FEET WITH RUPTURE OF TENDON OF TIBIALIS POSTERIOR

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When there is hallux valgus the function of the windlass mechanism of the big toe is defective, greater strain is then placed on the plantar fascial processes to the lesser toes when late heel elevation occurs. The oblique metatarsal axis of the foot is used requiring increased activity of tibialis posterior. The possibility therefore arises as to whether this increased strain could contribute to the rupture of the tendon.

Members of the Foot Society were asked to review their cases of tibialis posterior rupture and record the incidence of forefoot deformity.

Some information has been received on 80 cases of tibialis posterior rupture. Forefoot deformity had been recorded as follows:

- Hallux rigidus: 5
- Hallux valgus: 3
- Hallux valgus with lesser toe deformity: 20
- Claw toes: 1
- Previous Keller's procedure: 1

Twelve patients gave a history of minor injury.

Thirty-nine patients were operated on. The type of operation is recorded but results are not available.

Rupture of the tendon of tibialis posterior is being increasingly recognised as a cause of acquired painful "flat foot". In this small series with little clinical information about many cases there is a recorded incidence of forefoot deformity in 37/12%. There may have been more as the condition of the forefoot was not recorded in many cases. It is possible that deficiency of the windlass mechanism of the big toe may be a contributory cause of rupture of the tendon of tibialis posterior but further investigation may be worthwhile.

#### CO-REGISTRATION ISOTOPE X-RAY IMAGING IN THE FOOT: A NEW TECHNIQUE

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This paper reports a new technique for more accurate anatomical localisation of inflammatory lesions with increased isotope uptake in the foot. The isotope bone scans are useful investigations in detecting the presence of bone, joint and soft tissue lesions of arthritic, traumatic, tumours or infective origins in the foot. They are not, however, so accurate in localising the exact site of the lesion. This new technique overcomes the problem by taking the X-rays and gamma scans on the same reference grid, giving the same magnification and positioning. By overlaying the isotope scan on the X-ray, accurate anatomical localisation of the increased isotope uptake is obtained. This is further enhanced by computerised colour contouring of the different densities of the isotope gamma emission.

The technique, application and accuracy in a series of difficult foot lesions are presented using this new "Co-Registration I-X Imaging" method. It is considered to be an advance in providing more accurate investigation of latent foot lesions.

#### BONE ANTIBIOTIC CONCENTRATION IN FOOT SURGERY

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**Aim:** To demonstrate that there is an effective antibiotic bone concentration, if prophylaxis is used, during foot surgery.

**Background:** Previous investigation in this department has

shown an apparent reduced antibiotic concentration in samples of bone taken during knee surgery compared with hip surgery, in the order of 25 - 47%. If this gradient continued to the foot, antibiotic prophylaxis may be ineffective.

**Materials and Method:** This was a prospective study of 30 patients (31 feet) who underwent 1st metatarsal surgery. 1 or 2 grams of Cephadrine were given intravenously prior to surgery. The weight of the patient, timing of injection, inflation of tourniquet and bone sampling were noted. The procedures were; insertion of silicone implant (16), Keller type excision arthroplasty (7), osteotomy (6) and arthrodesis (2). A sample of cancellous bone was sent for analysis from the 1st metatarsal and the proximal phalanx. Antibiotic concentration was calculated from assays and a plate diffusion technique using *Micrococcus lutea* NCTC 8340.

**Results:** 9 male and 21 female patients age 32-86 years (mean 61 years) generated 45 bone samples. Analysis showed a mean concentration of Cephadrine to be 7.08 ug/gram of bone (SD 3.52 ug/gram) range 1.82 - 14.82 ug/gram.

**Conclusion:** This study showed antibiotic bone concentrations to be similar to those previously noted in the knee, thus disproving the theory of an antibiotic concentration gradient in the lower limb. However, 2 samples measured below the minimum effective concentration of 2 ug/gram. It was noted that both these patients received 1 gram of Cephadrine, suggesting that 2 grams may avoid ineffective administration of prophylactic antibiotics.

#### ILIZAROV TREATMENT OF FOOT AND ANKLE DEFORMITIES

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We report the results of treatment of 18 foot deformities in 17 patients aged between 5 and 48 years. Most patients had had multiple previous operations. 10 patients had resistant or recurrent CTEV, the remainder had primary neuromuscular problems (3), fibular hemimelia (2), post traumatic deformity (1) and rheumatoid subtalar dislocation (1).

The commonest complication was pin site infection, which necessitated pin removal on 2 occasions.

16 corrections were initially judged successful although 3 deformities partially recurred within 6 months. There was one late recurrence at 3 years. 2 failures were recognised. In one, an incomplete correction was accepted because of thrombosis, the second, an arthrogryptic with multiple previous operations, required amputation.

These patients comprise a group of difficult cases where orthodox treatment short of amputation had already failed. The Ilizarov apparatus can reduce almost any deformity and concurrently lengthen the limb if necessary. Neuromuscular imbalance must be eliminated in order to prevent recurrence.

#### A BIOMECHANICAL AND CLINICAL STUDY OF A NEW ANKLE PROSTHESIS

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Ankle joint replacements in the past have been designed to restore the function of the ankle joint alone. However, even those joint replacements which were mechanically successful continued, in many cases, to give pain which could be identified as arising from the subtalar joint which frequently is also affected in rheumatoid disorders. Similar problems are encountered in isolated arthrodesis (fusion) of the ankle joint alone. Consequently, a new design of ankle prosthesis has been developed. It replaces the functional movements at the ankle and provides a stabilising stem for the stabilisation/fusion of the subtalar joint in a single device initially indicated for patients with rheumatoid arthritis. Mechanical testing of this device confirmed the very low wear in a spherical design as well as providing stability and resistance to subluxation which was present in the more open designs with larger spherically or cylindrical tibio-talar articulation. The final design incorporates a spherical concave polyethylene component of 25 mm diameter with antero-posterior machined grooves on the lateral surfaces to resist vertical forces through the cement within the distal tibia. The talo-calcaneal component is machined

from cast cobalt-chrome material with a convex spherical head to match the tibial component to a depth of 6 mm within the polyethylene. The stabilising talar keel is 40 mm deep, 4 mm thick and the width extends to the full diameter of the head of 25 mm. The surface of the head is polished and the keel roughened by mechanical sand blasting. The surgical exposure utilises a modified posterior-lateral approach as described by Hayes and Nadkarni (*J Bone Jt Surg*, 78B,468,1996). The instrumentation to help the surgeon implant the device correctly comprises a plate that is held against the plantar surface and a variable height cutting surface parallel to the plantar surface allows a correct plantigrade cut of the talus to be made. A tensor type distractor forces the distal end of the tibia from the flat cut talar surface with the foot angulated under tension so that the talar surface is at right angles to a line passing through the centre of the knee as viewed from behind. The horizontal and two vertical faces of the tibial slot for the prosthesis are not cut. The vertical slot that traverses the subtalar joint is made with a slot cutting guide that is pushed into the space prepared for the prosthesis head and tibial component. At this stage that the fusion of the subtalar joint can be performed. The cut tibial and the horizontal surfaces of the talus are cemented and the bone harvested from the tibia and talus may be used to augment the vertical surfaces of the talar keel of the prosthesis across the subtalar joint for stability and enhance fusion. An assessment form of this procedure has been designed and used on the preliminary clinical trial of this device which incorporates clinical and subjective data producing a maximum score of 100. The first three patients produced a preoperative score of 40-45/100.

#### A STRESS ANALYSIS OF THE TALUS AND CLINICAL IMPLICATIONS

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A wire frame model has been constructed from a cadaveric casting of an adult talus and used to study the stresses within the bone under certain clinical conditions. Under the maximum forces encountered during gait acting on the proximal surface of the talus and reacted through the subtalar joints, high stresses could be seen around the lateral aspect of the neck of the talus, a common site of compression fractures. The computer model can also demonstrate the effect of surgery on the position and dissipation of the stresses through the talus.

As an example of the flexibility of the simulation, the head of the talus was "excised" in the computer and a prosthetic implant placed on the cut surface. Firstly, an UHMWPE prosthesis was fitted, and it could be seen that this resulted in a large increase in the stress levels within the talus, also moving their position to the medial aspect of the articulating surface. This is clearly undesirable, and so a Co-Cr-Mo alloy prosthesis was then simulated, and it was noted that this had the effect of reducing the stress levels back to their original values and positions. This indicates that this material would have benefits as a prosthesis from a structural point of view.

This study has shown that we are able to develop accurate 3D models of the talus. These can be used to simulate different loadings and conditions imposed upon the talus. Different prosthesis designs and materials can also be simulated, and it is envisaged that future work will include investigations into arthrodesis procedures and the effects that they have upon the talus.

#### LONG TERM FOLLOW UP OF ARTHRODESIS: CLINICAL, RADIOLOGICAL AND GAIT ANALYSIS

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Although ankle arthroplasty is gaining wider acceptance in Rheumatoid Arthritis, ankle arthrodesis remains the main-

stay of surgical treatment of disabling ankle arthritis. We present the results of a review of the clinical, radiological and kinetic effects of ankle arthrodesis.

Eighteen patients were followed up 17 to 129 months following ankle arthrodesis (mean 53 months). They were aged 21 to 73 years at time of follow-up (mean 52 years). Five had ankle arthrodesis for RA, three for primary OA, and ten following trauma. Fifteen were pleased with the result of their surgery. Thirteen had moderate to severe pain, nine had daily pain, eleven were taking regular analgesics. Six were still partaking in sport, ten were working (of a possible fourteen) and all of the rest were mobile out of the house. Four had clinical unstable ipsilateral knees and used a stick, three others used a stick. X-rays showed two patients to have persistent non-union. The position of the fusions varied from 3° valgus to 20° varus, 8° dorsiflexion to 20° plantar flexion, and 10 mm posterior translation to 12 mm anterior translation. There was no correlation between position of fusion and patient satisfaction, pain, or activity. Mazur's ankle scores were 5-84 (mean 55, median 67). Qualitative scoring of gait was 3-8/10 (mean 6). Stance/swing times and step lengths were all symmetrical. Walking speed varied between 0.13 and 1.3 m/s (mean 0.87 m/s). Force plate data showed abnormalities of poor push off and poor swing through of the contralateral knee but no overall pattern correlation was found. The sagittal and frontal knee movements were calculated. These were often lower than the "normal" values. In two of the patients with ipsi-lateral knee instability who had gait analysis, the knee movements were raised - explaining the knee instability.

Ankle arthrodesis gives a high level of patient satisfaction. However it also causes a significant morbidity in terms of residual pain and possible ipsi-lateral knee instability.

#### CHEILECTOMY FOR HALLUX RIGIDUS; DOES IT WORK?

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For cases of hallux rigidus that do not respond to conservative treatment, surgical options are discussed; these include excision or implant arthroplasties, dorsal wedge proximal phalangeal osteotomies and fusion.

The pros and cons of each method are discussed emphasising complications, limitations and long term sequelae of the procedures on the hallux in particular and the forefoot in general terms.

Forty seven dorso-lateral cheilectomies have been performed in forty four patients between 1990 and 1996. Follow up was from 6 months to 6 years with a mean of 2.9 years. There was a preponderance of dominant feet and hallux rigidus was more common in the female gender. Other arthropathies and affections of the hallux MTPJ were excluded.

A self devised PASS score was used to assess results, assessing pain, arc of motion, shoes worn and sporting activities or walking distance according to age group; the youngest patient was 21 years of age and the oldest 78 with a mean age of 51 years.

Results were found to be excellent or good in nearly 80 per cent of patients using the subjective PASS scoring in 35 patients. 7 patients scored fair, and 2 poor. Two patients had their cheilectomies revised into fusions approx 3 years post op. There was a single patient reporting a painful scar neuroma.

Cheilectomy is a good operation for hallux rigidus but as a temporary procedure before more definitive operations are considered. It relieves pain but the post operative arc of motion improvement is only moderate.

Cheilectomy is not suitable for end stage hallux rigidus where fusion or implant arthroplasty are the treatments of choice.

Cheilectomy is simple, has a very low morbidity and does not defunction the first ray, as it maintains the length of the hallux MT unchanged.

#### THE VILADOT IMPLANT IN FLATFOOTED CHILDREN

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Painless flatfeet have long been a concern to parents and General Practitioners because of cosmesis, footwear and perceived problems in adult life. They form a large source of referral through parental pressure to Orthopaedic Surgeons for advice and intervention.

In 1991, Viladot, described an implant to be inserted into feet, considered to be likely to cause adult problems, through a double approach into the sinus tarsi allowing the talus to function whilst limiting its ability to slide off the calcaneum. The wine-glass shaped prosthesis was inserted with a tibialis posterior advancement with soft tissue or bony corrections to allow the hind foot to adopt a neutral position. He reported a series of 234 feet which had been treated this way with excellent results in terms of function, podographic and radiological outcome.

In Sheffield, between 1992 and 1995, 22 implants were inserted into similarly "at risk" painless feet and the outcomes assessed using clinical pedobarographic and radiological parameters. The age ranges and sex distributions were similar in both series.

Viladot was able to demonstrate an improvement in all cases, clinically, podographically and radiologically with little or no discomfort and a return to pre-operative activity levels including sport. We found that in all cases, pain post operatively, was a major feature which limited activity in all but 2 implants and reduced the ability to take part in sport and pre-operative past times. Unlike Viladot, we were unable to demonstrate consistent improvements radiologically with only modest corrections of the bony architecture. Pedobarographically, the loading of the 1st metatarsal head remained unchanged and in only 14% was there an improvement in the centre of pressure.

We have been unable to reproduce Viladot's excellent results. In our hands, this implant appears to convert painless flatfeet to painful ones and we no longer use it in the problem flatfooted ambulant child.

#### THE ANATOMICAL BASIS OF THE EXTENDED LATERAL APPROACH TO THE HINDFOOT

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**Introduction:** The extended lateral approach has been described for the ORIF of calcaneal fractures. Compared to previous incisions damage to the sural nerve is avoided and healing is prompt. The incision is a vascularised fasciocutaneous flap based on the terminal branch of the peroneal artery (posterior peroneal artery, PPA). Further understanding of the anatomic basis for this incision has allowed surgical indications to widen in our experience.

**Methods:** Dissections were performed on 15 formalin preserved cadaveric feet and photographed sequentially. Measurements of the positions of relevant structures were made.

**Results:** The anatomy of the postero-lateral part of the hindfoot is described as two triangles, one deep to the other. The superficial triangle contains fat and the PPA. The deep triangle is described, the apex of which was situated a mean of 4.1 cms above the ankle joint. The deep triangle contains the anastomosis between the PPA and the posterior tibial artery. Entering the deep triangle by incising the fascia over flexor hallucis and reflecting it laterally protects the PPA during the extended lateral approach.

In 13 cases the PPA arose as a continuation of the peroneal artery and in two cases as a branch of the posterior tibial artery. The PPA crosses the superior border of the calcaneum a mean of 3.1 cms posterior to the lateral malleolus and always posterior to the sural nerve. An incision which identifies the sural nerve will divide this artery, rendering the posterior skin ischaemic.

**Conclusion:** The extended lateral approach should be based sufficiently posteriorly to avoid damage to the posterior peroneal artery. This approach may be used for opera-

tions on the lower 5 cms of the tibia, the talus and the calcaneus.

#### TOTAL ANKLE JOINT REPLACEMENT: EXPERIENCES WITH CEMENTED AND UNCEMENTED DESIGNS

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Ankle replacement is subject of controversial discussion. First implantations of cemented designs have been performed in rheumatoid patients in Bad Bramstedt in 1976 (TPR since 1978), of uncemented ones in II/1990 (New Jersey / BUCHEL - PAPPAS and S.T.A.R. / KOFOED - Link alternatively).

Until the end of 1995 at all 142 ankle joints have been replaced: 67 by cemented, 75 by uncemented designs.

Of the cemented implants after a follow up time of 12.6 years on an average 16 (=23%) had to be revised, all on account of aseptic loosening: 13 (=19.5%) by fusion, 3 (=4.5%) by exchange to a New Jersey implant (successfully and without any problems after 4 - 2 years now).

Of the uncemented endoprostheses, controlled 3.6 years on an average, 2 have been already removed and fused (10%) in one patient, both of them due to an osteonecrosis of the talus. In one joint heterotopic bone had to be removed, and the bearing was exchanged. Clinical, radiological and pedobarographic controls of the three different designs have been performed. A direct comparison of the results of cemented and uncemented designs is not yet possible due to the too short observation time of the latter ones (see above). But with all reservation we feel that the mobility is better with both of the cementless implants, following the Goodfellow-idea of a "meniscal" endoprosthesis. The pedobarographic findings are by no means "normal", but much closer to the physiological conditions compared to an ankle joint fusion. We feel that ankle joint replacement in RA is a useful procedure, frequently superior to arthrodesis.

#### WALKWAY LENGTH IN DYNAMIC FOOT PRESSURE MEASUREMENT

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**Purpose:** To determine whether the foot pressure characteristics of the second step after a standing start represent the subject's normal gait pattern.

**Introduction:** Controversy persists about the number of steps required from a standing start before a "typical" foot pressure measurement can reliably be recorded. Measuring foot pressures on the first or second step after a standing start makes it easier for the subject to centre their foot on the plate and reduces the length of walkway required.

**Method:** Ten asymptomatic volunteers were selected from hospital staff. Six steps were recorded from each foot using the full 6 meter walkway. A further 6 recordings were made for each foot on the second step after a standing start.

It has previously been difficult to compare foot pressure measurement techniques because of step-to-step variability in stance time and placement. We have therefore developed analysis software which standardises the time and position variation of foot pressure data from consecutive trials, aligning the spatial components of the data within 1° of rotation and 4 mm of translation; time components are completely normalised. The software then extracts relevant outputs such as centre of pressure curves, peak pressure contour plots, total pressure curves, pressure time integral etc, and produces a best fit mean to all data sets.

Having calculated the mean and distribution of these foot pressure data for an individual, it is possible to calculate whether data from the second step falls within this distribution.

Results: We identified significant differences in hindfoot pressure, total ground reaction force and the timing of events within the stance phase of gait when pressure measurements were made on the second step after a standing start. The first step footprint was longer ( $p < 0.0001$ ), more variable ( $p = 0.03$ ), has earlier midfoot contact ( $p = 0.01$ ) and slightly lower hindfoot pressures ( $p = 0.08$ ). We therefore recommend that subjects are asked to take at least four steps before the step which is recorded.

#### COMPLEX FOREFOOT INJURIES IN MOTORCYCLE COURIERS

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We reviewed all the severe forefoot injuries admitted over a twelve month period. These included thirteen tarsometatarsal injuries of which nine occurred in motorcycle couriers. There were also three pedestrians whose feet were run over by cars, and a recreational bicyclist who was hit by a van.

Young, otherwise fit patients are frequently affected with an average age in our series of 27 (18-40, 8 male, 1 female). Analysis of our nine patients suggests a combination of direct trauma leading to open multifragmental metatarsal fractures, and indirect force and dorsiflexion and rotation leading to midfoot disruption. In five cases the motorcyclist's foot was struck directly by another vehicle; in four it was twisted and trapped during a collision. In three cases there was significant other trauma which led to delayed treatment. In six of the nine cases inadequate footwear was noted. All the patients underwent operative reduction and stabilisation, and two necessitated later plastic surgical intervention.

The injuries included three complex metatarsal fractures which were reviewed using the Spector scoring system. There were four Lisfranc injuries and two combination injuries which were assessed using the Myerson scoring system. Follow up was for a minimum of twelve months after injury. Our review suggests that motorcycle couriers

are at significant risk of severe midfoot trauma. A high index of suspicion is necessary when such patients are admitted with multisystem injuries. Education regarding correct footwear is also warranted.

#### MANUAL LANDMARK SELECTION IN FOOT PRESSURE MEASUREMENT

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**Purpose:** To determine the reliability of identifying the metatarsophalangeal joints in dynamic foot pressure measurement.

**Method:** Dynamic foot pressure measurements were recorded from 10 subjects using the Musgrave Footprint system. Two experienced observers were asked to select four sensors corresponding to the 1st and 5th metatarsophalangeal joints using either a colour print of the footprint or a greyscale print. Both observers repeated the exercise two weeks later. Repeatability was defined as acceptable if two or more of the same four sensors were selected in both trials.

**Results:** Intraobserver repeatability was >80% acceptable for both landmarks and for both observers. The agreement between observers was dependent on the landmark selected, >80% acceptable for the 1st metatarsal head but <50% for the 5th metatarsal head. Colour prints produced similar repeatability, suggesting that location within the footprint is more important in landmark selection than the colour patterns representing pressure peaks.

**Relevance:** Manual selection of landmarks within the footprint is frequently used as a method of averaging sequential footprints because of step-to-step variation. This study shows that this manual method is a source of error, particularly when comparisons are made between different observers. The error is larger for the 5th than the 1st metatarsal.

An automated method of averaging sequential footprints would reduce this source of error in foot pressure measurement.

#### KIRKUP'S PROCEDURE FOR THE GROSS BUNION, SEVERE HALLUX VALGUS WITH METATARSUS PRIMUS VARUS

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Although excision arthroplasty or first metatarsal osteotomy are widely utilised in the treatment of hallux valgus, there is no single procedure suitable for the severe bunion when hallux valgus and metatarsus primus varus subtend an angle of 60°. A combination of Keller's excision arthroplasty and Wilson's bi-planar osteotomy can correct such a severe problem. In this preliminary report we present the results of 30 feet in 21 patients studied prospectively over 5 years. The mean follow up is 3 1/2 years (1-5). Prospectively weight bearing forefoot x-rays (AP) were taken for the measurement of HV angle and 1/intermetatarsal angle. Qualitative pedobarographs were taken using a child's Magic Drawing Board which will be illustrated.

Five feet had concomitant surgery to other toes, 8 cases were bilateral and 2 patients have further surgery to the contra-lateral foot.

At review a further pedobarograph was taken to assess the big toe pulp's involvement in weight bearing. Weight bearing forefoot x-rays were taken to measure HV angle and IM angle and true lateral forefoot x-rays were taken in "toe off" to measure the range of dorsiflexion. The mean HV angle reduced from 43° pre-op to 15° post op whilst the mean intermetatarsal angle was reduced from 17° to 8°. The mean post op dorsiflexion was 31°: the 1st MTP joint was often stiffer than pre-operatively and particularly so in patients with underlying rheumatoid arthritis.

The patient's own assessments of comfort and operative success were recorded, graded 1-5: 65% were grade 5. One patient continued with pain in the excised 1st MTP joint. Lower scores were mostly because of problems with toes other than the hallux. 3 cases complained of 2nd ray metatarsalgia subsequent to surgery, many feet had this and other multiple toe problems pre-operatively. Patients had presented because of the gross bunion with its pain and deformity; there was 100% patient satisfaction with the medial border outline of their foot. Traced outlines of the forefoot are available pre-operatively and post operatively.

This combination operation produces patient satisfaction over the bunion area and results in a functioning toe as seen from pedobarographs.