

ABSTRACTS OF RECENT LITERATURE

by

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Abstracts are drawn primarily from the orthotics, prosthetics, and sensory aids literature. Selections of articles were made from these journals:

American Journal of Physical Medicine and Rehabilitation
Ergonomics

Journal of Bone and Joint Surgery

Journal of Medical Engineering and Technology

Medicine and Science in Sports and Exercise

Orthopedics

Paraplegia

Physical Therapy

Prosthetics and Orthotics International

Scandinavian Journal of Rehabilitation Medicine

PROSTHETICS, ORTHOTICS, AND RELATED TOPICS

Accuracy of Diagnoses from Magnetic Resonance Imaging of the Knee: A Multi-Center Analysis of One Thousand and Fourteen Patients. Fischer S, Fox JM, Del Pizzo W, *et al.*, reprinted from *J Bone Joint Surg* 73A:2-10, 1991.

Magnetic resonance images of the knee were made for 1014 patients, and the diagnosis was subsequently confirmed arthroscopically. The accuracy of the diagnoses from the imaging was 89 per cent for the medial meniscus, 88 per cent for the lateral meniscus, 93 per cent for the anterior cruciate ligament, and 99 per cent for the posterior cruciate ligament.

The magnetic resonance examinations were done at several centers, and the results varied substantially among

centers. The accuracy ranged from 64 to 95 per cent for the medial meniscus, from 83 to 94 per cent for the lateral meniscus, and from 78 to 97 per cent for the anterior cruciate ligament. The results from different magnetic-resonance units were also compared, and the findings suggested increased accuracy for the units that had a stronger magnetic field.

Of the menisci for which the magnetic resonance signal was reported to be Grade II (a linear intrameniscal signal not extending to the superior or inferior meniscal surface), 17 per cent were found to be torn at arthroscopy.

Analysis of the Swing Phase Dynamics and Muscular Effort of the Above-Knee Amputee for Varying Prosthetic Shank Loads. Hale SA, reprinted from *Prosthet Orthot Int* 14:125-135, 1990.

The purpose of this study was to determine the effect of varying prosthetic shank mass, while maintaining the mass centre location and moment of inertia, on the swing phase kinematics, kinetics and hip muscular effort of free speed above-knee (AK) amputee gait. Six AK amputees, wearing similar prosthetic designs, had three load conditions applied to their prosthetic shank: 1) Load 0—unloaded ($X=39.1\%$ sound shank mass), 2) Load 1—75%, and 3) Load 2—100% sound leg mass. Despite increases in shank mass from 1.33 to 3.37 kg the AK amputee was able to maintain a consistent swing time and walking speed. As load increased, there were significant changes in the maximum knee and hip displacements, as well as phasic shifting. The prosthetic knee Resultant Joint Moment (RJM) was negligible while the shank was accelerating (periods 1 and 2), but was a major contributor during shank

deceleration (periods 3 and 4). During periods 1 and 2 the principal contributors to the shank acceleration (forces resisting excessive knee flexion) were the gravitational moment (S-G) and the moment due to thigh angular acceleration (S-AT). During the periods of shank acceleration (sections 1 and 2), there was not a significant increase in the hip muscular effort. However, during sections 3 and 4, the periods associated with shank deceleration, there were significant increases in the hip muscular effort. The hip muscular effort for the complete swing phase increased as load increased by 36.7% and 71.3% for loads 1 and 2. Despite the significant increases in hip muscular effort, four of the six subjects preferred load 1 condition.

Athletic Footwear: Unsafe Due to Perceptual Illusions.

Robbins SE, Gouw GJ, reprinted from *Med Sci Sports Exerc* 23:217-224, 1991.

Modern athletic footwear provides remarkable plantar comfort when walking, running, or jumping. However, when injurious plantar loads elicit negligible perceived plantar discomfort, a perceptual illusion is created whereby perceived impact is lower than actual impact, which results in inadequate impact-moderating behavior and consequent injury. The objective of this study was to examine how plantar tactile (mechanical) events affect perceived plantar discomfort. Also, we evaluated the feasibility of a footwear safety standard we propose, which requires elimination of the above illusion. Twenty subjects gave numerical estimates of plantar discomfort produced by simulated locomotion (concurrent vertical ($0.1-0.7 \text{ kg}\cdot\text{cm}^{-2}$) and horizontal ($0.1-0.9 \text{ kg}\cdot\text{cm}^{-2}$) plantar loads), with the foot supported by either a smooth rigid surface or a rigid surface with 2 mm high rigid irregularities. Vertical or horizontal load alone evoked no discomfort ($P > 0.05$), whereas together, discomfort emanated from loads as low as $0.4 \text{ kg}\cdot\text{cm}^{-2}$. Irregularities heightened discomfort by a factor of 1.89. This suggests that the proposed safety standard is feasible, since compliance could be achieved simply by adding surface irregularities to insoles and by other changes that heighten localized plantar loads. However, until this standard is adhered to, it might be more appropriate to classify athletic footwear as "safety hazards" rather than "protective devices."

Biomechanical Effects of Rockers on Walking in Plaster Cast. Hullin MG, Robb JE, reprinted from *J Bone Joint Surg* 73B:92-95, 1991.

Rockers are applied to lower limb casts to assist walking but there is little information on their biomechanical

effects. The performances of 10 commercially available rockers were compared. They were applied to a below-knee cast worn by a normal subject who was also tested walking in the cast alone. Gait analysis was used to evaluate kinematic and kinetic data.

The design of rockers had no effect upon the kinematics of walking. However, using new criteria for kinetic assessment of rocker function (tibial floor angular velocity and centre of pressure progression), most designs had a deleterious effect on the biomechanics of gait. Only two rockers approached the ideal kinetic criteria.

Biomechanical Factors in Wound Healing Following Knee Arthroplasty. Johnson DP, Eastwood DM, Bader DL, reprinted from *J Med Eng Tech* 15:8-14, 1991.

A significant proportion of deep infections following knee arthroplasty are consequent on a failure of primary wound healing. The management of such infections is difficult and the functional outcome is poor. It is essential to ensure that the initial biomechanical conditions are such that wound healing is encouraged. The ability of a wound to heal is dependent on factors such as the orientation of the skin incision, the wound tension and the viability of the wound edges as assessed by skin oxygen tension estimations. Consideration of these factors has led us to advocate the use of the medial parapatellar incision for knee arthroplasty. Early, excessive knee flexion following arthroplasty can lead to significant wound edge hypoxia but by modifying the rehabilitation programme and with the administration of 24% oxygen to the patient in the perioperative period, this effect can be minimized. Modification of the surgical techniques involved in knee arthroplasty can help preserve the vascular supply and hence the viability of the wound edge, and thus achieve a suitable biomechanical environment for primary wound healing.

Choices in Medicine: Illustrations from Imaging. Wells PNT, reprinted from *J Med Eng Tech* 14:225-232, 1990.

Progress in medicine is almost always led by advances in science and technology. During the last quarter of a century, startling developments have taken place in medical imaging. X-ray techniques have been extended by improvements in film-screen technology and image intensifiers; digital radiography and computed tomography have been introduced. The gamma camera has been combined with computer processing and new radio-pharmaceuticals have been devised. The resolution of real-time two-dimensional ultrasonic scanning has been improved almost to the diffrac-

tion limit and Doppler techniques provide detailed information about blood flow. Magnetic resonance imaging yields exquisite anatomical detail, tissue characterization and flow data and biochemistry can be studied through spectroscopy. Research aimed at improving all these methods is actively being pursued and there is interest in the potential of microwave, electrical impedance and light transmission techniques as medical imaging tools.

In parallel with these diagnostic advances, techniques for minimally invasive surgery are being developed. Guided by appropriate imaging methods, suitable forms of radiation can be directed through the intact skin, or small instruments can be introduced through natural orifices or tiny incisions. Thus it is possible to undertake many interventional procedures that previously required open surgery.

Because resources are limited, choices have to be made taking benefits, risks and costs into account. No diagnostic method is perfect; medical imaging is expensive in terms of equipment and trained personnel and its use has to be justified in competition with demands from other areas of health care. Unproductive work is having to be identified and abandoned. As diagnosis becomes more accurate and comprehensive, imaging resources are likely to be shifted towards screening, prognosis and minimally invasive therapeutic procedures.

Comparative Study of Two Laser Doppler Blood Flowmeters. Barnett NJ, Dougherty G, Pettinger SJ, reprinted from *J Med Eng Tech* 14:243-249, 1990.

A new infrared laser Doppler blood flow instrument (Moor MBF3D) was evaluated using an *in vitro* model allowing measurements over a range of flow velocities and concentrations. The responses correlated well ($r=0.96$, $p<0.01$) with those obtained simultaneously using a Perimed PF3 laser Doppler instrument. The different processing bandwidths of the instruments were investigated and the wideband mode of operation is recommended for flow measurements where there may be fast moving red blood cells (rbcs). The infrared instrument is capable of dual-channel operation, and the two channels are shown to respond almost identically for similar changes in blood flow through the *in vitro* model ($r=0.999$, $p<0.01$). The main advantage of the dual-channel instrument is that continuous measurements may be made simultaneously at two different skin sites allowing dynamic flow responses to be compared.

A Comparative Trial of Two Walking Systems for Paralysed People. Whittle MW, Cochrane GM, Chase AP, *et al.*, reprinted from *Paraplegia* 29:97-102, 1991.

A trial has been performed to compare two designs of reciprocal walking orthosis for paralysed people—the hip guidance orthosis (HGO) from Oswestry, England, and the reciprocating gait orthosis (RGO) from New Orleans, USA.

Eighteen male and 4 female paraplegic subjects used each orthosis for 4 months, in a crossover study. All aspects of the provision and use of the devices were monitored, and a variety of assessments were made.

Fifteen subjects were able to use both orthoses, 5 were unable to use either and 2 succeeded with the HGO but not the RGO. At the end of the trial 12 subjects chose to keep the RGO, 4 the HGO, and 6 kept neither. Those choosing the RGO liked its appearance; those choosing the HGO liked the speed of donning and doffing. The RGO was about 50% more expensive to supply than the HGO.

Constrained Standing: Evaluating the Foot/Floor Interface. Zhang L, Drury CG, Woolley SM, reprinted from *Ergonomics* 34:175-192, 1991.

A methodological study was conducted to provide a multivariate evaluation of the foot/floor interface in constrained standing. Measures of body movement (from force platform and video recording), leg muscle EMGs, reported exertion/discomfort and task performance were taken during a two-hour task. Factor Analysis showed four major factors named Body Movement, Muscle Contraction, Perceived Fatigue and Task Errors. Most measures showed strong effects of time on task (Period Effect), indicating cumulative fatigue. Hard-soled shoes were marginally worse than soft soled shoes on a number of measures. Mat thickness had little effect. To test the methodology a commercial mat was evaluated in a separate experiment. Strong period effects were again obtained, but again the mat had little effect on any measures. Implications for a measurement methodology are discussed.

Contribution of Angular Motion and Gravity to Tibial Acceleration. LaFortune MA, Hennig EM, reprinted from *Med Sci Sports Exerc* 23:360-363, 1991.

A bone-mounted accelerometer and high-speed cinematography were used to compare the axial tibial acceleration caused by ground impact with the total tibial axial acceleration as measured by a transducer. Due to the effects of gravity and tibial angular motion, the magnitude of the

peak acceleration at foot strike was 43% below and 18% above the peak axial acceleration due to impact for running and walking, respectively. Depending on the distance of the accelerometer from the tibial center of rotation which is located at the ankle joint, different axial acceleration signals should be expected during comparable locomotor activities.

A Controlled Study on the Outcome of Inpatient and Outpatient Treatment of Low Back Pain: Part III. Long-Term Follow-Up of Pain, Disability, and Compliance. Karkapaa K, Mellin G, Jarvikoski A, Hurri H, reprinted from *J Rehabil Med* 22:181-188, 1990.

The long-term outcome results of inpatient and outpatient treatment of low back pain (LBP) were studied in 476 subjects (aged 35-54, 63% men) randomly assigned to three study groups: inpatients ($n=157$), outpatients ($n=159$), and controls ($n=160$). The study included changes in the severity of low back pain, grade and disability, compliance with self-care, data on disability pensions, and days of sickness allowance during a 2.5-year follow-up period. These variables were used as outcome criteria. Pain and disability had decreased significantly in the two treated groups up to the 3-month follow-up. LBP was still a little slighter in the inpatients at the 1.5-year and 22-month follow-ups, but there were no significant differences between groups in disability caused by LBP. The refresher programme carried out 1.5 years after the first one did not bring about as clear short-term improvement in pain and disability as the first treatment. During the whole 2.5-year follow-up compliance with self-care was better in the two treated groups, especially in the inpatients. Days of sickness allowance had increased somewhat more in the controls than in the inpatients during the follow-up. No differences between the groups were found in the number of disability pensions granted.

A Controlled Study on the Outcome of Inpatient and Outpatient Treatment of Low Back Pain: Part IV. Long-Term Effects on Physical Measurements. Mellin G, Harkapaa K, Hurri H, Jarvikoski A, reprinted from *Scand J Rehabil Med* 22:189-194, 1990.

Effects of inpatient and outpatient treatment on physical measurements in chronic low back pain patients ($n=476$) were analyzed at 1.5- and 2.5-year follow-ups as well as 3 months after a refresher programme which was carried out 1.5 years after the first treatment. Physical measurements consisted of hip and lumbar spinal mobility, and

trunk muscle strength. At the 1.5-year follow-up the two treatment groups did not differ from the control group, but at the 2.5-year follow-up inpatients showed better improvements in physical functions from the pretreatment level. The refresher treatment was found to improve physical functions more effectively than the first treatment program, especially in the outpatients. Self-care with heavy exercising was related with the improvement of physical functions, but back exercises and light exercising were not. Statistically significant but modest correlations were found between improved physical functions and subjective progress during the long-term follow-ups.

The Edinburgh-ORLAU Prosthetic System to Provide Reciprocal Locomotion in Children and Adults with Complete Transverse Lower Limb Deficiency. Meadows CB, Stallard J, Wright D, *et al.*, reprinted from *Prosthet Orthot Int* 14:111-116, 1990.

A novel prosthetic system to provide reciprocal locomotion in children and adults with complete transverse lower limb deficiency is described. This is based on the hip joints from the ORLAU ParaWalker, a system with a proven record of success in the orthotic management of paraplegic patients. The fitting of the prototype system to an eight year old girl is described. This experience shows that the orthotic principles of the ParaWalker, which provides reciprocal locomotion for the paraplegic, is equally applicable to the prosthetic situation. Developments are therefore continuing to improve the design and to enable further fittings.

Evaluating Lifting Tasks Using Subjective and Biomechanical Estimates of Stress at the Lower Back. Waikar A, Lee K, Aghazadeh F, Parks C, reprinted from *Ergonomics* 3:33-47, 1991.

The objective of this study was to evaluate five different lifting tasks based on subjective and biomechanical estimates of stress at the lower back. Subjective estimates were obtained immediately after the subjects performed the lifting tasks. Rankings for different tasks were obtained according to the perceived level of stress at the lower back. A biomechanical model was used to predict the compressive force at the L5/S1 disc for the weight lifted considering link angles for the particular posture. The tasks were also ranked according to the compressive force loading at the L5/S1 disc. The weight lifted in these tasks for obtaining the subjective estimate of stress was the maximum acceptable weight of lift (MAWOL). This was determined

separately for each subject using a psychophysical approach. Subjective estimates of stress were obtained for infrequent lifting, specifically for a single lift, as well as for lifting at a frequency of four lifts per min. The results showed that a lifting task acceptable from the biomechanical point of view may not be judged as a safe or acceptable task by the worker based on his subjective perception. This may result in a risk of the worker not performing the recommended task or not following the recommended method.

An Evaluation of Computer Aided Design of Below-Knee Prosthetic Sockets. Topper AK, Fernie GR, reprinted from *Prosthet Orthot Int* 14:136-142, 1990.

Forty-eight below-knee amputees compared sockets designed using CANFIT computer aided design (CAD) software with sockets designed using conventional methods. Each subject was fitted by one prosthetist who used conventional techniques and one who used the CANFIT system to design the socket. Prosthetists alternated design methods for each new subject. The prosthetist using the conventional techniques was allowed up to 2 design attempts and the prosthetist using the CANFIT system was allowed up to 5 design attempts. After 2 design attempts with each method 21% of the subjects preferred the CANFIT design socket. Following up to 5 attempts 54% preferred the CANFIT designed socket. A jury of experts made an assessment of the CANFIT system and of CAD in prosthetics. The jury did not think that the version of the system tested was cost effective but that at the rate that it was improving it would become such within 3 to 5 years. The jury noted that, as well as monetary benefits, CAD presents the possibility of benefits in other areas such as research and teaching. A number of specific suggestions regarding the use and development of CAD in prosthetics were also made.

Exercise and Gait Effects on In Vivo Hip Contact Pressures. Krebs DE, Elbaum L, Riley P, *et al.*, reprinted from *Phys Ther* 71:301-309, 1991.

Virtually all hip rehabilitation programs include exercise for muscle force development. The specific effects of various exercise modes on the hip joint itself are unknown. We will report on the effects of common exercise modalities on *in vivo* hip pressures. Four years prior to data collection, a pressure-instrumented Austin-Moore-type endoprosthesis was implanted in an otherwise healthy 73-year-old woman with a traumatic right hip fracture. Hip

pressures during various experimental maneuvers were recorded periodically over a 5-year period. We compared measurements of peak pressure and rate of pressure rise obtained during gait with those obtained during isokinetic, isometric, and isotonic lower-limb exercises. Maximal exercise generated greater peak pressures than did gait, and tripling the angular velocity during exercise roughly tripled the rate of pressure rise. Torque production and resultant *in vivo* hip pressures varied directly during all experiments. Peak pressures and rate of pressure rise apparently can be controlled by varying the subject's exertion. The results reported are from a single subject: therefore, little generalizability is possible for these data. We suggest, however, that articular pressures may be important to rehabilitation planning; these data provide a direct insight into this potentially important exercise prescription consideration.

Isoelasticity and Total Hip Arthroplasty. Skinner HB, reprinted from *Orthopedics* 14:323-328, 1991.

Important parameters in designing an "isoelastic" prosthesis that transfers stress in a more physiologic manner are explored. The effect of material properties and geometry on the mechanical properties of a femoral component are discussed. The bending "stiffnesses" of cortical bone, metal prostheses, and composite prostheses are compared, and the bending rigidities of prosthesis and bone as they might vary with surgical technique are explained. It is shown that the flexural rigidity of a prosthesis stem as presently designed is close to the flexural rigidity of cortical bone, but 200 to 400 times greater than that of the material it replaces, i.e., cancellous bone and fatty marrow.

Methods of Treating Plantar Ulcers. Birke JA, Novick A, Graham SL, *et al.*, reprinted from *Phys Ther* 71:116-122, 1991.

The purpose of this article is to describe the indications, precautions, and fabrication techniques for orthotic devices the authors use to facilitate the healing of plantar ulcers. The methods of fabricating and applying the three types of orthotic devices developed by the staff at the Gillis W. Long Hansen's Disease Center—walking casts, walking splints, and cutout sandals—are described. Patient examples are given for each of the methods. These techniques, in conjunction with patient education and the use of special footwear, provide clinicians with procedures they can use to aid in the healing of plantar ulcers secondary to leprosy, diabetes, or other neuropathic conditions.

The Palpator: An Instrument for Measuring the Positions of Bone in Three Dimensions. Pronk GM, van der Helm FCT, reprinted from *J Med Eng Tech* 15:15-20, 1991.

In order to measure the three-dimensional (3D) positions of muscle attachments and joint surfaces in cadaver experiments, a measurement instrument, called the palpator, was developed. The palpator is composed of an open chain of four links connected by four hinges. By recording the rotation of the hinges using potentiometers, the position of the end-point of the palpator can be calculated. After the identification of 23 parameters of the palpator, a measurement accuracy of 1.43 mm is obtained.

Performance of Three Walking Orthoses for the Paralyzed: A Case Study Using Gait Analysis. Jefferson R, Whittle MW, reprinted from *Prosthet Orthot Int* 14:103-110, 1990.

Three types of walking orthosis are currently available to enable paralysed people to achieve reciprocal gait. This case study assesses the performance in walking of one patient who was proficient in the use of all three devices. The results of a biomechanical analysis are presented in which comparisons are made between the orthoses in terms of general gait parameters and movement of the lower limbs and pelvis.

A Plaster-Pylon Technique for Below-Knee Amputation. Harrington IJ, Lexier R, Woods JM, *et al.*, reprinted from *J Bone Joint Surg* 73B:76-78, 1991.

We reviewed 83 patients after below-knee amputation. In 56 with 69 amputations early management was by plaster-ylon. A plaster cast is applied in the operating room, and a pylon added one week later, after which full weight-bearing is allowed. We compared these patients with 27 who had soft bandaging.

The 'healing' time was reduced from 98 days to 40 days, and there were no major complications in the plaster-ylon group. The technique is simple and cheap and can be used by paramedical staff without specialised training or equipment.

Proportional Myoelectric Hand Control: An Evaluation. Sears HH, Shaperman J, reprinted from *Am J Phys Med Rehabil* 70:20-28, 1991.

The authors review the principle of proportional myoelectric control, in which the motor voltage of a prosthetic hand varies in direct proportion to the EMG signal, giving

the amputee control over speed and force of grip. This type of myoelectric control is contrasted with digital myoelectric control, in which the system is fully on or off, giving the amputee no control over speed of hand opening and closing, and the grip force is increased only by increasing the time of the sustained EMG signal. A survey was conducted of 33 patients wearing the proportional myoelectric hand. Patients rated quickness of opening and closing; control over speed and force; effort required to open and close; and comfort, convenience, and cosmesis of the hand; as well as giving it an overall rating in comparison with their previous terminal device. The ratings were made on a 5-level scale, so that they could be quantified. Patient responses were grouped according to previous experience with a terminal device type: group A: digital myoelectric hand; group B: body-powered terminal device; group C: no terminal device. Differences in group means were compared using Student's *t* test. Previous digital hand wearers gave significantly higher ratings to the proportionally controlled hand overall, especially for its quickness, control of speed and force, and the effort required to open and close the hand. Former body-powered terminal device wearers rated the proportionally controlled hand significantly better on control over speed and force and on cosmesis. Amputees with no previous terminal device had no basis for comparison but gave the proportionally controlled hand high ratings on control over speed and force, effort for opening and closing, and cosmesis. The former digital hand wearers rated the proportionally controlled hand significantly lower on convenience. This reflected early problems with battery life and reliability. Of the three groups of patients, the former digital hand wearers were most impressed with the proportionally controlled hand, and gave it the highest overall ratings.

Psychological Correlates of Walking Speed in the Visually Impaired. Beggs WDA, reprinted from *Ergonomics* 34:91-102, 1991.

Recent attempts to extend mobility evaluation techniques to include the partially sighted as well as the totally blind have demanded the development of new measures. One of these, the percentage of preferred walking speed (PPWS) reflects the slower walking speed of visually impaired pedestrians. This reduction in speed may be due either to the impoverished visual information available for the control of locomotion, or it may be due to a strategic response to the stress associated with travel. Using a client-derived mood checklist, this latter hypothesis was confirmed. In contrast, visual status, as measured by both acuity and field

loss, was unrelated to PPWS. This mobility index is an important addition to existing measures, which are concerned with safety, efficiency and visual function.

Reconstruction of the Upper Extremity in Tetraplegia: Functional Assessment, Surgical Procedures and Rehabilitation. Vanden Berghe A, Van Laere M, Hellings S, Vercauteren M, reprinted from *Paraplegia* 29:103-112, 1991.

The results of 22 procedures (8 for elbow extension, 14 for hand rehabilitation) on the upper limb in tetraplegia are reported. To evaluate the effect of surgery an objective hand function test is presented. The few complications after surgery must be attributed to the material used.

Stiffness and Hysteresis Properties of Some Prosthetic Feet. Van Jaarsveld HWL, Grootenboer HJ, De Vries J, Koopman HFJM, reprinted from *Prosthet Orthot Int* 14:117-124, 1990.

A prosthetic foot is an important element of a prosthesis, although it is not always fully realized that the properties of the foot, along with the prosthetic knee joint and the socket, are in part responsible for the stability and metabolic energy cost during walking.

The stiffness and the hysteresis, which are the topics of this paper, are not properly prescribed, but could be adapted to improve the prosthetic walking performance. The shape is strongly related to the cosmetic appearance and so can not be altered to effect these improvements. Because detailed comparable data on foot stiffness and hysteresis, which are necessary to quantify the differences between different types of feet, are absent in literature, these properties were measured by the authors in a laboratory setup for nine different prosthetic feet, bare and with two

different shoes. One test cycle consisted of measurements of load deformation curves in 66 positions, representing the range from heel strike to toe-off.

The hysteresis is defined by the energy loss as a part of the total deformation energy. Without shoes significant differences in hysteresis between the feet exist, while with sport shoes the differences in hysteresis between the feet vanish for the most part. Applying a leather shoe leads to an increase of hysteresis loss for all tested feet.

The stiffness turned out to be non-constant, so mean stiffness is used. Because very little is known about the optimal values of stiffness and hysteresis, and substantial differences in stiffness between different feet and shoes exist, further investigation into the importance of stiffness and hysteresis to the walking quality of a foot is necessary. Foot-wear counts too for this quality because it modifies the variation in stiffness among the feet.

Survivorship Analysis of Total Knee Arthroplasty: Cumulative Rates of Survival of 9200 Total Knee Arthroplasties. Rand JA, Ilstrup DM, reprinted from *J Bone Joint Surg* 73-A:397-409, 1991.

From 1971 through 1987, 9200 total knee arthroplasties were performed at the Mayo Clinic. Actuarial analysis was used to estimate cumulative rates of survival. Use of a proportional-hazard, general linear model led to the identification of four independent variables that were associated with a significantly lower risk of failure: primary total knee arthroplasty, a diagnosis of rheumatoid arthritis, an age of sixty years or more, and use of a condylar prosthesis with a metal-backed tibial component. When all four of these favorable variables were present (without regard for radiographic changes and non-disabling symptoms), the probability of an implant being *in situ* was 97 per cent at both five and ten years.