Abstracts of Recent Articles

The following articles have been abstracted by Joan E. Edelstein, R.P.T., Research Scientist, New York University Post-Graduate Medical School, Prosthetics and Orthotics, 317 East 34th Street, New York, N.Y. 10016. Mrs. Edelstein received a special award at the June 1979 American Physical Therapy Association Annual Conference, for her outstanding contribution as an abstractor for the Journal of Physical Therapy.

Above-Knee Amputation — An Ideal Situation: G. Murdoch (Department of Orthopaedic Surgery and Traumatology, University of Dundee, Scotland) Prosthetics and Orthotics International 3:13-14, 1979.

Amputation should be as distal as possible, compatible with prosthetic fitting and components. A distance of at least 120 mm above the knee joint preserves the neurovascular bundles and acommodates most knee mechanisms. Ideally, anterior and posterior flaps should be equal. Gentle handling of skin edges ensures a sufficiency of skin; close abutment ensures primary wound healing with a thin scar. Minimal dissection between skin and deep fascia is advised.

Muscle managment is controversial. Suturing hamstrings and adductors to drilled femoral holes is better than muscle-to-muscle suture over the bony end; the latter risks inefficiency, earlier fatigue, distortion of stump shape, and lateral migration of the distal femur.

A high, clean nerve cut locates the neuroma away from the distal scar. The bony medulla should be closed by a periosteal flap to retain normal intramedullary pressure. The anterior edge of the bone must be smoothed to prevent bursae. Normally hemostasis should be ensured and a tourniquet and closed suction drainage used.

Afferent Electrical Nerve Stimulation for Sensory Feedback in Hand Prostheses: Clinical and Physiological Aspects: Lars Korner (Department of Orthopaedic Surgery I, University of Goteborg, Sweden) Acta Orthopaedica Scandinavica Supplementum No. 178, 1979.

Development of sophisticated externally powered below-elbow prostheses has accelerated during the past two decades. These prostheses provide much less feedback about movement, position, and force as compared with body-powered cable-driven appliances. Properly designed myoelectric control systems may yield significant feedback information through the action of muscles at the control sites, thus reducing the need for a purely artificial sensory feedback system. Electrical nerve stimulation can convey sensory feedback from the prosthetic hand.

An experimental study performed on normal subjects and amputees involved stimulation of forearm nerves with percutaneous intraneural wire electrodes. Subjects could discriminate changes in stimulus intensity and frequency both with intermittent stimulation and in a tracking task using continuous stimulation. Interference between nerve stimulation current and the myoelectric control system was minimal. Stimulation was readily accepted by the subjects. Markedly delayed response in the tracking performances was reduced to acceptable levels by training.

Sensory feedback should be derived from the myoelectric control system through electrical stimulation of the stump nerves. The method is safe, reliable, and self-contained within the prosthesis.

Below-Knee Orthosis: A Wrap-Around Design for Ankle-Foot Control: Bruce M. Gans, Gordon Erickson, Diane Simons (Department of Rehabilitation Medicine, University of Washington School of Medicine, Seattle, Washington) Archives of Physical Medicine and Rehabilitation 60:78-80, February 1979.

Traditional bracing relies almost exclusively on the three-point principle of support, with forces applied in discrete regions by rigid materials which resist motion. The wrap-around orthosis uses the hydraulic support principles developed in casting. Diffuse circumferential contact with rigid closures maintains limb immobility by a diffuse supporting mechanism. The new orthosis requires materials with limited elasticity, such as very thin polypropylene. Total contact is achieved with the aid of an inner foam layer. The orthosis is extremely soft and pliable. One hundred fifty-five such orthoses have been provided to eighty-nine patients, most of whom have cerebral palsy.

Advantages of the soft orthosis include elimination of skin irritation, easier fit into shoes, reduced shoe wear, and greater cosmesis as compared with metal braces. There are fewer returned to the orthotic laboratory for refitting. The orthosis accomodates circumferential and longitudinal growth in children. Spastic children appear to have unusually good reflex relaxation with it, enhancing voluntary motor capabilities in the lower limbs and elsewhere in the body.

Disadvantages of the design relate to lack of adjustability of the ankle angle, although heel and sole lifts compensate somewhat by changing the angle of the tibia to the floor. The device is warm and may cause contact allergy or eczema; a thin cotton sock underneath acts as a wick to maintain better heat transfer. Patients who load the anterior lever arm heavily during walking may cause gapping and eventual buckling of the plastic.

The Clinical Assessment of the Normal and Abnormal Foot During Locomotion: M. T. Manley and E. Solomon Department of Biomedical Engineering, University of Cape Town and Groote, Republic of South Africa) Prosthetics and Orthotics International 3:103-110, 1979.

Traditional methods of quantifying the performance of the foot include measuring interface pressures from impressions

on plaster bags or rubber mats, both suitable for visualizing the loading pattern on the standing foot. Pressure transducers attached to the body or the shoes are fragile and cumbersome ways of measuring the walking foot. The force plate used with motion pictures is unsuitable for assessing foot biomechanics because the gross data recorded by the plate and the small movements of the foot during stance are processed very slowly and the method is impractical for clinical use.

The instrumentation devised by the authors measures and displays the magnitude and distribution of vertical force acting on the sole during the stance phase. The system consists of a force plate composed of 16 transparent beams mounted on a walkway. Both ends of each beam rest on load cells. Two television cameras provide simultaneous visual data on the swinging and bearing feet. A video picture with superimposed histogram and pressure centerline is generated every 20 milliseconds. One can see the magnitude of the load carried by different sections of the foot and the pattern of loading applied to the plantar surface. The usual stance phase occupies 35 video frames.

Analysis of the normal foot shows that the ankle is slightly plantar flexed at heel strike, with the calcaneus everted. The heel is heavily loaded as the forefoot descends and the lower leg moves toward the vertical. As the foot supinates, more load is applied to the mid and forefoot, lateral to the longitudinal midline. After heel rise, the ankle plantar flexes and the loading is medialward across the metatarsal heads. The first and second metatarsal heads carry most of the load generated by the leg. Analysis of a patient with claw toes shows initial loading on the calcaneal midline, then along the lateral border. The hindfoot contacted the plate until well after midstance, with minimal plantar flexion. The hallux never contacted the plate. Arthrogrypotic feet were also analyzed.

The Diabetic Patient: Orthotic Considerations: Edward P. VanHanswyk (College of Medicine, State University of New York, Syracuse, New York) Orthotics and Prosthetics 33:32-39, September 1979.

Diabetes is caused by pancreatic inability to produce insulin. The discovery of insulin allowed treatment of acute diabetes, permitting more diabetics to survive presenting more complications. Two percent of Americans have the disease. Hereditary diabetes is more common than nonhereditary. The juvenile type is dependent on insulin for control and is sudden in onset; the adult type usually occurs after age 40, develops slowly, and may be controlled by diet with or without insulin.

Severe retinopathy affects two percent of diabetics. Nephropathy can be fatal. Neuropathy is due to vascular insufficiency and derangement of peripheral nerve metabolism. Polyneuropathy is most common, beginning at the feet with sensory impairment, then numbness and stiffness. Motor symptoms, weakness, poor proprioception, and trophic changes occur. The common peroneal nerve is most frequently involved in mononeuropathy. In arthropathy, sensory and autonomic nerves within the joint are damaged. Anhidrosis manifests itself in cracking feet. Amyotrophy is iliopsoas and quadriceps pain and weakness. Bluish limbs indicate diabetic cold feet, due to sympathetic disturbance.

The postacute stages of insensitive feet, Charcot joints, and weakness require orthoses. Feet exposed to trauma from ground contact require protective footwear. Foot lesions from pressure points through deep ulcers heal without amputation; lesions involving abscess osteitis and gangrene require partial foot amputation. Plaster casts protect the foot against unappreciated trauma, pressure, and shear, provided there is no arteriosclerosis or undrained abscesses. After healing, Plastazote shoe or insole reduces trauma. Hygiene is mandatory. Charcot joints must be supported, unweighted, and protected from further stress by a rigid sole, rocker bar, and Plastazote insole. An ankle-foot orthosis with patellar tendon bearing protects the ankle and proximal foot joints. Tibial crest protection and mediolateral ankle stability are important. Patients with proximal muscle weakness require a knee-ankle-foot orthosis, while those with peroneal loss respond to an ankle-foot orthosis.

Energy Cost of Ambulation in Paraplegic Patients Using Craig-Scott Braces: Chi-Tsou Huang, and others (Spain Rehabilitation Center, University of Alabama, Birmingham, Alabama) Archives of Physical Medicine and Rehabilitation 60:595-600, December 1979

Energy expenditure of eight male paraplegics was measured by the Mobile Automatic Metabolic Analyzer which provides continuous reading of inspired and expired gas fractions, unlike Douglas bags and Tissot spirometers. All patients were trained with Craig Scott braces. They ranged from 14 to 43 years of age; 7 had functional levels between T9 and T12. Subjects walked on a straight 33.5 meter corridor at comfortable speed.

Five could not maintain a steady rate of ambulation. They averaged a very slow 14 meters/min, ranging from 2.2 to 44 meters/min. Everyone had a rapid rise in oxygen consumption at the onset of exercise which was sustained during ambulation. Energy expenditure, averaging 53 cal/min/kg was equivalent to moderate work in unimpaired men. All subjects were in oxygen debt postwalk. Oxygen uptake returned to within 10 percent of resting level within 12 min after cessation of walking. Subjects consumed 3.1 times their resting rate of oxygen. The subject with the highest lesion, T4, consumed the least oxygen but incurred the greatest oxygen debt.

Paraplegics work with arm and shoulder muscles. Other studies have demonstrated that responses of heart rate, hemodynamics, lactate level, blood pressure, and ventilation to arm work are greater than similar responses to leg work.

Energy Costs of Below-Knee Prostheses Using Two Types of Suspension: Victor Cummings, and others (Department of Rehabilitation Medicine, Albert Einstein College of Medicine, Bronx, New York) Archives of Physical Medicine and Rehabilitation 60:293-297, July 1979.

Seventeen unilateral amputees ranging from 14 to 78 years of age were studied; 13 had diabetes. None had worn a

prosthesis prior to the study. They were fitted with prostheses which could be converted from cuff to corset suspension easily. The corset weighed two pounds more than the cuff. Patients wore a polyethylene bag to collect expired air, and had electrocardiograms immediately after each walk. Each trial was 35 meters long at comfortable speed with a walkerette, twice with the cuff suspension and twice with the corset.

Eight of the patients then received 1 week of prosthetic training, each session consisting of 2 half-hour periods of prosthetic use daily, 3 days with cuff and 3 with corset. Patients stood, balanced, and walked in and outside parallel bars with aid as needed. They also had general conditioning exercises and games.

Walking time and energy cost did not differ significantly between the two suspensions. After training the eight who had been trained had significantly faster cadence, lower total energy expenditure, and lower cost per distance, without distinction as to suspension. No patient had significant increase in heart rate.

Differences in oxygen uptake and speed after one week of brief unstructured exercise were probably due to decreased anxiety and increased emotional adaptability to the task of walking. All patients were deconditioned and had been confined to a bed-wheelchair regimen, causing a detrimental effect on speed and energy, although not exceeding physiologic limits. The excessive energy requirements were probably due to the very slow pace, upper limb work using the walkerette, inexperience with prosthesis, and deconditioning.

Energy Cost of Walking of Below-Knee Amputees Having No Vascular Disease: Michael A. Pagliarulo, Robert Waters, and Helen J. Hislop, University of Southern California, Los Angeles, California. Physical Therapy 59:538-542, May 1979.

Twelve male and three female unilateral below-knee amputees whose amputations were traumatic or congenital participated. All were younger than 40 years, in good health, and had walked with a patellar tendon bearing prosthesis for at least a year. Each walked on a level, 60-meter track under five conditions: free cadence with prosthesis; slow cadence with prosthesis; fast cadence with prosthesis; free cadence without prosthesis, with crutches; fast cadence without prosthesis, with crutches. Their expired air was collected in a modified Douglas bag and analyzed for volume, oxygen, and carbon dioxide content.

Velocity with prosthesis and with crutches did not differ significantly. Crutch use increased the average heart rate to 135 beats/min, compared with the average 106 beats with prosthesis. Respiratory rates were up to 23 breaths/min with crutches,from 16 with prosthesis. Oxygen uptake increased with crutches, whether computed against time or distance. Energy costs with prostheses were higher when subjects walked faster or slower than free cadence.

Although crutch walking did not increase the time to traverse a distance, the increased physiological stress decreases endurance. Comparison of data from this study with previous investigations showed that amputees with prostheses consume 32 percent more energy than nonamputees. The energy cost of amputee crutch walking was 90 percent greater than for nonamputees walking at the same velocity.

Clinicians can assess gait performance and stress by measuring velocity and heart rate, inasmuch as heart rate usually varies with oxygen uptake.

The article is followed by Comments of Discussant James Clinkingbeard, Educational Affairs Director of the American Physical Therapy Association, who complimented the design, sample size, data collection, analysis, and interpretation, but noted while free cadence cost in nonamputees is 39 percent of predicted maximal aerobic capacity, the cost in amputees was 36 percent of predicted capacity although amputees require 32 percent more energy.

A Gait Analyzer/Trainer Instrumentation System: R. H. Gabel, R.C. Johnston, and R.D. Crowninshield (Biomechanics Laboratory, Orthopaedic Surgery Department, University of Iowa, Iowa City, Iowa) Journal of Biomechanics 12:543-549, 1979.

A microprocessor and instrumented walkway measure gait without requiring the subject to wear any apparatus. Foot position is recorded, together with thirteen gait parameters for each cycle. The parameters include step lengths, length ratio, stride length, velocity, cycle time, stance times, single limb support times, and double limb support time. These data are printed and may be retained and later averaged for several trials. The training mode involves audible tones related to step length. The subject learns to produce a gait with minimal deviation of pitch, indicating symmetry.

The walkway consists of flat linear pressure sensitive parallel switches in multiples of sixteen to complement sixteen channel multiplexers. A walkway 3.6 meters long has 240 sensors.

Data may be collected outside the laboratory at a physician's office by secretarial personnel. Data has been obtained from normal subjects, twenty in each of seven decades of life, and on forty preoperative total hip replacement candidates and fifty postoperative patients. Since cadence is nearly constant for normal subjects while velocity decreases with age, stride length must decrease. Preoperative hip patients walk slower, and have lower cadence, shorter stride length and shorter single support times. Postoperative patients walk in a manner similar to normal age mates. Accurate knowledge of gait parameters can provide an index of disability and recovery.

The Impact of Musculoskeletal Disorders on the Population of the United States: Jennifer L. Kelsey, and others (Yale University School of Medicine, New Haven, Connecticut) Journal of Bone and Joint Surgery 61-A: 959-964, October 1979.

The United States National Health Survey reported the frequency of chronic and acute disorders based on a continuing nationwide survey conducted by household

interviews. The data exclude the institutionalized population. Musculoskeletal conditions are the most common, affecting 18.9 millions in 1971, plus 1.4 million paralytics and 0.3 million amputees. The 8 million Americans with back and spinal disorders compose the largest subgroup, followed by those with lower limb (7.4 million) and upper limb (2.4 million) impairments. Musculoskeletal disorders predominate among men and women in each age category. Among acute conditions, respiratory disorders are first, infectious and parasitic ones second, and musculoskeletal third. Musculoskeletal conditions account for the second highest number of physician visits, fifth highest number of hospital visits, and third highest number of operations. They are the leading cause of disability of people in their working years, and rank second only to circulatory disorders among conditions for which disability allowances are granted.

The total cost attributable to musculoskeletal conditions is $20 billion, including lost earnings, lost productivity, and direct medical costs, being second only to circulatory diseases, and totaling $40 billion. Musculoskeletal disorders cost more than any other non-fatal illness. They rank second to circulatory disorders in frequency with which worker's disability allowances are granted, and first in cost as measured by Workmen's Compensation. If this loss had been prevented, the gross national product would have increased by $19 billion.

Back and spinal impairments are most common among persons younger than 45 years. Osteoarthritis affects 13 millions, while rheumatoid arthritis involves five million; the total cost attributable to arthritis is estimated to be $13 billion. Osteoporosis is the most common condition affecting older people. Almost all women older than seventy-five have evidence of lumbar porosis.

The Kinematics and Energy Variations of Swing-Through Crutch Gait: R. P. Wells (Department of Kinesiology, University of Waterloo, Ontario, Canada) Journal of Biomechanics 12:579-585, 1979.

Analysis of the system dynamics of crutch walking involves examination of energy variations of the body. Gaits of three normal subjects walking with axillary crutches in the swing-to and swing-through patterns at various speeds were analyzed in the sagittal plane with additional data obtained on lateral crutch excursion. Timed motion pictures and a force platform were used. One subject also wore hip-knee-ankle-foot orthoses for comparative testing.

The crutch gait cycle begins with heel contact, followed by double support, then crutches are lifted and swung forward during single support phase. A second double support phase occurs, followed by lift and body swing. As speed increases, the proportion of time in double support decreases. As disablement increases, the proportion of time spent in double support increases and the time spent in body swing decreases. As speed rises, range of lower limb motion increases, lengthening the stride. Orthotic restriction of knees decreases shank motion, but does not affect trunk and thigh orientations. Restriction of hip and knees increases sagittal and vertical trunk motion. Slow swing-to gait exhibits almost static behavior between heel contact and thirty-five per cent of the cycle. Later strong energy interchanges occur.

Disablement increases the amplitude of potential and kinetic energy components markedly. The trunk conserves about half of its energy. Crutch walking is tiring because, although a similar amount of mechanical work is done as compared with normal gait, the work is performed by different muscles. The shoulder girdle prime movers in swing and weightbearing are ill-suited to the task. Fatigue is also due to the discontinuous nature of movement. After heel strike, motion comes to a standstill.

Knee Disarticulation Versus Above-Knee Amputation: R. F. Baumgartner (Balgrist Orthopaedic Hospital, University of Zurich, Switzerland) Prosthetics and Orthotics International 3: 15-19, 1979.

If short below-knee amputation is impossible, disarticulation should be considered, regardless of etiology and patient's age. Wound surface is small, minimizing the danger of hemorrhage and infection. In children, the distal epiphyseal line is preserved. The stump is fully endbearing with all thigh muscles intact. Disarticulation leaving the femur and patella untouched is preferable to the Slocum method in which the distal femur and patella are removed, and the Gritti in which the patella is fused to the cut femur.

Disarticulation is performed with the patient supine, with or without a tourniquet. The scar should lie between the condyles, far from the endbearing area. Nerves are cut at least 70 mm proximal from the stump end. Hamstrings are sectioned, and gastrocnemius completely removed. The patellar tendon is sutured to the anterior capsule and the hamstrings to the posterior capsule. There will be no muscular retraction or imbalance, nor bony outgrowth. Total endbearing makes the ischial seat superfluous in the prosthesis. Hip motion is complete.

Postoperative shrinkage is considerable. The dorsal sides of the condyles and the patella are extremely sensitive and must be protected during bandaging, casting, and prosthetic fitting. An inflatable plastic splint is suitable for immediate ambulation.

Superficial necrosis of a small portion of soft tissue can heal conservatively. Larger necrosis including ligaments, cartilage, and bone requires surgery.

New disarticulation prostheses are more functional, comfortable, and cosmetic than above-knee limbs. The socket has an inner foam component, providing total contact and transforming the bulbous stump into a cone. The outer socket is plastic, rigid distally and gradually becoming more flexible proximally for comfortable sitting and easier donning. The socket terminates 50 mm below the inguinal ligament. Above-knee knee units are unsuitable. Various four-bar linkage mechanisms permit acute knee flexion, with or without swing phase control.

Within the past 10 years, the author performed 72 disarticulations, mainly for vascular occlusion; 7 required high above-knee reamputation.

Modular Adjustment Mechanism for the Balanced Forearm Orthosis: William E. Drew and Peter H. Stern (Burke Rehabilitation Center, White Plains, New York) Archives of Physical Medicine and Rehabilitation 60:81, February 1979.

Fitting the balanced forearm orthosis is facilitated by an adjustment mechanism which permits proximal/distal change of the forearm pivot point without disassembling the unit.

A knurled thumbscrew is turned to unlock a rectangular slider bar attached to the forearm trough. The bar can be pushed through the swivel piece (rocker assembly) to any desired location. A reverse turn of the thumbscrew locks the bar.

Screws of varying lengths, inserted into the two threaded holes located proximally and distally to the thumbscrew on the swivel piece, limit the range of elbow elevation (extension) and depression (flexion).

A screw in the distal hole can enable the patient to reach the wheelchair control and his face, yet prevent extreme positions from which he cannot regain balance.

The mechanism is modular, replacing the standard swivel component on commercially available orthoses.

Orthoses to Fit Shoes: R. G. S. Platts, A. Field, and S. Knight (Institute of Orthopaedics, University of London, United Kingdom) Prosthetics and Orthotics International 3:89-90, 1979.

Usual practice has been to fit polypropylene and polyethylene orthoses intimately to the ankle and foot, and then to apply the shoe over the rounded rigid foot piece. The orthosis thus fits the shoe poorly. Orthoses sustain either vertical loading or stabilize the foot horizontally in the sagittal or frontal planes or both. Forces are transferred from the exoskeletal shell-like orthosis through the shoe to the ground. The shoe is also a shell, removable from the orthosis, but connected to it by friction and straps or laces. An intimate fit should be created between the two shells. On uneven ground, the shoe tends to rotate around the ordinary orthotic heel.

To achieve intimate fit of orthosis to shoe, one must obtain the inside shape of the shoe by use of a slightly smaller last of a standard or custom-lasted shoe, or by casting the shoe. A last shell made from the last cast should have an extension at the posterior heel to prevent tissue deformation when taking the weight of a flail leg. The cast of the patient's leg is taken over the last cast which has been taped to the leg. The plastic orthosis molded on the positive version of the patient's cast fits the shoe. Minor heel height variations can be accommodated by the flexibility of the orthotic foot piece.

The method has been used for 54 ortholene knee-ankle-foot orthoses and 31 polypropylene ankle-foot orthoses. It requires that the orthotist have the intended footwear prior to fabrication. This emphasizes the need to coordinate footwear with the orthosis, and makes it easier to control the attitude of the foot when casting.

The Pedynograph: A Clinical Tool for Force Measurement and Gait Analysis in Lower Extremity Amputees: David C. Symington, Philip J. Lowe, and Sandra J. Olney (Department of Rehabilitation Medicine, Queen's University, Kingston, Ontario, Canada) Archives of Physical Medicine and Rehabilitation 60:56-61, February 1979.

Immediate postoperative fitting has made regulation of weightbearing important. Below-knee amputee subjects were fitted with the Winnipeg modular prosthetic system with Kinston prefabricated sockets. A force transducer recording vertical and horizontal loads was placed in the pylon of the prosthesis. Voltage variations were amplified by a signal conditioning unit and displayed on an oscilloscope on a wheeled cart in view of patient, therapist, and operator. Tracings could be photographed.

The pedynograph has been used to study 1 above-knee and 13 below-knee amputees. Case histories illustrate the applications of the device. One patient bore most of her weight on her immature stump, in spite of instructions to the contrary. Variation in tracing indicated lack of proficiency in cane use. The device provides feedback to the patient and therapist about the amount of weight being borne. Tracings change when walking is faster and more consistent. Analysis of tracings identified a specific gait problem and its correction.

The device has been used clinically for 2½ years. It permits continuous exact monitoring and documentation of performance, aiding management decisions, such as selection of walking aid. It assists teaching the regulation of weightbearing.

It requires a half-hour to assemble and prepare the equipment. A physical therapist can learn to operate it in two half-hour sessions. The equipment costs less than $1000, plus the cost of photographic film.

Revascularization or Amputation: A. H. Boontje (University Hospital, Groningen, Netherlands) Prosthetics and Orthotics International 3:20-25, 1979.

Medical and surgical efforts should focus on prevention of limb loss by conservative measures and by revascularization by direct arterial reconstruction and by indirect lumbar sympathectomy. A natural leg is generally preferable to a prosthesis. An amputee risks losing the other leg. Efforts to save the limb should not prolong hospitalization excessively. Factors determining the choice include extent of gangrene, state of ischemia, general bodily condition, angiography, skill of vascular surgeon, effect of revascularization, patient's motivation, his life expectancy and economic factors, and the quality of limb fitting available.

Severe irreversible ischemia with marked discoloration and sensory and motor loss demand amputation. Revascularization is generally unsuccessful when gangrene extends far on the plantar or dorsal aspect of the foot, but is more difficult to predict in patients with limited gangrene; such patients should be observed for several days. Conservative treatment includes elevation, analgesics, dry dressings, and local

incision and drainage, as well as prevention of flexion contractures. Treatment may reduce the manifestations of ischemia to a more distal level, suitable for below-knee amputation. Operative mortality is significantly higher with amputation as compared with vascular reconstruction. A translumbar aortograph is necessary to determine the localization and extent of obstruction. For reconstruction, there should be no inflow obstruction caused by a more cranially located obstruction and no marked outflow obstruction. The effect of reconstruction is not always immediately discernible; rest pains disappear quickly, but necrosis may remain. If necrosis progresses amputation is unavoidable. Toe amputation is required only in purely diabetic angiopathy where there is no obstruction of leg arteries and when infection is controlled, or after arterial reconstruction or lumbar sympathectomy; otherwise a necrotic toe will be shed spontaneously after several months.

Amputation is less time-consuming rehabilitation and carries a relatively certain prognosis of rehabilitation. Poor cardiac function or arthritis interfere with prosthetic fitting. Arterial reconstruction is not indicated in those with extremely short life expectancy. Reconstruction followed by prolonged bedrest may be more expensive than amputation followed by limb-fitting.

Significance of Free Dorsiflexion of the Toes in Walking: Finn Bojsen-Møller and Larry Lamoreux (Anatomy Department C, University of Copenhagen, Denmark and Laboratory of Biomechanics, University of California at Berkeley) Acta Orthopedica Scandinavica 50:471-479, 1979.

Motion and still photographs of 21 normal barefoot students walking at usual speed revealed the duration and range of toe dorsiflexion.

Toes dorsiflex slightly during midswing. At heel strike, the hallux dorsiflexes 20 to 25 degrees and strikes either with the other toes or with the fifth toe and the ball, followed by the second, third, and fourth toes. At push off, the toes rest on the ground while the heel circles 60 degrees about an axis at the metatarsophalangeal joints. Then there is a sudden displacement of the axis to the tip of the hallux, while the toes and metatarsophalangeal joints circled 90 degrees about this point, reducing the relative toe dorsiflexion. At the conclusion of toe contact, only the tip of the hallux remained on the ground. Heel rise starts when the shank inclines forward 8 to 25 degrees, caused by gastrocsoleus tension, rather than by capsular tension. Tension in the flexor hallucis longus causes the ball of the foot to rise after submaximal toe dorsiflexion.

Toe motion reduces the resistance of the foot by nearly 30 percent at the beginning of push off. Motion also prolongs the effectiveness of the triceps and stretches the flexor hallucis longus so it can deliver the final stance thrust. A transverse axis through the first two metatarsophalangeal joints allows forceful pushing on level surfaces, while an oblique axis through the second through fifth toes aids uphill climbing, adjusting the direction of propulsion to ground angle. Toe dorsiflexion also pulls the plantar aponeurosis in windlass action to support the longitudinal arch.

Dorsiflexion converts the normally pliable plantar skin into a firm, stiff structure, ensuring that shear forces from accelerations do not damage skin, but are absorbed by underlying connective tissue and bone. Medial dorsiflexion restricts skin movement more than lateral. A shoe which hinders dorsiflexion restricts plantar tightening and shear transfer. A shoe with a negative heel and rocker sole reduces toe dorsiflexion.

Socket Design for the Above-Knee Amputee: J. Foort (Department of Surgery, University of British Columbia, Vancouver, Canada) Prosthetics and Orthotics International 3:73-81, 1979.

The adjustable brim-fitting equipment, and prefabricated above-knee sockets for temporary use, developed from experience with plaster sockets. Thin laminate jigs were put against the stump which was then wrapped with plaster. These Berkeley Brims were the basis of the shapes from which prefabricated sockets were designed. If all sockets were prefabricated, some people would fall outside the range of socket series. If all were fabricated from objective data, this would create a system of customized sockets. One can replicate a socket, and produce a cosmetic cover, from data taken from the normal leg by machine.

The socket links the amputee to the prosthesis by transmission of support and control; it contains the stump, allowing optimum biological function, provides sensory information to control the prosthesis, and protects the stump.

The adjustable brim-fitting technique is based on the quadrilateral socket and led to the establishment of 10 right and 10 left sockets with adjustable features. The mediolateral diameter of the brim was the basic dimension, and the fundamental design of the proximal socket was the triangle formed by the ischial tuberosity, adductor longus tendon, and greater trochanter. Brims are adjustable on the medial and lateral sides. Selection is based on mediolateral width or the stump diameter. The aim of selection is to lock the stump proximally into the socket.

Ischial weightbearing is the prime source of support during stance phase on the prosthesis. The location of the tuberosity depends on the volume of stump tissues. Every portion of the residual limb contributes to weight support, the amount varying with the period of gait cycle. Forces should be distributed along the entirety of the limb with firm distal support.

The casting method is described, as is model modification, and recommendations for use of prefabricated socket for temporary prostheses. A feasible, economically sound method for shape data processing is included.

Socket Fabrication: J. Van Rolleghem and X. Berteele (Centre Belge D'Appareillage Orthopedique et de Prothese, Brussels, Belgium) Prosthetics and Orthotics International 3:68-72, 1979.

Controversy still exists regarding the best method of making an above-knee socket. Immediate or early prosthetic fitting should not deform the stump by causing skin folds in the upper region. Postoperative edema must be controlled. The authors

give each amputee a leaflet informing them of the advantages of good stump preparation. They also inform the nursing staff. For those with persistent edema, a Jobst pump is used and the patient is fitted with a temporary socket.

Suspension by waist belt and front opening polyethylene sockets are no longer used. The socket should contact all portions of the stump including the distal end. Allowance must be made for muscle function in the socket. Bearing on the ischial tuberosity is not ideal because of its position and shape, but is the only bony bearing point. It is impossible to cast by using only the hands because they are unreliable.

A series of above-knee quadrilateral brims are used. The casting brim should be low to avoid changing the shape of the stump when casting. Sizing is based on mediolateral dimension, the lowest being 2 cm medial and 4 to 5 cm lateral, and the largest is 5 to 6 cm medial, and 10 to 12 cm lateral. The brim has four points of suspension, at medial posterior aspect, medial anterior aspect, at the gluteus maximus, and at the rectus femoris, all with cables and hooks. There are thirteen basic left and right brims, plus eight sets of left and right brims for short or atrophied stumps with more anteroposterior pressure and greater ischial support.

The patient stands during casting. Suspension is adjusted to provide a horizontal seat with weight bearing. Geriatric or bilateral amputees may use a special chair. Information on physical condition of the stump aids correction of the positive cast. The plastic socket is made of polyamide felt, glass fibre and nylon tubing, together with polyester resin. Contact is intimate for children and those with firm stumps, but intermediate for geriatric patients where filling with polyurethane balls or injected silicone is used. More than three thousand patients have been fitted with this method. For patients with flexed stumps, a "S" shaped tube is fitted below the knee joint to place the foot posterior to give stability.

The patient dons the prosthesis by sitting, wrapping a cord around his stump from the proximal thigh to the end, passing the cord through the valve opening. He pushes himself into the socket, and pulls the cord out. A new socket is required for the primary amputee after four to six months.

The following article has been abstracted by Susan L. Rendsburg, Research Physical Therapist, Institute of Rehabilitation Medicine, and H.R. Lehneis, Ph. D., C.P.O., Director, Orthotics and Prosthetics, Institute of Rehabilitation Medicine, NYU Medical Center, 400 E. 34th St., New York, N.Y. 10016

Are Present Socket Shapes Appropriate for Geriatric Amputees? A. Bähler; Orthopädie Technik (in German with French and English abstracts) 30(11):175-177, Nov. 1979.

The quality of a prosthesis is determined by its construction and the fit of the stump. The above-knee socket brim shape popular in Europe is the cross-oval (in the M-L direction) configuration. Another shape used, coming from the Anglo-Saxon countries, is the quadrilateral shape. Both configurations have their pro's and con's (the cross-oval shape is preferred by the author).

With increasing longevity and with a higher percentage of people with vascular problems, the number of lower-extremity amputations increases. Thanks to improvements in medical care, a high percentage of these amputees can be rehabilitated. It is evident that something must be done with geriatric amputees, taking the basic illness into consideration. With circulatory problems, some patients have difficulty adjusting—and apathy results.

Special attention should be given to fitting of the residual limb more thoroughly. Flabby, weak muscles prevent firm contact between socket wall and stump. However, too tight a fit is to be avoided as well, as it would compromise an already endangered circulatory system of lymph and venous return flow, and would block arterial flow. Within hours, damage may occur which may take weeks or months to heal. This problem emphasizes the importance of proper fitting. In this respect, the most crucial area of concern is the inguinal area. Most important in this area is the trigonum femorale, or femoral triangle. In this region, a cross-section of the thigh at the level of the anterior proximal socket brim will show the femoral artery and vein directly behind the anterior subcutaneous tissue. Thumb pressure at this point can stop arterial and venous flow of blood. Similarly, incorrect socket shape at the anterior brim can give like negative results.

Especially in sitting, an incorrectly formed socket brim can cause increased pressure in the inguinal area. The "veinstar" in this region is especially sensitive to pressure. Here, the whole venous backflow of the blood out of the leg can be interrupted at one point. It has been shown that not only does such interruption at the level of the inguinal ligament affect the normal arterial-venous circulation, but that even strongly developed collateral circulation provides only partial compensation. The posterior seat region of the brim is relatively less problematic; because of anatomical reasons, that rarely causes circulation problems.

While the cross-oval shape provides good control of the prosthesis in geriatric patients, the pad over the femoral triangle can exert too great a pressure on the femoral artery and vein, in an area where circulation is already precarious. The quadrilateral shape minimizes this danger, but sacrifices and minimizes stability needed for prosthetic control. (Reviewer's note: the converse would seem to be true since the Scarpa's pad in the quadrilateral socket is more prominent than in the cross-oval shape.) As yet, there is no ideal solution to these problems.

Signs of failure in this endeavor are discoloration and edema. When all else fails, it becomes necessary to apply a Silesian bandage, and, in some cases, a shoulder strap.

(Reviewer's note: presumably because of a looser fit.)

The changes in the residual limb — discoloration, edema — lead to a further prerequisite for successful fitting — total contact. The more precisely the residual limb's end is fitted, the better are wound healing and blood circulation. Blood circulation is the most important consideration with a geriatric amputee, and it depends on socket fit.

The question whether present socket shapes are suitable for geriatric patients can be answered with a qualified "yes": the prerequisite for successful management is and remains blood circulation in the residual limb, which, for the most part, depends on the socket fit but must not be compromised by the socket brim.

In summary,

1. Prosthetics management of patients with peripheral vascular disease requires precise anatomical knowledge, especially of the precarious regions; e.g., femoral triangle.
2. The geriatric patient suffers from a basic disease which affects the entire body and which must be considered in prosthetics management.
3. Special attention must be given to a broad area pressure distribution across the femoral triangle.
4. The total-contact socket is a prerequisite for optimal socket fit.
5. Auxiliary suspensions may be necessary in difficult cases which require a loose socket fit.

Ehlers-Danlos Syndrome: The Amputation and Rehabilitation of a Patient (A Case Report): L. Reyes, G. Kulick, J. Ho Cho, and A. Stensrud. Orthopadie Technik 30(11):172 — 174, Nov. 1979.

Ehlers-Danlos Syndrome is a severe disturbance of the collagen structure. It is characterized by hyper-extension of the joints, hyper-flexible skin, and a tendency toward bruising. Although there are uncountable examples of the surgical difficulty with this disease to be found in the literature, amputation was found in only one reference (Johnson, S.A.M., and Falls, H.F.: Ehlers-Danlos Syndrome. Arch. Derm. Syph., 60 (1949), 82-105), though this did not include the post-operative healing and rehabilitation process.

Described is a case report from Helen Hayes Hospital of a 40-year-old white female amputee with Ehlers-Danlos Syndrome. Related rehabilitation problems are described. At the age of 22, the patient received a Syme amputation on the right and a pantalar arthrodesis on the left. Since the time of surgical intervention, the patient had been confined to a wheelchair. Following the amputation, wound-healing took more than one year, at which time she was fitted with a PTB SCSP (Supracondylar Suprapatellar) BK prosthesis. The severe looseness of the soft tissue caused a number of problems:

1. There was a heavy flesh roll proximal to the brim of the socket.
2. Loose tissue combined with the long Syme stump produced negative pressure in the socket which made it difficult to remove the prosthesis.
3. Instability of the knee joint and the jell-like consistency of the soft tissue caused an unsatisfactory gait, especially through insufficient knee-joint control. The flesh roll and the suction effect caused bleeding in the thin, easily-damaged skin.

Examination of the patient showed the following symptoms: bruising of the skin, severe stretchability of the skin, numerous large but well-defined areas of bleeding on both legs in various degrees of healing, and, in the calf areas, the beginning of several hematomas, hyperextension of all joints including genu valgum and recurvatum bilaterally. The left foot was fixed in 30° of equinus.

Rehabilitation management consisted of fitting the entire left lower limb with a Jobst elastic stocking with 25-mmHg compression, which significantly reduced the jell-like movement of the tissues. The patient was fitted with an ischial seat, thigh cuff, and side joints on a patellar-tendon-bearing BK prosthesis, with the side joints set at 5° of flexure. Holes were drilled into the socket to avoid the formation of negative pressure. Distributing weightbearing between the ischium and the patellar tendon reduced the pressure on the blood vessels in the soft tissues of the limb.

Cosmetic considerations were believed to be very important since the patient has spent so many years in a wheelchair and now needs to be motivated in the use of a prosthesis.

A Statistical Study on Wheelchair Management — 8 Years Wheelchair Supply by the Health Insurance Section, Stuttgart (Part II). E. Seifert and P. Simon. Orthopädie Technik, 30(8):128, Aug. 1979.

A detailed study is presented of the supply of wheelchairs to 962 patients over a period of eight years. Tables presented list diagnostic cause, age, sex, and the prescribers of the wheelchairs by medical specialty.

Regarding age, it is noted that users of wheelchairs who have bone and joint changes are mostly over 60. The same may be said for patients with neuromuscular changes, hemiparesis. The age of patients with muscular sclerosis lies between 30 and 70. Cerebal palsy affects children overwhelmingly, up to the age of 15. As expected, muscular dystrophy is rarely extant beyond the 15th year.

Of special interest was the fact that approximately 50 percent of all wheelchairs were prescribed by general practitioners, 22 percent in clinics, while only 3.7 percent were prescribed by orthopedists. The most common causes for supplying the wheelchairs were hemiparesis, CVA's, amputation, and arthrosis.