

# Abstracts of Recent Articles

The following articles have been abstracted by Joan E. Edelstein, R.P.T., who is a Senior Research Scientist, New York University Post-Graduate Medical School, Prosthetics and Orthotics, 317 East 34th Street, New York, N.Y. 10016.

**Kinematics of the Elbow:** James T. London (San Pedro, California) *Journal of Bone and Joint Surgery* 63-A:529-535, April 1981.

Kinematic analysis of the normal elbow can define the axis or axes of rotation and the type of motion occurring at the joint surfaces. Previous studies produced conflicting results, such as a locus of instant centers, a pathway of instant centers, and changes in the carrying angle following either linear or oscillatory patterns. Disparities may be related to the analytic techniques.

This study used a refinement of Reuleaux's technique, based on the concept that as two bones move in relation to one another in a single plane, there is at any instant an axis of rotation that has zero velocity where joint motion is pure rotation. Using X-rays in lateral view, for each increment of elbow flexion the instant centers of rotation of the radiohumeral and the ulnohumeral joint are superimposed on each other. The two points define a line that is the axis of rotation. Previous measurements of 50 cadaver elbows revealed considerable variation in size of the distal end of the humerus, but minimal variation in shape. The sulcus of the trochlea forms a nearly complete circle from the center of the coronoid fossa to the center of the olecranon fossa. The plane of the trochlear sulcus defines the plane of elbow flexion.

Eight elbows were x-rayed, four from cadavers and four from healthy individuals. Flexion and extension occur about a single axis and are of a sliding type, except at the extremes of the range, when the axis moves and rolling occurs. The axis passes through the center of the arcs formed by the trochlear sulcus and the capitellum. The axis of elbow rotation is internally rotated 3 to 8 degrees from the plane through the epicondyles. The carrying angle remains constant throughout the range of flexion.

**The Role of Joint Load in Knee Stability:** Keith L. Markolf, William L. Bargas, Stephen C. Shoemaker, and Harlan C. Amstutz (Division of Orthopedic Surgery, University of California, Los Angeles, California) *Journal of Bone and Joint Surgery* 63-A:570-585, April 1981.

The effects of tibiofemoral contact force on knee stability and the role of the menisci were investigated in eight cadaver knees. They were tested on a servohydraulic materials-testing machine, subjecting the joints to varus-valgus stress, tibial torsion, anterior-posterior drawer testing, and mediolateral shear testing.

In each test mode, the knees stiffened with applied joint loading, indicating the protective mechanism afforded by the

ligaments. Unloaded knees resisted applied forces internally by the ligaments and capsule. Displacements and rotations caused by external loads were converted to internal ligament strains. The increases in stiffness and decreases in laxity when compression is applied indicate that less tibial displacement and rotation result from a given force and that ligament strains will be reduced, especially when varus-valgus stress is applied. Joint congruency, a function of the contours of the tibial plateaus and femoral condyles, contributes to the stabilizing effect of joint loading. Menisci did not resist medio-lateral tibial movements at full extension very much. The menisci stabilized against antero-posterior displacement and torsion somewhat more. Their greatest effect was evident in varus-valgus tests when the knees were not loaded. Compression is generated by superincumbent body weight and the knee muscles. The neuromuscular control system in vivo can stabilize a flexed knee in stance.

**Burns Following Application of Plaster Splint Dressings:**

Samuel S. Kaplan (Scottsdale, Arizona) *Journal of Bone and Joint Surgery* 63-A:670-672, April 1981.

Arabs were probably the first to use plaster in the ninth century, mixing calcium oxide and egg whites to make a rigid dressing for fractures. Calcium sulphate was introduced in 1798, a less irritating but more difficult mixture to apply. In 1852, Antonius Mathysen impregnated cotton bandage with plaster. In 1900 a loose-coated bandage became commercially available. In 1927 binders such as starch and gum were added to create the hard-coated bandage.

The basic chemical reaction when plaster reacts with water to create gypsum is exothermic. Two patients who sustained second- and third-degree burns are described—one of these cases resulted in litigation with settlement in the plaintiff's favor. Both patients' burns healed spontaneously. Both had had plaster splints, rather than cylindrical casts.

References to elevated temperatures are cited. Temperatures of 50 degrees Celsius have been recorded ten minutes after plaster application. A third-degree burn can result if such temperature is sustained for five to 15 minutes. Second-degree burns occur with high temperature lasting 12 minutes, and seven minutes of heat causes burn blisters. The temperature generated from heat of crystallization varies from 32.2 to 82.2 degrees Celsius. Thicker dressings increase more in temperature because plaster dries from the outside to the inside. Covering plaster with cotton bandage or other insulation slows heat transfer, allowing higher temperatures within the plaster. Immersing plaster too briefly may cause rapid, intense

local heat, as can squeezing water too thoroughly before application of plaster; water has a high capacity for specific heat absorption. Water temperature should remain cooler than 40 degrees Celsius.

**Idiopathic Scoliosis:** Stuart L. Weinstein, Donald C. Zavala, and Ignacio V. Ponseti (Department of Orthopedic Surgery, University of Iowa Hospitals and Clinics, Iowa City, Iowa) *Journal of Bone and Joint Surgery* 63-A:702-712, June 1981.

One hundred ninety-four patients with untreated adolescent idiopathic scoliosis were evaluated. Of these, 33 had died; the average age of the living patients was 53 years. Eighty-four percent were women. About a third had thoracic curves, a quarter had lumbar curves. Approximately one-quarter of the group had curves less than 50 degrees, and half had curves greater than 75 degrees. Most patients are homemakers or gainfully employed. A fifth of the group had mild psychological reactions to their deformity, but none required psychiatric treatment. Backache was reported by about 60 percent of the population, particularly those with thoraco-lumbar curves. Osteoarthritic changes were found in X-rays of the spines of approximately one-third of the patients who had recent X-rays. Twenty-nine percent complained of shortness of breath that limited their activities, particularly those with thoracic curves. Diminished vital capacity correlated well with severity of the thoracic curve.

Nearly all of the group were married, a finding contrasting with other studies. The mortality of the current group is similar to that of the general population, but differs significantly from the findings of other investigations. Inasmuch as a relatively small number of patients complained of back pain, surgery is seldom indicated; surgery may not have a beneficial effect on pulmonary function. Patients whose curves are unresponsive to bracing are treated surgically, sacrificing spinal mobility. Those with double major or lumbar curves that are not severe should be braced, so that with aging they will not be limited by pulmonary dysfunction or backache.

**The Effect of Prolonged Physical Training on the Properties of Long Bone: A Study of Wolff's Law:** Savio L.-Y. Woo and others (Division of Orthopedic Surgery, University of California, San Diego, California) *Journal of Bone and Joint Surgery* 63-A:780-787, June 1981.

Mechanical and geometric properties of bone were studied following long-term exercise. These properties were correlated with biochemical composition of bone including density, ash content, and calcium content.

Nine swine were subjected to 12 months of exercise training on a treadmill and track. The animals ran an average of 40 kilometers per week. Four animals were kept sedentary as controls. The animals were killed and their femora sectioned. The bony samples were subjected to materials testing.

Exercise had a more pronounced effect on the posterior part of the femur. The mechanical properties, represented by the modulus of elasticity and ultimate bending stress, were similar for the control and exercised animals. Bone from exercised animals had a third more maximum load and maximum energy stored. Biochemical analysis of bone composition showed no difference between the groups. The experiment showed

that exercise increases the internal stresses in bone which responds by increasing cortical thickness and narrowing the medullary cavity, although the quality of bone was unchanged. Cortical thickness in the exercise group increased by 17 percent.

**Case Note—A Combined End-Bearing and Patellar-Tendon-Bearing Prosthesis for Chopart's Amputation:** N. M. Moustapha, F. McCard and A. T. Brand (Artificial Limb and Appliance Centre, Liverpool, England) *Prosthetics and Orthotics International* 4:156-158, December 1980.

A 42 year old woman had a "verruca" removed from her right foot 11 years ago. An ulcer developed which led to partial foot ablation at the Chopart level. Sepsis postoperatively delayed healing, but the end result was a mobile ankle with neutrally positioned calcaneus. The amputation limb was too short and bulky for ladies' footwear, and was tender on the plantar surface and at the anterior scar which was adherent.

A blocked leather prosthesis was fabricated combining socket, shin, heel and sole attached to a wood forefoot. The socket is a patellar tendon bearing design permitting partial end-bearing on a distal pad. The prosthesis opens posteriorly. An elastic stocking closes the split and suspends the prosthesis.

The patient walks well and performs a full day's work as a housewife, wearing the prosthesis 5 hours a day. Although most patients with a Chopart amputation can be fitted with the "Ortholen" prosthesis which assumes a good end-bearing sole pad and neutral foot, the present prosthesis is an alternative combining end-bearing and proximal-bearing in a cosmetically and functionally acceptable manner.

**Reproducibility of Gait Measurement Using the Lamoreux Goniometer:** E. Jansen and H. Orbaek (Department of Orthopaedic Surgery T-2, Gentofte Hospital, Copenhagen, Denmark) *Prosthetics and Orthotics International* 4:159-161, December 1980.

A self-aligning goniometer was designed by Lamoreux in 1971 at the University of California and is now manufactured by Een-Holmgren, A.B., Uppsala, Sweden. Four goniometers were mounted on an aluminum exoskeleton, part of a self-aligning system of parallelogram linkage and a sliding rod. The goniometers use potentiometers of conductive plastic. The subject walked on a treadmill at an average speed of 4 km/hour. The system was applied 10 consecutive times by the same operator; 60 seconds of continuous recordings were used in each test.

None of the tests was significantly different from the others, indicating that the self-alignment of the goniometers functioned well when measuring hip and knee flexion and extension. There was no difference between the right and left side recordings.

The goniometers are thus suitable for basic gait studies, as aids to alignment of lower limb prostheses, and as a tool of control following surgical or medical procedures.

The standard deviation of maximum flexion/extension was approximately 5 percent at the hip and 10 percent at the knee.

**A Clinical Study of Amputations of the Lower Limb:** A. K. Agarwal, M. K. Goel, R. K. Srivastava, and S. Rastogi (Re-

habilitation and Artificial Limb Centre, K.G.'s Medical College, Lucknow, India) *Prosthetics and Orthotics International* 4:162-164, December 1980.

A retrospective study of 525 lower limb amputees treated from January 1976 to March 1978 was conducted. Nearly all were men. Half were between 21 and 40 years of age. Approximately two-thirds of the amputations were due to trauma, particularly train and automobile accidents. Fifty-seven percent of the cases were below-knee amputations. Three-fourths were suitable for prosthetic fitting with either a standard or modified prosthesis.

On first attendance in the outpatient department approximately 10 percent required amputation limb preparation and preprosthetic management. Less than 3 percent had infection, which was treated with local dressing.

Other causes of amputations in the group of 343 traumatic amputees were crush injuries, firearm injuries, and miscellaneous trauma, such as falls. In the smaller group of nontraumatic amputees, approximately 20 percent had vascular disease. Less than 10 percent had neoplastic lesions.

Other than below-knee amputations, a third had above-knee amputations, and fewer than 5 percent had foot amputations, Syme's, through-knee, and through-hip amputations. Twelve percent of the entire group required surgical correction prior to prosthetic fitting. Approximately one-fourth of the below-knee amputees had short and very short amputation limbs, and fewer than 18 percent of the above-knee amputees had short or very short limbs.

**An Integrated Biomechanical-Bioenergetic Technique for Evaluation of Human Locomotion:** D. N. Tibarewala, A. K. Ghosh, and S. Ganguli (Bioengineering Unit, University College of Medicine, Calcutta University, India) *Journal of Medical Engineering and Technology* 4:241-246, September 1980.

Level walking characteristics of 10 normal subjects and 10 individuals with various lower-limb paralyses and amputations were analyzed to determine temporal, kinematic, and kinetic factors, and energy expenditure simultaneously. The instantaneous velocity of each subject's center of gravity was recorded, together with analysis of expired air, as subjects walked at comfortable and fast speeds. These data were used to construct a gait abnormality index, a measure of temporal gait asymmetry.

The investigators derived a walking efficiency factor by dividing the energy expenditure by the product of body weight times distance traversed. This factor ignores the pace and pattern of walking, which are components of the gait abnormality index. Normal and handicapped locomotion can therefore be evaluated in terms of walking efficiency factor, walking velocity, and the gait abnormality index. Statistical correlation theory demonstrates that the cumbersome energy expenditure measurement can be avoided, because this ergonomical parameter can be estimated from the biomechanical parameters of gait abnormality index and velocity.

**The Changing Pattern of Scoliosis Treatment Due to Effective Screening:** Gunnar Torell, Anders Nordwall, and Alf Nachemson (Department of Orthopaedic Surgery I, Sahlgren Hospital, Goteborg, Sweden) *Journal of Bone and Joint Surgery* 63-A:337-341, March 1981.

The effect of early detection and treatment of scoliosis was assessed in a stable population in Sweden between 1968 and 1978. The study was done at the only center for referral in the western district of Sweden. All patients younger than 20 years who were referred to the center were studied—a sample of 725 individuals. They were followed with regard to development of curve, chronological and skeletal age, and treatment. The mean age at referral was 14 years, and more than 90 percent were female. For the first 5 years of the study, all with curves between 25 and 45 degrees were treated with a Milwaukee brace. Those with smaller curves were observed, and larger curves were operated on. In 1976 the maximum thoracic curve braced was 40 degrees. Since 1977 the minimum curve braced was 30 degrees. Since 1976 the Boston brace has been used for all curves between 25 and 40 degrees with an apex at or below the tenth thoracic vertebra. In 1968 a scoliosis information campaign was launched, but no specific training in screening was provided.

Although a constant number of children had been born during the study period, many more referrals were noted, almost a fivefold increase, with the mean age of referral decreased, and the size of the curve decreased from 46 to 28 degrees at referral. Fewer patients with severe curves were noted. Early in the study, 32 percent had surgery; later only 12 percent required operation.

**The Anterior Aspect of the Knee Joint:** Bruce Reider, John L. Marshall, Bert Koslin, Bruce Ring, and Fakhry G. Girgis (Hospital for Special Surgery, New York, New York) *Journal of Bone and Joint Surgery* 63-A:351-356, March 1981.

Forty-eight cadaver knees were dissected, approximately half from men. Knees were from subjects ranging from 40 to more than 80 years of age.

The four-part structure of the quadriceps was identified. The four bellies become aponeurotic at the anterior aspect of the knee. The rectus femoris is a long fusiform muscle, which narrowed to a tendon from 5 to 8 centimeters above the superior aspect of the patella. The tendon fans distally as it approaches the patella, and continues over the anterior surface of the patella into the infrapatellar tendon. Most subjects had continuity of tendinous fibers.

The vastus medialis obliquus showed wide range of angular variation. The vastus lateralis approaches the patella at an average 31 degree angle. Its fibers terminate more proximally than do those of the vastus medialis. The vastus intermedius fibers insert directly into the superior border of the patella, never continuing over the anterior surface. The articularis genu and fascial investments of the knee were also measured, as were the patella and infrapatellar tendon. Negative correlation exists between the length of that tendon and the width of the medial patellofemoral ligament, as seen in patella alta with lateral patellar deviation. Much variability exists on the lateral side of the knee, associated with patellar deviation and chondromalacia patellae. Lateral tethering of the patella restricts patellar mobility.

**The Biomechanics of Control in Upper-Extremity Prostheses:** Craig L. Taylor (University of California, Los Angeles, California) *Orthotics and Prosthetics* 35:7-28, March 1981.

This article appeared originally in "Artificial Limbs," September 1955. Structural replacement of the missing hand and arm is comparatively easy. Functional replacement by remote control and substitute mechanisms is much harder. The man-machine combination determines performance.

Bony landmarks enable accurate positioning of prosthetic components. Typical measurements of the male torso were derived from Army personnel. They establish harness patterns and control paths, and the basis for sizing prostheses for unilateral and bilateral amputees. The motions of the arm are simplified, stated in terms of the three spatial planes, rather than as intermediate angular excursions.

The shoulder girdle consists of the scapula and clavicle, although the proximal humerus contributes to coordinated activity of the girdle. Muscular control of the various joints of the girdle is described in terms of the motions produced. The humerus and its glenohumeral joint comprises the arm. Muscular control of the arm and of combined arm and shoulder movements are illustrated, as are control mechanisms of the forearm.

Musculoskeletal mechanisms are analyzed in terms of bony structure, synovial characteristics, and muscle fiber arrangements. Maximum torques at each joint are charted. Prosthetic sockets obtain purchase on the limb and must bear weight axially and laterally, as well as serving as attachment for mechanical components. Single, dual, cineplasty, and triple control systems for all amputation levels are analyzed.

**New Casting Material and Improved Functional Design for Lower Femoral Fracture Bracing:** T. Vaughan-Lane and B. F. Meggitt (Orthopaedic Department, Addenbrooke's Hospital, Cambridge, England) *Prosthetics and Orthotics International* 4:145-149, December 1980.

Cast bracing combines the advantages of safe conservative treatment with early mobilization associated with internal fixation, without risk of infection and other surgical problems. Crystona, white alumino-silicate polyacrylic acid in a bandage, is activated by immersion in tepid water. It has a longer setting time than plaster, up to 12 minutes, and is more adhesive. The resulting cast is twice as strong, allowing full weightbearing within 1 hour of application. The cast is porous, unaffected by water, and can be removed with plaster shears.

The knee hinge cylinder brace has been used in treatment of over 200 distal femoral fractures since 1973. The older brace had a quadrilateral thigh section joined by polycentric hinges to a below-knee walking cast. It functions as an antibuckling tube, with leg loading limited by the fracture load itself, rather than the cast. Thus, weight transference through the foot cast was unnecessary. The newer brace has adjustable three-point suspension from a waist belt to studs in the thigh section, polycentric hinges, a calf enclosure, and no ankle or foot components. A foot section is needed by patients with conical thighs where suspension would be difficult otherwise.

The brace is applied at 5 to 7 weeks when early callus has formed. The patient walks with crutches one hour later, initially with knee locked, then with locking screws removed permanently. The brace is removed when the patient can place full weight for 10 seconds steady standing on the leg.

**Selected Factors Influencing Job Satisfaction of Attendants of Physically Disabled Adults:** Madelyn Stelmach, Jan Postma, Steven Goldstein, and Katherine F. Shepard (Ralph Davies Medical Center, San Francisco, California) *Rehabilitation Literature* 42:130-137, May-June 1981.

Forty attendant care workers were interviewed, with data entered on demographic collection forms, a standardized interview schedule consisting of eight open-ended questions, a modification of Locke's Action Tendency Interview Schedule for job satisfaction, and a five-point self-rated scale developed by the investigators. The study was prompted by the comments of many disabled people that attendants are difficult to retain.

Three-fourths of the sample were women. The group ranged from 18 to 65 years of age, most being younger than 30. The disabled cared for by these attendants were approximately 50 percent male; 70 percent were older than 30. Most needed more than 25 hours per week of care. Two-thirds of the disabled required multiple attendants. The disabled person was the most often-cited source of information about disability and specific skills needed for the job. Health professionals were mentioned by 30 percent of attendants as a source of skill training. The most often-cited positive factors, according to attendants, were doing worthwhile work, having a satisfactory schedule, and friendship with the disabled person. Attendants least-liked aspects of the work schedule: wages and benefits, and attitudes of the disabled person toward the attendant.

Inasmuch as the independent living movement (which makes disabled people, rather than health professionals, responsible for control of their own medical and personal needs) is increasing in importance, disabled people should be prepared to supervise, educate, and train their attendants. The most satisfied attendants were those who had held five or more previous attendant jobs, and those caring for persons needing less than 25 hours weekly care.

**Hip Hinge Thigh Brace for Early Mobilization of Proximal Femoral Shaft Fractures:** B. F. Meggitt and T. Vaughan-Lane (Orthopaedic Department, Addenbrooke's Hospital, Cambridge, England) *Prosthetics and Orthotics International* 4:150-155, December 1980.

Conventional cast bracing cannot control the position of upper femoral shaft fractures, primarily lateral bending. The new brace controls varus buckling by lateral support at the fracture site with medial support at the pelvis and at the distal femur. The distal fixation is provided by a thigh cast extending to just above the knee. Knee hinges and a calf section are unnecessary. Proximal fixation consists of a quadrilateral thigh cast attached to a metal uniplanar hip hinge and rigid pelvic band unit. The band continues to a waist belt and is suspended by a shoulder strap.

The hip hinge thigh brace was introduced in 1976, and in 1978 was made of Crystona, a lighter material than plaster. It is applied when the fracture is at the stable callus state, by 7 weeks. After 1 hour, the patient can walk with crutches, moving the hip and knee actively with maximal weight-bearing. The brace is removed when the limb tolerates full body weightbearing for 10 seconds.

After skeletal traction is removed, the patient sits on a firm

support with the thigh held by an assistant. The hip axis is marked at the greater trochanter. Stockinette is applied from groin to below knee, then an elastic bandage above knee to ankle, covered by an elastic knee support. Felt is placed around the groin and also above the patella. Crystona is wrapped on the thigh, and a quadrilateral thigh mold is positioned to shape the plastic; then the mold is removed. The rigid pelvic band and hinge are positioned with the leg abducted 20 degrees and fixed firmly with Crystona. Shoulder and waist straps are attached.

**A Terminal Question:** Robert Radocy and Ronald E. Dick (Therapeutic Recreation Systems, Boulder, Colorado) *Orthotics and Prosthetics* 35:1-6, March 1981.

Upper limb prosthetic terminal devices have remained unchanged for more than a quarter century. Most hooks are voluntary-opening split hooks. Such hooks are inadequate, for they provide forceps pinch with grip strength limited by the power provided by rubber bands or springs (approximately 4 pounds per rubber band.) These hooks are suitable for light use by bilateral amputees, but tools tend to be forced out when pressure on the hook fingers exceeds the capacity of the rubber bands.

The voluntary-opening system uses relative motion between parts of the human body through a harness and cable system to open the fingers by overcoming a closing force. The voluntary-closing system is one in which the amputee closes the fingers by overcoming an opening force. The merits of each system should be evaluated in relation to the needs of specific segments of the amputee population. Unilateral below-elbow amputees, the majority of the population, wear the same terminal device as bilateral and above-elbow amputees, although the unilateral below-elbow amputee has more leverage. This patient needs a useful option. Earlier analyses concluded that the voluntary-closing principle is the most desirable if engineering problems can be solved.

Many designs are improvements on the split hook. Amputees should be involved in design efforts. Interviews with below-elbow amputees reveal strong opposition to myoelectric control because of its fragility and lack of feedback. Weight, size, locking, appearance, versatility, and reliability are important factors in terminal device design.

**Cardiovascular Stress of Crutch Walking:** Robert Patterson and Steven V. Fisher (Department of Physical Medicine and Rehabilitation, University of Minnesota Hospitals, Minneapolis, Minnesota) *Archives of Physical Medicine and Rehabilitation* 62:257-260, June 1981.

Eight healthy young men ambulated with underarm crutches using the three-point gait pattern at six speeds on level surfaces; they also walked up a 5 percent incline and climbed 19-cm-high steps at two speeds. Each task was performed twice, and most runs were performed for 6 minutes. Not more than three runs were performed on a given day. Respiratory gases were collected and analyzed. The subjects also had upper-extremity and lower-extremity stress tests.

The slope of the heart rate response compared with oxygen uptake parallels the response for the upper-extremity stress test; this slope is much steeper than for the lower-extremity

stress test. Thus, upper-extremity work causes a significantly higher heart rate than does lower-extremity work. A continuous increase in heart rate was observed at all speeds. Heart rate does not achieve steady state during upper extremity activity except at light workloads or after 6 minutes. The rise in the ventilatory equivalent at relatively faster crutch speeds suggests the development of anaerobic metabolism.

The average energy requirements of level crutch walking at 60 meters per minute is approximately two-thirds of the maximal upper-extremity stress test values. The rise in heart rate may be due to shift from fat to carbohydrate metabolism, balance between hyperventilation and hypoventilation, central response to arterial acidosis, and response due to stimulation of peripheral receptors where specific muscles are heavily loaded. A subject with pulse rate limit of 140 beats per minute could either crutch walk at 60 meters per minute or run at 134 meters per minute.

**Disabled and Nondisabled Persons' Satisfaction with Conditions in the World of Work Before and After the Rehabilitation Act of 1973:** Stanford E. Rubin, Charles E. Worth and William G. Emener (Rehabilitation Institute, Southern Illinois University, Carbondale, Illinois) *Rehabilitation Literature* 42:138-142, May-June 1981.

Section 503 of the Rehabilitation Act of 1973 mandates federal contractors with a contract of more than \$2500 to actively employ and advance qualified handicapped persons. Section 504 of the act requires employers to make reasonable accommodations for handicapped persons. One hundred fifteen questionnaire respondents from the National Association of the Physically Handicapped, Inc., and from Mobility on Wheels participated. Most were male, older than 40 years, and had been disabled for an average of nearly 30 years. Half used a wheelchair. A random sample of 250 individuals from the general population was also surveyed. Both groups compared working conditions during the periods 1968 to 1973 and the period 1974 to 1979.

The only significant difference between work perceptions before and after 1973 was in the way the supervisor treated those confined to a wheelchair who were younger than 39 years. The 1973 law apparently has not affected employment conditions for able-bodied workers. The disabled noted a significant positive change in supervisors' attitudes, and satisfaction with salary, as well as in the attitudes of co-workers.

**Energy Cost of Ambulation with Crutches:** Steven V. Fisher and Robert P. Patterson (Department of Physical Medicine and Rehabilitation, Saint Paul-Ramsey Medical Center, Saint Paul, Minnesota) *Archives of Physical Medicine and Rehabilitation* 62:250-256, June 1981.

Eight healthy young men ambulated with underarm crutches on a level surface, walking with three speeds; they also walked on a 5 percent ramp, and climbed stairs at several speeds. Four also ambulated with forearm crutches on level surfaces and up stairs. All subjects also ambulated on all surfaces without crutches. An electrocardiogram was recorded continuously and oxygen consumption and ventilation were monitored with an Oxylog portable oxygen consumption device. Expired gas samples were obtained in meteorologic bags. Stress test-

ing was conducted with an upper-extremity maximum bicycle ergometer and a lower-extremity maximum treadmill. Speed, oxygen consumption and ventilation, calories, heart rate, cadence and step length were recorded for each ambulatory situation. The data were compared with figures published in four other studies by other investigators.

The current subjects had a twofold increase in oxygen consumption when crutch walking compared with normal gait. At the slowest speed, consumption was 40 percent of the maximum upper-extremity stress test; at the comfortable walking speed of normal ambulation, consumption was 90 percent of maximum upper-extremity stress. Heart rate was always greater when crutch walking, even at the slowest cadence, than when walking without crutches. Crutch walking is one-third as efficient as normal walking at slow speeds, in terms of energy used per unit body weight per unit distance traveled. Use of underarm crutches was not statistically different from use of forearm crutches.

**Parapodium Redesigned for Sitting:** Martha Gram, Edwin Kinnen and James Brown (Department of Pediatrics, University of Rochester, Rochester, New York) Physical Therapy 61:657-660, May 1981.

The original design of the parapodium is successful in allowing children with meningomyelocele lesions of L3 to T12

to stand and walk, but sitting is very difficult. Difficulties are due to the knee- and hip-lock design of the Motloch design which requires two hands for locking or unlocking. Sitting required leaning backward against a chair, then collapsing into a partial sitting position which is frightening. Standing required full body extension in order to engage the locks, a precarious and space-consuming requirement.

The new design allows separate hip and knee locking which can be accomplished with one hand. The locks do not project from the sides of the parapodium, so the wearer can engage the locks in a restricted space, such as in a wheelchair. In order to stand, the wearer draws a knee-extension-assist rod out and downward, causing the knee joints to extend and lock automatically. The patient then turns over and pushes to extension, causing the hip locks to engage automatically.

Ten patients have been fitted with the new design. A case report of a 10-year-old boy with a T10-12 lesion illustrates the improved function obtained with the device. The youngest patient to sit and stand unaided was 3 years old. All wearers swivel with greater speed and agility, greater leverage being provided by the forward rigidity and lateral flexibility of the side bars of the redesigned parapodium.

## Recent Patents<sup>a</sup>

**Device for Air-Massage:** Katsumasa Hara. The device may be manufactured as a shaped article (e.g., a boot), a wraparound for an arm or leg, or a mat for the entire body. It consists of an elastic element which contacts the skin and is affixed to an air bag. Cycling a small volume of compressed air in the air bag produces the massage effect in the elastic element. Hot or cold water, or a heating and cooling gel, may be used in the device to enhance the massage effect. (Patent No. 4,231,355, Nov. 4, 1980; filed Sept. 15, 1978; Appl. No. 942,709; 8 claims.)

**Electrically Heated Surgical Cutting Instrument:** George D. Lipp, assignor to Corning Glass Works, Corning, New York. The heating element is printed or deposited along the cutting edge of the blade. It sterilizes the blade and cauterizes tissue, to reduce infection and hemorrhage and promote rapid healing. The blade is thermally insulated from the instrument handle and detachable. (Patent No. 4,231,371, Nov. 4, 1980; filed Nov. 16, 1978; Appl. No. 961,191; 6 claims.)

**Gripping Device for Handicapped Persons:** Willem D. van Zelm. Operable with one hand by a wheelchair occupant, the invention employs a mechanically-operated hinged arm and double-acting jaws, to lift and move objects or bring them directly to the operator. The device is lightweight and has a relatively long reach span. (Patent No. 4,231,603, Nov. 4, 1980; filed Feb. 15, 1979; Appl. No. 12,336; 9 claims.)

**Inflatable Supports:** Aubrey E. Corbett, Siu L. Ho, and Ronald J. Clark, assignors to Glynwed Group Services Ltd., Birmingham, England. A ripple bed helpful in preventing bedsores is described. It consists of upper and lower inflatable layers and a source of controllable compressed air. The upper layer has separate air passages independently inflatable and deflatable for the rippling

effect. It may include air bleed apertures for evaporating moisture and cooling the patient. The lower layer is separately inflatable to support any area of the upper layer which is deflated. (Patent No. 4,225,989, Oct. 7, 1980; filed Oct. 5, 1978; Appl. No. 948,798; 9 claims.)

**Insert Travel Chair and Method of Transporting the Handicapped:** Frederick L. Day. The chair width is normally between only 12 and 16 inches. The chair and occupant can be transferred from an automobile, bus, or plane, pushed down an auditorium or theatre aisle and, by unlocking and dropping the back of the chair, transferred to an assigned seat. It may also be inserted in a conventional chair or wheelchair. The front wheels are easily removed and the chair folds compactly for storage. A head restraint is provided. (Patent No. 4,229,039, Oct. 21, 1980; filed Sept. 11, 1978; Appl. No. 941,253; 28 claims.)

**Method for Recording the Walking Ability of an Individual:** David F. Webster. A continuous form of multiple sheets is described, the top sheet blank, the middle an inking element, and the bottom an ink receiving element. The top and bottom sheets are moisture-resistant. Laid on a floor or other firm surface, the form permanently records the footprints of an individual walking on it, e.g., a stroke patient or a drug or alcohol user. In the case of a patient, the method may be repeated at intervals to record recovery progress. (Patent No. 4,228,599, Oct. 21, 1980; filed Sept. 28, 1978; Appl. No. 946,769; 4 claims.)

**Method of Measuring Blood Perfusion:** Arye Rosen, William P. Santamore, assignors to RCA Corporation, New York, New York. As a means of determining if tissue is normal or ischemic, the method measures temperature decay in a given volume of the tissue which has been heated by microwaves of known rate,



amplitude, and frequency. The procedure may be used to determine the rate of flow of any fluid used for diagnostic purposes moved or moving through a volume of tissue. (Patent No. 4,228,805, Oct. 21, 1980; filed Nov. 8, 1978; Appl. No. 958,605; 4 claims.)

**Orthopedic Device:** Renald A. Cote. An improvement in the treatment of congenital and acquired deformities of children's legs and feet is claimed. The device consists of two foot plates on either end of an adjustable bar, and a pair of children's shoes. A fastener such as Velcro connects the shoes to the plates. The assembly allows continuous adjustment of the shoes (as opposed to incremental adjustment), easy positioning of the shoes on the plates, and quick removal of the shoes from the plates if necessary. Indicia on the plates enable exact repositioning of the shoes. (Patent No. 4,230,103, Oct. 28, 1980; filed Nov. 30, 1978; Appl. No. 966,192; 7 claims.)

**Portable Therapeutic Water Massage Mechanism:** Donnie R. Lindsey. The device consists of a pump, an electric power control switch, and several nozzles fitted along each of two conduits placed ordinarily on the bottom of a conventional tub near the tub walls. The nozzles create turbulence, using water pumped from the tub, and may be adjusted to direct jets of water selectively, e.g., to the ankles or feet. An in-line heater may also be used to maintain optimum therapeutic water temperature. For travel, the invention can be disassembled and packed in a luggage-size container. (Patent No. 4,225,984, Oct. 7, 1980; filed Apr. 5, 1979; Appl. No. 27,526; 10 claims.)

**Pressure Sensor:** Warren C. Lyon and William H. Hayes, Jr., assignors to Hittman Corporation, Columbia, Maryland. The sensor transmits pressure data from a body cavity to minimal reading equipment outside the body without lead wires or tubes. It employs radioactive material in movable shielding. The shielding is connected to a bellows and moves with the reaction of the bellows to sensed pressure. Made of biologically-inert materials, the device is fully implantable and, using long-lived radioisotopes, can be left in place for the patient's lifetime. The radiation dosage is negligible. The device is said to be accurate to within several millimeters of water pressure and unaffected by ambient temperature variations. (Patent No. 4,231,376, Nov. 4, 1980; filed Aug. 7, 1978; Appl. No. 931,526; 8 claims.)

**Surgical Immobilizing Bandage and the Like:** Koji Usukura, assignor to Tokyo Eizai Lab. Co., Ltd., Tokyo, Japan. The bandage is formed of an elastic base material, such as tricot or rubber-threaded fabric, impregnated with an immobilizing preparation. It becomes soft and adhesive in hot water (50° to 100° C.) and can be deformed by partial heating. Other desirable features named are: excellent molding properties, durability, water resistance, lightness, and X-ray transmittance. (Patent No. 4,231,356, Nov. 4, 1980; filed Oct. 25, 1978; Appl. No. 954,467; 7 claims.)

**Training Apparatus for Visually Impaired Person:** James D. Hajduch. The apparatus enables a visually impaired person to improve his use of a cane, his mobility, and self-confidence without a sighted supervisor in attendance. It employs two light beams in parallel, each aligned with a photo-electric cell, and a special cane. The trainee walks between the beams, using the cane. If he veers from a substantially straight line a light beam is interrupted and an audio signal tells him which side he has veered to. Running may also be practiced. (Patent No. 4,212,116, Jul. 15, 1980; filed Feb. 5, 1979; Appl. No. 9,740; 10 claims.)

**Vehicle Control System for the Handicapped:** Robert J. Appley. The device enables a wheelchair occupant, who may lack normal hand and/or arm dexterity, to drive a motor vehicle. A unique hand system controls both the braking and throttle functions by a single lever. The driver pulls the lever toward himself to move the vehicle and pushes it away to brake or stop. Body momentum also aids the braking function. The lever may be shaped to accommodate particular hand and/or arm handicaps. (Patent No. 4,228,865, Oct. 21, 1980; filed Aug. 7, 1978; Appl. No. 931,613; 4 claims.)

**Viscous, Flowable, Pressure-Compensating Fitting Compositions Having Therein both Glass and Resinous Microbeads:** Jack C. Swan, Jr., assignor to Hanson Industries Inc., Boulder, Colo. Composed of microbeads and suitable waxes and oils, the material is lightweight and has low density. Used in envelopes as fitting pads, or with or without envelopes in cavities of such articles as medical devices, orthopedic and prosthetic appliances, footwear (e.g., ski boots), hand grips, and cushioning structures, it provides comfort, support, and protection against pressure, impact, and shock. The material's properties may be altered for particular uses by varying the proportions of the ingredients, or by adding ingredients such as oil-soluble soaps. (Patent No. 4,229,546, Oct. 21, 1980; filed Jul. 27, 1978; Appl. No. 928,563; 39 claims.)

**Wheelchair:** Gene B. Shaffer. The device moves a handicapped occupant from sitting to standing and vice versa, without assistance. The movement causes the occupant no anxiety because the lever system is designed to move his legs, seat and torso coordinately. A single switch controls electric power. Reliability, relative simplicity, and low cost are also featured. (Patent No. 4,231,614, Nov. 4, 1980; filed Oct. 27, 1978; Appl. No. 955,391; 17 claims.)

\*Patents may be ordered by number from the Commissioner of Patents, Washington, D.C. 20231, at 50¢ each.