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.

For this issue of the Journal, Joan Edelstein has selected 28 articles for abstraction and one book for review. You will find the 22 abstracts falling into the following general categories:

Gait analysis 7
Upper limb orthotics 2
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Spinal / cervical orthotics 5
Lower limb prosthetics 5
Prosthetics and orthotics materials 3
Adaptive wheelchair seating 1
General 1

The articles have been drawn from the following journals:

Clinical Orthopaedics and Related Research 1
Prosthetics and Orthotics International 5
Physical Therapy 8
Ergonomics 2
Orthotics and Prosthetics 4
Journal of Biomechanics 1
Archives of Physical Medicine & Rehabilitation 3
Acta Orthopedica Scandinavica 1
Spine 1
Journal of Bone and Joint Surgery 2

The book reviewed for this issue is a history of functional assessment and an overview of the available self-care and vocational assessment procedures for individuals having physical impairment, mental or psychiatric disturbances, or communication problems. It addresses readers ranging from policymakers and program planners to clients who wish an active role in their rehabilitation.


Nineteen normal adults were studied with a uniaxial electrogoniometer to determine the range of wrist motion required in 14 daily activities, 7 of which required placing the dominant hand at various locations on the body as would be needed for routine personal care. The other activities were those requiring wrist motion, such as bringing a glass to the mouth, cutting with a knife, and rising from a chair. No significant differences were found between data from men and women. Activities about the trunk require 5 to 20 degrees of flexion, while combing the hair requires 15 degrees of extension, as does placing the hand on the shoe. Perineal care requires the wrist to be neutral. Most personal care is done with the wrist slightly flexed. Eating and drinking need a range of 3 degrees of flexion to 35 degrees of extension. Rising from a chair employed the greatest arc, 63 degrees. Ten degrees of extension is probably the most versatile position for wrist fusion. Prostheses in arthroplasties which provide 55 to 64 degrees of flexion and extension range are adequate.

Spatial Parameters of Gait Related to the Position of the Foot on the Ground: IC. Rigas (University of Ioannina, Greece) Prosthetics and Orthotics International 8:130-134, December 1984.

Gait characteristics of 35 healthy young adults were compared with those of 24 healthy old subjects. They walked along a corridor covered with paper laid over carbon paper. Heel and toe contact points were marked by pins on the shoe. The foot angle varied from subject to subject and within the same subject. Young subjects had mean foot angles ranging between -2.6 and +17.4 degrees, compared with from -3.0 to +24.8 degrees for the old group. Most of the older subjects and many of the younger ones had a mean foot angle on the left different from that on the right, with the angle on the left in all cases smaller than on the right. The step length was significantly different on each side in a fifth of the young subjects and a fourth of the older adults. Lengths were longer for men and for the young, although the step length as a percent of the subject's stature is the same for young
men and women, 42.2 percent of stature. The mean value for old men is significantly larger than for old women and smaller than for young subjects. Young subjects had stride widths approximately 3.3 percent of the subject's stature, but old women had a mean value of 5.5 percent and old men a mean of 4.2 percent of stature.

Statistically significant asymmetries between right and left foot angle and step length occurred in many subjects considered normal. Since length showed the least variability between steps of the same subject or between subjects of the same subgroup, this parameter is a useful differentiator between normal and pathological gait. Old subjects show significant increase in foot angle and stride width, which aids those who suffer more instability due to weaker hip abductors. The instability of the elderly was not shown to result in greater side-sway, indicating that instability is adequately counterbalanced by the increase in the supporting base.

Gait Analysis Techniques: Rancho Los Amigos Hospital

Gait Laboratory: Jo Anne Gronley and Jacquelin Perry (Rancho Los Amigos Hospital, Downey, CA 90242) Physical Therapy 64:1831–1838, December 1984.

The technical emphasis of the pathokinesiology service has been on dynamic electromyography, footswitch stride analysis, and energy-cost measurements, although force plate and instrumented motion analysis are also used. A system of observational gait analysis involves systematic assessment of the motion pattern of the foot, ankle, knee, hip, pelvis, and trunk. Notations are made on a chart listing 32 common errors and the gait phases in which they occur. Mechanisms that obstruct standing stability, inhibit progression, or increase energy cost are identified. For quantified motion analysis, electrogoniometers are used for the knee, ankle, and subtalar joints. A videodisk camera and a microcomputer have been combined into a single-plane system which requires 1 hour to process the data. The electromyographic system uses wire electrodes in eight muscles; signals are transmitted by telemetry to recorders. To obtain stride characteristics of gait, insoles with compression-closing switches at the heel, the heads of the first and fifth metatarsals, and the great toe are used. Signals are transmitted by telemetry to the recorder and indicate stride distance and timing, automatically calculated by a microcomputer-based stride analyzer.

Energy-cost measurements are made on a circular walkway, an outdoor 60-meter track. The subject has electrocardiogram electrodes, a thermal sensor for respiratory rate, and a footswitch for gait velocity. Expired air is collected in a plastic Douglas bag. Such testing has demonstrated that most patients accommodate to their disability by slowing gait velocity. A force plate with piezoelectric crystal sensors measures ground reaction forces which are influenced by gait velocity. The Moss visible vector system has made the force plate clinically useful to differentiate appropriate and inappropriate muscle action.

Techniques for Clinical Assessment of Human Movement:


Methods of movement measurement and analysis depend on the investigator's experience with instrumentation and analysis techniques, available resources, experience with the particular pathology, the apparent subtlety of the deviation, the underlying mechanism of the disorder, and the goal of the assessment. Most assessments are based on descriptive data with subjective evaluation of the recordings of some aspects of the movement pattern. Description alone is not always productive. Harmonic analysis permits complex variables to be compared. In cyclical motions such as walking, the temporal aspects of the variables produce a pattern of variation which may be described according to symmetry and normality. Visual observation is the primary tool used to assess movement qualitatively. Formal strategies make observation more efficient and reliable. Observation is a subjective assessment which does not determine the causes of movement, and comparisons with previous trials are limited. Temporal and spatial data can be quantified and used to describe gait. These variables have a direct relationship with forward walking velocity which is also influenced by physiological and psychological, sociological, and environmental factors, prompting caution in interpreting these data.

Kinematic data for the lower limb involves 50 variables, but the major consideration is given to imaging techniques and electrogoniometry, the characteristics of which are compared. Data may be plotted as a function of time to show an average pattern, or data may be displayed in angle-angle diagrams or harmonic analysis. Joint displacement data may be redundant in normal subjects, but useful in evaluating orthotic or prosthetic devices. Displacement data are descriptive, rather than diagnostic. Kinetic data are obtained with accelerometers and force platforms. Electromyography gives insight into the neural control of movement. Complex analyses include energy analysis and moment analysis.

Objective Clinical Evaluation of Function: Gait Analysis:


Objective gait analysis is relatively new. The Mayo Clinic Gait Laboratory permits recording and monitoring most gait problems and meets the general conditions for a laboratory to be clinically useful: accurate, reliable, valid, and minimally encumbering instrumentation. The laboratory has two walkways, one for stairs, and ramps. Instrumentation consists of three-dimensional electrogoniometers. Foot-floor contact is measured with binary foot-switches at the heel, fifth and first metatarsal heads,
and great toe. Step lengths and widths are measured with an instrumented mat. Force plates measure three component forces; one plate measures the areas of pressure beneath the foot. Data are reduced and stored by computer. Test-retest results indicate the methods to be reliable and reproducible. Automated analysis methods generate average motion patterns from 15 to 20 gait cycles. Each curve is fitted with Fourier coefficients that facilitate curve averaging, storage, and analysis. Composite indexes provide a general overview of function. Assessment requires 45 minutes; data analysis and summarization require 30 to 45 minutes.

Clinical applications of the gait analysis method include illustration of an amputee with pain at the stump-socket interface and the broad-based gait observed in an above-knee amputee. Instrumented gait analysis aids in examining the effectiveness of a particular treatment. A patient who had used a prosthesis for many years complained of low back pain. Back treatment and gait retraining resulted in a report of reduced pain but no change in objective gait pattern. The ability to document the effectiveness of a particular treatment is increasingly important and is aided by electronic instrumentation.


Fourteen men participated in a study involving measurement of maximal oxygen uptake, comparative energy cost of walking and running in shoes and boots, and comparative cost of running in shoes and weighted shoes. Subjects ran and walked on a treadmill. Footwear consisted of athletic shoes (usually a running shoe) weighing an average of 616 grams, and standard leather military boots weighing an average 1776 grams. Each type of footwear was evaluated at three walking and three running speeds. Eight subjects also were tested with shoes plus weights making the shoe weight equal to the boot weight. The energy cost of boots was significantly greater at all speeds except the slowest walk, with the oxygen uptake ranging from 5.9 to 10.2 percent more, while the increment in weight added by the boots was only 1.4 percent of the subject's body weight. Heart rate during boot trials was higher at all but the slowest walk. Energy cost for running in weighted shoes was significantly higher at all running speeds. Weight alone appeared to account for most of the increase. Comparison of energy data for trained and untrained subjects revealed no significant difference, although heart rates were significantly higher for the untrained subjects at all but the slowest walking speed. The mean difference between trained and untrained subjects was 23.3 beats per minute.

The data support the calculations of others which demonstrated that an equivalent weight carried on the feet as opposed to the torso costs 4.7 to 6.3 times as much energy, depending on the speed of ambulation. A large proportion of the energy cost of wearing boots may be attributed to weight, although the remaining cost may be due to biomechanical limitations such as stiff soles and restrictive uppers.

Sheet Plastics and Their Applications in Orthotics and Prosthetics: David Showers and Martha Strunck (Hospital of the University of Pennsylvania) Orthotics and Prosthetics 38:41-48, Winter 1984.

Since 1970, polypropylene has become the most widely used material for ankle-foot orthoses: however, many other plastics are used today. Low-temperature plastics include Orthoplast, possibly the most common one. It
can be applied directly to the patient, eliminating the need for a negative impression. It is used in fracture bracing. It can be incorporated in a device which needs to be flexible and can be molded over two positive models. It has a short life expectancy. It can be easily adjusted with a heat gun, making it suitable for scoliosis orthoses. High-temperature plastics include Kydex, a rigid plastic used in the Philadelphia collar, spinal orthoses, and nonarticulated wrist-hand orthoses. Nyloplex is cosmetic, transparent and durable in upper extremity orthoses, but with a heat gun, making it suitable for scoliosis orthoses. It can be flexible and can be molded over two positive models.

To be flexible and can be molded over two positive models. Polypropylene, standard grade, is the most popular plastic, used for the nonarticulated ankle-foot orthosis; it is the strongest sheet plastic which can be formed over a positive model, and permits attachment of metal hinges. Co-polymer is more rigid after forming than orthopedic grade polypropylene, but is more flexible than standard grade polypropylene. Co-polymer is ideal for permanent orthoses for post-polio myelitis patients. Polypropylene, orthopedic grade, is more flexible and more durable than standard polypropylene; orthopedic grade is suitable for fracture orthoses. Ortholen is used most frequently for posterior leaf spring ankle-foot orthoses, although it is not very durable. Vitrathene is pink polyethylene used often in body jackets since the plastic is somewhat flexible. Polyethylene can be combined with polypropylene for good color matching. Polyethylene is inexpensive, flexible, and easy to fabricate. Thermo-vac Surlyn and Lexan are transparent high-temperature plastics. Among the soft foam interface plastics are Pelite, Plastazote, and Aliplast.


Plastazote is lightweight, relatively durable, nontoxic, needs little skill in handling, is inexpensive, and finds ready patient acceptability. It is used with painful ulcerated feet, allowing the ulcers to heal, although the means of healing remained unclear and the lesion often broke down again when the Plastazote insole was discarded. (Healing may be related to satisfactory redistribution of underfoot pressures.) Analysis of the footprint impressed on a piece of Plastazote involves photographic and photogrammetric means. Deformation tests were conducted on Plastazote samples under different thermal conditions at typical peak pressure values, 150–200 kPa.

Four specifications were tested, ½-inch and ¾-inch low density, ¾-inch medium density, and ¾-inch heavy duty foam. Load deformation tests were performed on an indentor testing machine, with 10 samples of each material for each test.

None of the materials have linear load-strain curves, and all are markedly different. When the applied force is above 100 N, the curve for the ¾-inch low density foam approaches a straight line. Testing within an oven set at 150 degrees centigrade showed non-linear responses. Response to cooling was also measured. The tests show that ¾-inch low density Plastazote is ideally suited for the application to underfoot pressure studies. Since all samples exhibited nonlinearity of deformation, particularly at low loads, this may lead to errors around the periphery of the foot impression. In clinical practice the weight of the average patient is above 500 N and planter pressures of 180 kPa in areas where foot pathology exists, such as under the metatarsal heads, is within the range of pressure tested. Temperatures of the foot in normal subjects, up to 36 degrees centigrade (and 24 degrees centigrade in those with circulatory disorders) have little influence on the molding characteristics of the material which does not exhibit plastic flow even at 150 degrees centigrade.


A study of 113 Finnish war-disabled amputees included 84 with below-knee prostheses and 29 above-knee amputees. The amputations were performed 39 to 45 years before the study. Patients were interviewed with a questionnaire, particularly with regard to low back, hip, and knee symptoms. Lower-limb length was measured with a weightbearing roentogram of the pelvis. The difference in heights of the femoral heads indicates the inequality of the weightbearing lower limbs. Clinical examination of pelvic tilt, lumbar scoliosis, and other asymmetries were radiologically documented.

Although most amputees believed their prostheses were of equal length with the intact leg, most showed discrepancies ranging from shortening of 47 mm to lengthening of 40 mm. Two-thirds had length discrepancy more than 10 mm. In below-knee prostheses, length was less than 5 mm different in 12 percent of the subjects. One-fourth of the above-knee amputees had minimal discrepancy. Chronic low back pain was present in 88 subjects; those with severe pain had a mean length discrepancy of 21.7 mm. Amputees with marked discrepancy also had a hip pain with or without knee pain.

Amputees who engaged in daily sport activity had a mean leg length inequality of 9.7 mm, while those without daily physical activity had a mean inequality of 18.5 mm, even though the mean length of the amputation limbs in the two groups was comparable.

Experimental equalization of the pelvic tilt in subjects with length inequality by means of a shoe lift was generally experienced as comfortable. Conventional assessment of limb length seems to be inaccurate and unreliable, while the radiographic method is accurate, reliable, simple and inexpensive.
Biomechanical Evaluation of SACH and Uniaxial Feet:
J. C. H. Goh, S. E. Solomonidis, W. D. Spence, and J. P. Paul (University of Strathclyde, Glasgow, Scotland)

Six below-knee and five above-knee amputees were tested while wearing SACH and uniaxial feet. The uniaxial foot originated in 1861 when J. E. Hanger replaced the cords in a prosthesis with rubber bumpers. The SACH foot was developed in the early 1950's, and is the most common foot prescribed in North America. In the United Kingdom, the uniaxial foot is most common.

The activity level of the subjects was scored and showed high activity. Feet were fitted to an Otto Bock modular system. All below-knee amputees had cuff suspension, while all above-knee amputees had suction sockets. Amputees walked on a force platform 20 meters long and were photographed by three cameras. The prosthesis was aligned dynamically by an experienced prosthetist prior to the walking trials. Amputee and prosthetist were questioned regarding foot performance in terms of function, appearance, comfort, and effects on other prosthetic components.

The plantar bumpers supplied with the Otto Bock modular uniaxial foot were too soft for most amputees and were replaced by firmer bumpers. The Radcliffe and Foot guide for SACH stiffness was also inadequate; a revision should make provision for level of amputation, body weight, and activity level in selecting heel stiffness. A standard should be compiled for the articulating ankle in which ankle moment versus angular displacement is significant difference was the action of the uniaxial foot, the period of heel-strike to foot-flat took twice as long as that of the normal foot. Comparison of the trajectories of the joint centers of the lower limb and shoulders showed no significant differences. Ankle angle was significantly different because of the plantar flexion of the uniaxial foot. Ground reaction forces were comparable, although the SACH showed two peak loading patterns and the uniaxial had three.


A Double Video Forceplate was used to assess amputee and non-amputee subjects. The instrument consists of a pedestal with a separate forceplate for each foot, an output display for monitoring, a printer, and a microprocessor. The subject was asked to stand evenly as possible for 15 seconds. Patients were also asked to transfer load fore and aft or from the inside to the outside border of the foot, to enable measurement of the range of motion of the individual center of foot pressure.

Previous studies indicated reproducibility of the anteroposterior individual center location to better than 7 percent. For normal subjects, weightbearing is close to 50 percent on each limb, and the individual centers lie in the range of 32 to 51 percent of shoe length in the anteroposterior direction and 34 to 63 percent of shoe width in the mediolateral direction. Above-knee amputees load 40 percent of body weight on the prosthesis; individual centers range from 23 to 71 percent anteroposteriorly on the prosthetic foot. Below-knee amputees show a similar pattern. The large scatter in location of individual centers for amputees did not correlate with the type of prosthesis and socket, but may be due to variations in limb alignment.


Ninety-two lower-limb amputees had an ergonomic evaluation including pulmonary measurement, use of an arm pedal ergometer in conjunction with electrocardiogram, and measurement of oxygen consumption and minute ventilation. Subjects also were reviewed by a clinic team consisting of physiatrist, physical therapist, occupational therapist, social worker, nurse, and three prosthetists. The team assessed the individual's motivation and state of physical condition. Deconditioned patients were reevaluated after an appropriate conditioning program was instituted. Those with marked cardiopulmonary disease had a trial with a temporary device before a decision was made on a permanent prosthesis.

On the basis of arm pedalling without significant cardiovascular limitations, 80 patients were judged as having no prosthetic contraindication. Of the remaining 12, 7 were judged by the clinic team as suitable for a prosthesis, of whom 5 could ambulate without cardiorespiratory problems. Thus, agreement existed between clinic team and laboratory for 92 percent of the patients. Five patients rejected by the laboratory became functional ambulators. The physiologic criterion was 9 to 10 ml oxygen consumption per kilogram per minute, assuming household ambulation at 0.5 miles per hour for which a normal individual requires 6.3 ml, since a below-knee amputee uses 25 percent more oxygen and an above-knee amputee needs 60 percent more (7.9 ml and 9.5 ml, respectively). Arm pedalling at 150 kpm elicits oxygen consumption of 9 to 10 ml. Ten patients with significant ST segment depressions were given prostheses and survived more than a year. Thus a well-trained clinic team can make an appropriate decision regarding prosthetic prescription even in patients with marginal cardiorespiratory reserve.

Twenty-five lower-limb amputees, with various unilateral and bilateral amputations, walked on Shutrak recording paper with the usual walking aids and footwear. Five data elements were derived from the recordings: stride length, step length, foot angle, stride width, and qualitative distribution of foot pressure. Each patient’s physical therapist and physician judged the clinical usefulness of the raw and derived data for problem solving and documentation. They also ranked the usefulness of the five derived gait elements.

Derived data were significantly useful, and the pressure distribution was considered the most useful of the elements. Physicians and therapists showed little difference in the ranking. The overall perceived usefulness of footprint measures was moderate, because only some walking difficulties are shown, problems associated with malrotation. The presence of a significant correlation and no difference between the usefulness of the analysis for problem solving and for documentation emphasizes the importance of documentation in gait studies. Data are now normalized to patient height and walking speed is recorded. Because of the small difference between the perception of usefulness of raw data as compared with derived data, raw footprints are photoreduced for inclusion in the patient’s chart, together with the derived data. Both physicians and physical therapists need firsthand information about the patients they evaluate and treat, thus explaining the lack of significant difference in comparison between the ratings of the two professional groups.


Qualities of various liner materials (Pelite, Plastazote, and silicone gel) are related to durometer (hardness) and wear resistance. The desirable characteristic may be strategically located within the interface of the liner, especially for patients with very bony, badly scarred, or intermittently painful areas, or for those who are very active.

During the period from 1974 to 1980 a search for materials to replace silicone gel in liners led to the development of two hybrid liners known as multiple-durometer liners. The hot melt copolymer gel (Haflex 1962) is used also in the manufacturing of fishing lures. For use in lining a socket the material is melted, then a leather liner is immersed in it to create a build up of 1/4 inch. The liner was tried on three problem below-knee amputees without reports of skin irritation or allergic reactions. Within 3 months, the liners had cracked at the patellar notch area, but were repaired by local heat. Additional repairs involved sewing Kemblo rubber patches over the patellar notch area. The gel-like consistency of the liner reduces shear forces; unlike silicone gel, the hot-melt liner does not migrate.

The Aliplast-Kemblo liner is fabricated by starting with a standard leather insert. Very soft Aliplast patches are glued to it and the liner is completed with a Kemblo layer. Pelite or Spenco could replace the Kemblo. At least six such liners have been worn for more than a year, with the Aliplast buildups continuing to provide cushioning.

In high-activity sports prostheses, multiple-durometer liners plus a Lenox Hill brace may be indicated.

Quantitative Description of Two Sitting Postures With and Without a Lumbar Support Pillow: Cheryl Majeske and Cindy Buchanan (Richmond Metropolitan Hospital, Richmond, VA 23220) Physical Therapy 64:1531-1533, October 1984.

Nineteen healthy adults between the ages of 20 and 40 years were photographed while sitting in two postures. Adhesive markers delineated seven body segments, and aided measurement of segmental angles from the photographs. Relaxed sitting involved having the buttocks in contact with the chair back, feet flat on the floor, eyes fixed horizontally, and forearms resting on the thighs. Sitting with a lumbar pillow was identical, except that the pillow was placed at the third lumbar level.

With the pillow, the pelvis tilts anteriorly and the trunk tilts posteriorly, a position of greater lordosis, and may prevent low back pain related to loss of lordosis during sitting. With the pillow, the head was held higher and the torso was straighter.

Although good posture is not the only treatment for all low back pain, postural training is an essential element in rehabilitation. The extension position is contraindicated in certain instances, such as spondylolysisis. Sitting with a flattened lumbar spine is associated with raised intradiscal pressure and a taut posterior annular wall. Consequently, the lumbar support pillow may alleviate pain related to a loss of lordosis during sitting.

Rising from a Chair: Influence of Age and Chair Design: Joyce Wheeler, and others (Good Samaritan Hospital and Medical Center, Portland, OR 97210) Physical Therapy 65:22-26, 1985.

Ten young women were compared with 10 older women, mean age 75 years, with regard to electromyographic activity of the vastus lateralis and triceps brachii and joint motion as measured by an electrogoniometer as subjects rose from a standard armchair and from a chair designed specifically for the elderly.

The chairs were similar with regard to seat height and width and width between armrests. They differed in seat depth, seat slant, armrest height, backrest incline, and
clearance in front of the chair. Trunk forward lean, hand placement, foot placement, ratio of supported femoral shaft to total femoral length, knee flexion, and elbow flexion were recorded.

With the standard chair, the younger group did not place the feet as far back as the older group. Vastus lateralis activity was greater in the older group; other measurements were similar for both groups. Performance with the special chair differed from that with the standard chair. Older subjects placed their feet farther forward and attained greater trunk forward lean. Less of the femur was supported. Older women showed more vastus lateralis activity when rising from the special chair than from the regular chair.

The special chair did not facilitate the act of rising, possibly because the special chair had less foot clearance, interfering with movement of the center of gravity over the feet. The increased forward trunk lean with the special chair may relate to the greater posterior slant of the seat, tilting the body's center of gravity farther back. The lower armrests of the special chair may account for the subjects' need to lean farther forward when rising from the special chair. Although the special chair was designed for comfortable sitting, it does not facilitate rising.


A method for assessing the severely involved adult in order to adapt the wheelchair involves examining the client in the sitting position over the side of a mat table. Attention must be paid first to the pelvis, especially anterior and posterior tilt and lateral symmetry while the knees and feet are stabilized at 90 degrees. The impact of righting reactions on sitting posture is observed. Although the hips must maintain an angle of 90 degrees or less to prevent extensor spasticity, the posterior pelvic tilt is the start of hip extension in sitting. Changes in the lower extremities and head position and control are also observed, as well as upper extremity position and function.

A trial in a fitting chair will indicate the effects of each adjustment. A specially made chair may be used, or the regular wheelchair can be adjusted with triple-density cardboard spacers and angled segments. The client should be placed in the fitting chair as close as possible to a position of 90 degrees horizontal seat and 90 degrees vertical for the backrest. The pelvis should be in slight anterior tilt, with equal weightbearing on the ischia, and with the iliac crests equally against the backrest. The foot-support system may have to be adapted, to prevent the hamstring from functioning as hip extenders, by having a lengthened foot support to allow more than 90 degrees of knee flexion. The fit, height, and tilt of the lap tray are important in achieving best posture and muscle tone; the tray may have a high inner rim for trunk support or may provide support only through the elbows.

Electromyography has demonstrated that reclining the backrest with the hips maintained at 90 degrees elicits high extensor tone; thus, reclining should be avoided for most clients.


Intra-abdominal pressure was measured using a pressure-sensitive radio pill with 16 normal adults who sat on a chair adjustable for lumbar support vertically and horizontally, in backrest height and inclination, and in thoracic-support inclination and seat height. Subjects sat with feet flat on the floor and knees at 90 degrees, with the torso against the lumbar and thoracic supports while lifting a 12 kilogram weight bar at shoulder level. The main significant effects were lumbar-support horizontal movement, backrest inclination and thoracic support inclination. Intra-abdominal pressure decreases as the lumbar-support horizontal movement increases. As both lumbar and thoracic supports increase, intra-abdominal pressure decreases. The lumbar support was fixed 13 centimeters above seat level. Vertical movement of the support had no statistical significance. Moving it toward the thoracic support may diminish the effect of both supports. It is possible to minimize intra-abdominal pressure by increasing backrest inclination and by combining it with lumbar and thoracic support. Lowest pressures occurred when the lumbar support was 4 centimeters forward, the thoracic support was inclined 10 degrees, and the backrest was inclined 100 to 110 degrees; also when the lumbar support was 1 centimeter forward, the thoracic support was inclined 10 degrees, and the backrest was inclined 100 to 110 degrees. As the lumbar support moves forward and the thoracic support inclines backwards, the thoracic spine moves backwards to remain in contact with the thoracic support, increasing lumbar lordosis, causing a substantial part of the body weight and the load imposed by the lifted weight to be transmitted to the thoracic support.


Thirty consecutive patients, all with right convex thoracic and left convex lumbar idiopathic scoliosis, were fitted with the Boston brace without upright. The range of scoliosis was determined radiographically by Cobb measurement in a standing relaxed posteroanterior position with and without the brace. Sagittal curves were evaluated with a noninvasive spinal pantograph. The mean correction
of the thoracic and lumbar scolioses was about 50 percent. The mean correction of the kyphosis was 26 percent and of the lordosis 40 percent. There was no correlation between the range of thoracic scoliosis and the kyphosis, nor between the lumbar scoliosis and the lordosis. No correlations were observed between correction of scolioses and the range of kyphosis and lordosis without braces. A positive correlation was noted between correction of the lumbar scoliosis and the correction of the lumbar lordosis, and between the range of correction of the thoracic scoliosis and the range of lumbar scoliosis correction, indicating a coupling between proximal and distal curves.

Forces acting as a correction with braces are distraction and lateral forces. Distraction, however, is of little importance in mild scoliosis. The most effective force is the lateral push on the trunk. The derotational effect of the Boston brace was demonstrated to be 38 percent. The brace also has a passive delordosating property. With the brace, the kyphosis could be actively corrected by 30 percent while the lordosis remained unchanged. A negative correlation may be suspected between the kyphosis and thoracic scoliosis, as flattening of the kyphosis is often seen in progressive, severe scoliosis.


Two hundred fifty-five female patients with scolioses with initial Cobb measures of 15 to 30 degrees were divided into a group who had Milwaukee or Boston braces and another group of comparable size who remained untreated. Data were obtained by retrospective chart analysis. Both groups had the curve apex caudal to the fifth thoracic vertebra and were of comparable age and curve severity. The braced group spent approximately 3 years in the brace, while the untreated group was observed for 2 years. More than 60 percent of both groups had Cobb measures that did not change by more than 5 degrees over the study duration. For those curves exhibiting greater progression, a systematic but not significant trend suggested that the brace was effective, with fewer curves progressing in the braced group and more curves regressing in the braced group. Thirty-nine percent of the patients who were untreated during the study period later received braces.

The study compared curve progression rates in a group of braced patients with a control group of similar unbraced patients. Since the effects of the Milwaukee and Boston braces have been shown to be similar, data were combined. The results suggest that braces may alter slightly the natural course of scoliosis in moderate curves, since the data show a systematic trend in which fewer curves progressed and more regressed in the braced group, and the mean annual progression rate was negative in the braced patients while the untreated patients progressed an average of 3 degrees per year. The trends are not statistically significant. Three-fourths of the untreated curves did not progress, suggesting that many of the braced curves might not have progressed had a brace not been worn. In retrospect, it is likely that many were braced unnecessarily.


Fractures have been classified according to the spinal segment and degree of osseous and neurological injury. Early treatment involved postural reduction with operative reduction and stabilization only for unstable fractures. Those with stable fractures had bed rest for 3 months or until osseous union and then used external orthoses. Recent use of computer-assisted tomography has led to more elaborate classification, including the degree of instability and neural compression, the latter sometimes continuing beyond 48 hours after injury. A patient with complete spinal cord and cauda equina injuries who had not recovered any function 2 days after injury would continue with a permanent lesion. Since the spinal cord or conus ends at the thoracolumbar junction with all lumbar and sacral nerve roots passing, injuries at this level may result in incomplete neuropathy. The shift in emphasis toward rapid mobilization and rehabilitation has not been shown to increase neurological recovery. Improved internal-fixation devices have been developed. Immediate immobilization protects the spinal cord; any compression by bony fragments can be corrected surgically.

Upper thoracic fractures are reasonably stable; patients may sit, after 3 to 6 weeks of recumbency, in a molded orthosis. More severe fractures require 6 weeks of recumbency, then use of an orthosis or internal fixation. Fractures of the eleventh thoracic to the fourth lumbar vertebrae are treated with open reduction and stabilization and use of a molded orthosis to permit ambulation within days after surgery. Fractures of the fifth lumbar vertebra with neurological deficit are not common. They are treated with operative decompression and fusion.


Chart review of 391 patients with diaphyseal tibial fractures treated with prefabricated braces during a 4½-year period was conducted. Three-fourths of the subjects were male; the age range was 15 to 83 years. Vehicu-
lar accidents were the most common etiology. Two-thirds of the fractures were closed. The most common type of fracture was comminuted. Closed fractures were treated by reduction and use of a toe-to-groin cast. Open fractures had debridement with the patient anesthetized; external fixators or pins-and-plaster method was used for extensive soft-tissue damage, significant shortening, or marked instability. Fixators or pins were removed 4 to 6 weeks after injury. The initial cast is applied with the knee slightly flexed to permit early graduated weightbearing; the ankle is neutral to avoid genu recurvatum. The brace, available in five sizes, is applied when acute pain and swelling subside and the cast is removed. Walking aids are used only until distal edema and pain subside. Braces are more successful if some motion is present at the fracture site, allowing the fracture to be aligned by the flexible plastic. The brace is contraindicated if rotatory deformity has developed. The brace is removed one week after application when the patient learns skin care. The average time for healing was 22 weeks.

Closed fractures healed in an average of 20 weeks, while open fractures needed 25 weeks. Ninety-one percent of fractures had 10 mm shortening or less. Ninety-two percent had valgus angulation of 5 degrees or less. The great majority of patients had no knee or ankle joint limitation. Complications involved 2.5 percent of the group, particularly open fractures. The brace foot-plate suspends the brace and condylar extensions prevent rotational and angulatory deformities. Function is desirable for osteogenesis and alignment and stability can be maintained in most cases by the prefabricated brace.

Total Contact Casting in Diabetic Patients with Neuropathic Foot Ulcerations: Phala Helm, Steven Walker, and Gerry Pullium (University of Texas Health Science Center, Dallas, TX 75235) Archives of Physical Medicine and Rehabilitation 65:691–693, November 1984.

Complications of diabetes account for 50 to 75 percent of nontraumatic lower extremity amputations. Half of such amputees die within 3 years. Of those who survive the first amputation, two-thirds will lose the remaining limb, with 45 percent of those being amputated within 5 years. Most diabetics admitted to hospitals for foot problems have ulcerations resulting from pressure and shear applied to the foot while walking. Insensitivity prevents the patient from shifting gait patterns, resting, or removing the shoe. The ulcer can become infected; continued walking forces the infection further into the wound, causing abscess formation, osteomyelitis, and gangrene leading to amputation. Bedrest, hospitalization, and wound care have proven ineffective because they rely heavily on patient compliance. The total-contact short-leg plaster walking cast protects the wound, promotes fluid exchange in the limb, and permits ambulation with uniform distribution of pressure over the entire foot.

Twenty-two diabetics with 24 ulcers were treated in a 6-month period. Most ulcers were under the metatarsal heads. Mean ulcer duration prior to treatment was 9 months. Following examination, each patient was fitted with a cast which was changed weekly or biweekly. Sixteen patients healed in an average 38.3 days. Three others had measurable improvement. Specific wound grade and size have the most direct influence on healing in a cast. Age seems to have a broad, less direct, effect on healing. Casting permits the patient to ambulate during ulcer healing, and allows the patient to be treated on an outpatient basis.


The TRIO knee orthosis was developed to aid treatment of sports-related knee injuries, especially to provide controlled range-of-motion for patients 5 weeks after surgery. The orthosis can be adapted for controlled, free, or limited motion. When the patient is able to return to sports activity, posterior trimlines at the knee are modified to allow more motion and the length of the orthosis is reduced. The orthosis can be modified to control specific knee instabilities and has a rotational control system more effective than other orthoses with rotational straps. TRIO is made of Subortholen and Pelite. Attachments or modifications to the knee joint include a 0-to-45-degree adjustable extension stop or drop lock, free motion achieved by removing the extension lockplate and extension-flexion dial, and screw control of extension and flexion. Most patients are fitted with the free-motion joint, suitable for anteromedial rotary instability. Rotation control consists of one or two rubber straps, 3 inches wide, and a 1-inch-wide elastic pretilial strap used to retard anterior tibial subluxation. Bilateral supracondylar wedges provide suspension.

The orthosis is fabricated over a plaster model of the leg. After the usual cast modifications and marked medial supracondylar plaster removal, a Pelite liner is first molded, then a two-section Subortholen shell. After the leg and thigh sections are trimmed, the desired knee joints are formed to the model. More than a hundred TRIO orthoses have been fitted, with very good patient acceptance and good control of knee instability. Because the orthosis is waterproof, it can be worn in snow and water skiing.


The Louisiana State University (LSU) Lively Orthosis exerts subliminal dynamic corrective force to combat ankle and knee contractures, depending on the configuration of the orthosis. The orthosis provides free ankle and subtalar motion with elastic straps to dorsiflex the ankle and invert or evert the subtalar joint. The longer version has a rigid posterior section and a knee cap with elastic
straps to extend the knee. The orthosis is to be used in nonambulatory fashion.

Development was started in 1975 by Roy Douglas, who was confronted with many muscular dystrophy patients who had severe equinovarus deformities, and for whom surgery was not feasible. Refinement of the original design included repositioning the mechanical articulations close to the anatomic joints to minimize relative motion. Mechanical components now consist of five different-sized assemblies in neutral alignment — to date, no problems have surfaced because the assembly is not made specifically for the right or left leg. The orthosis is manufactured in knee-ankle-foot design to control the biarticular gastrocnemius.

The LSU Lively Orthosis is indicated for soft-tissue contractures of the foot and ankle and secondary knee involvement, minimal spasticity, good ambulation prognosis, and cooperative patient and family. It is contraindicated by bony involvement, severe spasticity, poor ambulation prognosis, or uncooperative patient or family. The orthosis requires frequent progressive adjustment and periodic skin care. It is fabricated over a full-length lower limb cast which is modified to relieve bony prominences. The model is covered with Pelite which will serve as a liner in the finished orthosis. The ankle-subtalar assembly is selected on the basis of the width of the ankle, and is placed on the cast to correspond with approximately normal joint alignment. Polyethylene is vacuum-formed over the model.


Eight paraplegics who were fully trained in the use of long-leg braces participated in five tasks during which pulse and expired gas were measured. All subjects were younger than 32 years; six wore Scott-Craig braces and two used standard braces which allowed free dorsiflexion. Tasks included walking a course consisting of 10 turns 1 meter apart, climbing 10 steps, and climbing a 12-degree ramp. All tasks were performed in one afternoon with one type of brace and were repeated the following afternoon with the other brace type.

Turns, stairs, and ramps were chosen as commonly encountered architectural impediments. On a per-minute basis, the subjects used approximately the same amount of oxygen as the established norm for able-bodied walkers. On a per-meter basis, subjects used as much as 15 times more energy. Scott-Craig users demonstrated a 25 percent advantage on level surfaces, but showed no significant difference when negotiating barriers. The standard braces afforded a slight advantage during ramp ascent, probably caused by accommodation of the free ankle to the incline of the ramp.

One type of brace does not have a significant advantage over another type during the negotiation of most barriers. Subjects, including those trained on standard braces, preferred the Scott-Craig braces because they felt more stable.

As compared with normal values of 0.16 ml, subjects expended 2.3 ml oxygen making turns with standard braces, 2.08 ml with Scott-Craig. Stair ascent exacts 0.16 ml from normal subjects but 0.92 ml from Scott-Craig wearers and 0.83 ml from standard brace users. Ramp ascent cost normal subjects 0.16 ml, versus 2.37 ml with Scott-Craig and 1.26 ml with standard braces.


An orthosis based on the mechanical position between scapula and humerus and the scapular plane has been successfully fitted to more than 75 patients for postoperative management of rotator cuff injuries, and to 3 patients for treatment of scapular neck fractures. Previous studies demonstrated that, whether the arm is elevated to the vertical in the sagittal, coronal or any other plane, the end result is always the same and when the arm is elevated to the vertical in the coronal plane it rotates laterally. At the end of the movement, the humerus must lie in the plane of the scapula, a plane drawn at right angles to the glenoid cavity through its greatest vertical diameter. When the body is recumbent, the natural position of the arm is one with the axis of the humerus in line with the axis of the spine of the scapula, and the head and neck of the humerus in the same plane; the deltoid, supraspinatus and infraspinatus are relaxed, and it is the most favorable position for physical repair of proximal lesions. This is the “zero-position” because muscular rotatory forces acting on the humerus are almost zero. The “zero-position” is at about 155 degrees of elevation with the axis of the humerus about 45 degrees anterior to the coronal plane. The scapular plane is inclined forward 30 to 45 degrees to the frontal plane. The orthosis consists of a Subrotational pelvic girdle, upright bar, transverse crossbar, and an arm. The length of the upright bar, the distance from axilla to elbow and from palm to forearm, and the angle of humeral and forearm rotation can be adjusted.

Immediately after repair of a rotator cuff injury, the “zero-position” of the shoulder should be maintained by skin traction. Three days later the orthosis, made preoperatively, is applied. The orthosis is also useful in reduction of scapular neck fractures to prevent shoulder contracture and muscle imbalance.

BOOK REVIEW on next page.