

# ABSTRACTS OF RECENT LITERATURE

by

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

*American Journal of Physical Medicine and Rehabilitation*  
*Archives of Physical Medicine and Rehabilitation*  
*Journal of Bone and Joint Surgery*  
*Journal of Medical Engineering Technology*  
*Paraplegia*  
*Physical Therapy*  
*Physiotherapy*  
*Prosthetics and Orthotics International*  
*Scandinavian Journal of Rehabilitation Medicine*

## PROSTHETICS, ORTHOTICS, AND RELATED TOPICS

**Aerobic Power of Competitive Paraplegic Road Racers.** Hooker SP, Wells CL, reprinted from *Paraplegia* 30:428-436, 1992.

The purpose of this study was to determine peak aerobic power and associated physiological responses in highly competitive spinal cord injured (SCI) paraplegic road racers. Seven (6 male and one female) active paraplegic (lesions T4-T12) road racers and 9 healthy untrained able-bodied males performed continuous graded arm crank ergometer tests to exhaustion for determinations of peak power output (PO), oxygen uptake ( $\dot{V}O_2$ ), pulmonary ventilation ( $\dot{V}_E$ ), heart rate (HR), and respiratory exchange ratio (RER). Compared to able-bodied subjects, male paraplegic road racers elicited significantly ( $p \leq .05$ ) higher mean ( $\pm$ SD) peak levels of PO ( $141.6 \pm 8.8$  vs  $111.4 \pm 27.7$  W), absolute  $\dot{V}O_2$  ( $2.72 \pm .52$  vs  $2.22 \pm .38$  l/min), and  $\dot{V}O_2$  per unit of body weight ( $43.06 \pm 7.4$  vs  $30.33 \pm 4.3$  ml/kg/min). Although peak HR ( $180.3 \pm 9.5$  vs

$173.2 \pm 8.5$  bpm) and VE ( $92.8 \pm 17.2$  vs  $74.6 \pm 20.3$  l/min) tended to be higher for male paraplegic road racers than able-bodied subjects, the differences were not statistically significant. The female paraplegic road racer achieved the highest peak levels of PO (119W) and  $\dot{V}O_2$  (1.99 l/min; 38.0 ml/kg/min) reported to date for wheelchair-dependent women. These data suggest that intense physical training via wheelchair propulsion can markedly enhance upper body cardiovascular fitness in SCI paraplegics. However, the correlational analysis between 10 km time and peak  $\dot{V}O_2$  was nonsignificant ( $p > .05$ ) indicating that factors other than peak upper body aerobic power may influence wheelchair road racing performance.

**Age Related Changes in Surface Myoelectric Signals.** Merletti R, Lo Conte LR, Cisari C, Actis MV, reprinted from *Scand J Rehabil Med* 24:25-36, 1992.

The initial values and the time course of muscle fiber conduction velocity and of surface myoelectric signal spectral variables were studied during voluntary or electrically elicited contractions of the tibialis anterior muscle of 15 healthy elderly human subjects. Age ranged from 65 to 84 years. Isometric voluntary contractions were performed at 20% MVC (Maximal Voluntary Contraction) and 80% MVC for 20 s. Tetanic electrical stimulation was then applied to the main muscle motor point for 20 s with surface electrodes. Two stimulation rates 20 Hz and 40 Hz) and two stimulation amplitudes were used to induce different degrees of fatigue. One stimulation amplitude was supramaximal, the second was adjusted to induce a response (M-wave) about 30% of the maximal. Results were compared with those reported in previous work on healthy adults (age range 18 to 43 years).

The main findings of this work are: (a) when voluntary contraction level is increased from 20% MVC to 80% MVC conduction velocity and spectral variables increase; this increase is significantly smaller in elderly subjects, (b) during sustained contractions at 80% MVC the decrease of conduction velocity and spectral variables is significantly smaller in elderly subjects, (c) during contractions induced by supramaximal stimulation at 40 Hz the decrease of conduction velocity and spectral variables is not significantly different in the two age groups.

It is concluded that points *a* and *b* reflect the age related decrease of number and size of fast twitch fibers indicated by histological data. Point *c* is discussed and possible explanations are suggested.

**Application of a Shape Memory Alloy to Hand Splinting.** Takami M, Fukui K, Saitou S, et al., reprinted from *Prosthet Orthot Int* 16:57-63, 1992.

This paper describes new passive splints which have been developed using a shape memory alloy. The peculiar feature of the splints is that the way in which they change shape in use conforms to the stretching motion which it would be desirable to apply in certain conditions of deformity.

The alloy consists of 55.66% by weight Nickel and 44.34% Titanium. The heat treatment of the alloy for memorising shape was implemented at 500° C for one hour. This alloy was easily bent when cool, but the original shape was recovered on heating.

It was used as the supporting structure of the reverse knuckle bender splint and the cock-up splint. The new splints could be easily attached to the deformed limb after cooling. The splints avoided the development of spasticity, because they gradually recovered their original shapes and corrected the deformities when the heat of the room or body heat warmed the splints.

Since the shape memory alloy has the dual function of thermal sensor and kinetic power source it was a simple device. The splint was, as a result, small and smart. It was apparent from clinical use that the splint was easy to wear and could be worn with comfort for an extended period.

The design of the splints and the fabrication process are described and their application is indicated.

**Beaumont Lifestyle Inventory of Social Support: Can It Predict Disposition Prior to an Inpatient Rehabilitation Admission?** Tamler MS, Perrin JCS, reprinted from *Am J Phys Med Rehabil* 71:149-155, 1992.

Predicting which rehabilitation patients will ultimately be discharged to a nursing home is a difficult task because methods used to evaluate preexisting home environment and quantify social support have been inadequate. To address this problem, the Beaumont Lifestyle Inventory of Social Support (BLISS) was developed. This questionnaire examines the family's willingness to care for, supervise and provide financial assistance to the patient. Organized into 10 weighted questions, BLISS results in a maximum score of 12. A prospective study was conducted to determine the correlation of the BLISS score with discharge disposition. Prior to rehabilitation admission, continuing care coordinators administered the BLISS to an involved family member of each patient. After 6 months, all BLISS forms were scored and compared with discharge disposition. Seventy-nine patients were included in this study and six (7.6%) were discharged to nursing homes. Comparison of BLISS scores obtained in patients discharged home versus nursing home revealed averages of 9.3 and 4.0, respectively ( $P < 0.0006$ ). These findings indicate that BLISS can quantify a patient's social situation and provide a predetermination of the social factors that lead to nursing home discharge. Consequently, BLISS will be a useful screening tool during the rehabilitation selection process.

**Biomechanical Comparison of the Energy-Storing Capabilities of SACH and Carbon Copy II Prosthetic Feet During the Stance Phase of Gait in a Person with Below-Knee Amputation.** Barr AE, Siegel KL, Danoff JV, et al., reprinted from *Phys Ther* 72:344-354, 1992.

In this study, the energy-storing capabilities of solid-ankle cushion heel (SACH) and Carbon Copy II prosthetic feet during the stance phase of gait were compared. A person with a unilateral below-knee amputation served as a component of the instrumentation to test the feet under dynamic loads. Ten trials per foot of bilateral stride at "free" velocity were collected with a video-based, three-dimensional data-acquisition system and two

force plates. There were no differences between the prosthetic conditions in step length, single-limb support time, and swing period (analysis of variance) or in double-limb support time, cadence, and velocity (Student's *t* test). Angular kinematics and moments of the hip and knee were unaffected bilaterally by the type of foot. The progression of the center of pressure under the Carbon Copy II was delayed from 15% to 80% of stance as compared with the SACH foot. The Carbon Copy II showed slower unloading in late stance and a later peak propulsive force than did the SACH foot. The Carbon Copy II performed greater work in both the energy-storage (Carbon Copy II = 2.33 J, SACH = 1.16 J) and energy-return (Carbon Copy II = 1.33 J, SACH = 0.34 J) phases of stance and returned energy with 57% efficiency. Although the energy returned by the Carbon Copy II was clinically insignificant during level walking, these results confirm that it performs as an energy-storing device.

**Clinical Trial of a Low-Temperature Plastic Anterior Ankle Foot Orthosis.** Wong AMK, Tang K-T, Wu S-H, Chen C-M, reprinted from *Am J Phys Med Rehabil* 71:41-43, 1992.

The modification of a new design in orthosis usually has its clinical indication. In this study, a low-temperature thermoplastic ankle foot orthosis (AFO) was designed in anterior leaf type, called anterior AFO, to meet the need of indoor barefoot walking in Taiwan. It could be easily molded and remolded to fit the foot, as well as to adjust the position of the foot and ankle.

Sixty-eight patients with acute hemiplegia were fitted with this anterior AFO during ambulation training: 46 had good fitting (67%), 15 had fair fitting (22.1%) and 7 had poor fitting (10.3%). Two patients were observed to have ankle clonus, and four patients experienced breakage or tear of the AFO within 4 wk.

The gait characteristics were measured in six chronic hemiplegia patients to compare the effect of anterior AFO with posterior AFO (Teufel style). Their gait pattern did improve by AFO fitting, especially from the foot pressure distribution, but no significant difference between the two types of AFO was found.

**Comparative Biomechanical Analysis of Energy-Storing Prosthetic Feet.** Menard MR, McBride

JE, Sanderson DJ, Murray D, reprinted from *Phys Ther* 73:451-458, 1992.

Gait analysis was performed on eight men who had unilateral traumatic below-knee amputation and on nine control subjects. Each subject was given two prostheses—the Seattle Foot and the Flex Foot—which differed only in the energy-storing foot component. Analysis of subjects consisted of clinical gait observation, forceplate analysis of the ground reaction force (GRF) while using each prosthesis during level walking at the natural cadence, and evaluation of subject preference between the two prosthetic feet. In the control subjects, there was no significant asymmetry in any averaged GRF patterns or parameters. In the subjects with amputations, the amputated limb had a weaker propulsion and the nonamputated limb had a stronger propulsion than controls. This was true for both prostheses. During ambulation with the Flex Foot, there was a pattern of larger late vertical forces but smaller late anteroposterior and mediolateral forces. This is consistent with a medial heel whip, and it was observed when the Flex Foot was used. Three months after the biomechanical studies, four subjects used the Flex Foot exclusively, two used the Seattle Foot exclusively, and two used both, ie, the Flex Foot for sports and the Seattle Foot for work. Application of these results to the choice of prosthetic components is discussed.

**A Computerized Wheelchair Ergometer: Results of a Comparison Study.** Veeger HEJ, van der Woude LHV, Rozendal RH, reprinted from *Scand J Rehabil Med* 24:17-23, 1992.

To determine the validity of propulsion simulation on a stationary wheelchair ergometer, nine male able-bodied subjects performed submaximal exercise tests on the ergometer and on a motor driven treadmill (MDT). Oxygen uptake, ventilation and stroke parameters were equal for both devices, but heart rate was lower and trunk movement was less for the ergometer test. Analysis of forces and power output on the ergometer indicated that power output was equal for both wheels. The ratio between applied forces and the effectively directed force component was approximately 80%. Also a small torque was applied by the hand onto the handrim surface which contributed to the total propulsion

torque around the axle. It is concluded that the ergometer is capable of simulation of wheelchair propulsion, although the different trunk motion may necessitate sufficient wheelchair propulsion experience. Force analysis results are discussed.

**Contralateral v. Ipsilateral Cane Use: Effects on Muscles Crossing the Knee Joint.** Vargo MM, Robinson LR, Nicholas JJ, reprinted from *Am J Phys Med Rehabil* 71:170-176, 1992.

Although using a cane contraterally has been shown to reduce muscular activity across the hip joint, little is known about effects on the knee. We measured muscular activity around the knee in 10 able-bodied subjects. We simultaneously recorded integrated rectified surface electromyographic activity from the right quadriceps, medial and lateral hamstrings, gastrocnemius and hip abductors during various standing maneuvers: two-legged stance, unsupported one-legged stance and one-legged stance putting maximal, moderate (20% body weight) or minimal (10% body weight) force through an ipsilateral or contralateral cane. Electromyographic activity was expressed as the percentage of that recorded during unsupported one-legged stance in each muscle. Hip abductor activity was lowest when maximal weight was placed through a contralateral cane (66%) and highest with maximal weight ipsilaterally (424%). Medial hamstrings activity increased by 404% and 200%, respectively, when maximal and moderate force was applied to a contralateral cane, although there was no change with ipsilateral cane. Lateral hamstrings were also most active during contralateral cane use. Quadriceps activity decreased using a cane in either hand with moderate or minimal force (range 57 to 84%). Gastrocnemius activity decreased during contralateral (60 to 66%) and ipsilateral (75 to 96%) cane use. This data suggests that forces generated by muscular activity around the knee are not uniformly diminished by holding a cane in the contralateral hand and may even be increased.

**The Dual-Task Methodology and Assessing the Attentional Demands of Ambulation with Walking Devices.** Wright DL, Kemp TL, reprinted from *Phys Ther* 72:306-315, 1992.

The purposes of this article are (1) to provide a preliminary examination of the attentional demands

of ambulating with two commonly prescribed walking aids (a standard walker and a rolling walker) and (2) to introduce the dual-task methodology to the physical therapy community. Five subjects familiar with the appropriate use of the walkers and five subjects uninformed as to the correct use of the walkers participated in the study. Each subject completed the three phases of the experiment: (1) performing the reaction time (RT) task only; (2) performing each of the walking tasks only; and (3) performing each of the walking tasks in conjunction with the RT task, which constituted the dual-task conditions. The findings indicated that walking aided by either the rolling walker or the standard walker was highly attention demanding. More importantly, it appears that greater attentional demand was required when ambulating with the standard walker. These results are discussed with respect to the gait modifications and accuracy demands required when using these walkers. The usefulness of the dual-task methodology as a research tool for addressing clinically oriented questions is emphasized, and some potential applications of this methodology for the therapist within the clinic are discussed.

**Factors Influencing Reintegration to Normal Living After Amputation.** Nissen SJ, Newman WP, reprinted from *Arch Phys Med Rehabil* 73:548-551, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

This study identified factors affecting reintegration to normal living (RNL) after lower extremity amputation. A questionnaire was used to evaluate RNL at a veterans' medical center and private rehabilitation clinic. The patients were 42 elderly individuals ( $68 \pm 1.5$  years). Eighty-eight percent were men and 76% had additional health problems. Unilateral below-knee amputations, unilateral above-knee amputations, and bilateral amputations accounted for 38%, 36%, and 26% of subjects, respectively. Eleven questions were asked to evaluate mobility, self-care, work, recreation, social activities (daily functioning), relationships, social self, and life events (perception of self). The median overall RNL score was 16 of 22 (range, 5 to 22). Poor reintegration occurred in community mobility, work, and recreation. Perception of self

questions showed satisfactory reintegration. Examination of variables impacting reintegration showed only additional illness significantly reducing the RNL score. It was concluded that current rehabilitative efforts regarding home mobility and psychological adjustment are satisfactory. More attention to community mobility, recreation, and additional illnesses would improve RNL after amputation.

**Functional Benefit of an Adaptive Myoelectric Prosthetic Hand Compared to a Conventional Myoelectric Hand.** Bergman K, Ornholmer L, Zackrisson K, Thyberg M, reprinted from *Prosthet Orthot Int* 16:32-37, 1992.

Eight patients with a traumatic unilateral upper limb amputation, who used conventional myoelectric prostheses, were also fitted with a commercially available myoelectric prosthetic hand with an adaptive grip, in order to compare the functional benefit of the two types of prostheses.

Comparisons were made regarding width of grip, force of grip, scores in a standardised grip function test and prosthesis preference. The conventional prosthesis showed significantly better results regarding these parameters. The adaptive hand does not appear to be fully developed for practical use in prosthetic rehabilitation.

**Heart Rate Evaluation of Axillary and Elbow Crutches.** Hall J, Elvins DM, Burke SJ, et al., reprinted from *J Med Eng Tech* 15:232-238, 1991.

The aim of this study was to compare the possible effect on heart rate in patients with a walking disability using 11 different crutch designs. Eighteen patients, over the age of 18 years, who had used crutches for a minimum of 2 weeks before the study were divided into two groups: elbow and axillary crutch users respectively. The former tested six different designs of elbow crutches and the latter five different pairs of axillary crutches. Heart rate was recorded, using a portable digital pulse monitor during a 5-min walk on the level at self-selected velocities. Walking heart rates increased between 28.6 and 58.8% compared with the resting phase. No differences were found in either heart rate or walking speed between elbow crutches. However, a significant difference ( $p < 0.001$ ) in heart rate was noted between elbow crutch users who were non-

weight bearing on their injured leg compared with those who were partial-weight bearing. The Canadian axillary crutch showed the lowest increase in heart rate at comparable walking speeds compared with other axillary crutches. Prescribers should be aware that the reduced energy requirements of the Canadian crutch would benefit patients with reduced cardiorespiratory function.

**Is "Handicap" Affected by a Hospital Based Rehabilitation Programme?** Roy CW, Hunter J, Arthurs Y, Prescott RJ, reprinted from *Scand J Rehabil Med* 24:105-112, 1992.

"Handicap," categorised according to the ICIDH, and "Disability," measured by the Smith Activities of Daily Living (ADL) Index, were assessed in over 300 patients (suffering from strokes, lower limb amputations, cardiac disorders, low back pain and other diseases) on admission to and after discharge from a hospital based rehabilitation programme. Statistically significant improvements were found in Physical Independence and Mobility Handicaps which correlated with improvements in ADL Self-care ( $R = 0.58$ ,  $p < 0.001$ ) and ADL Mobility ( $R = 0.53$ ,  $p < 0.001$ ) averages. Small but significant improvements were also found in Orientation, Occupation and Social Integration Handicaps but there was no change in Economic Self Sufficiency Handicap. Thus it is possible to use the Handicap categorisations to assess disabled people sequentially during a rehabilitation programme. The problems of data collection, however, are so formidable that its usefulness must be limited.

**Leg Load Monitor for Rehabilitation.** Betts RP, Watson AG, reprinted from *Physiotherapy* 78:172-173, 1992.

A leg load monitor with audio and visual feedback is described, which provides an objective measurement of static and dynamic leg loading. Clinical trials have shown the device to be a useful tool in a number of rehabilitation areas, some of which are described. The monitor has the potential to reduce significantly the time involved in training patients to load their legs correctly to predetermined levels, with the implications of earlier discharge from hospital, increased patient throughput and reduced waiting lists and costs.

**Longitudinal Changes in Adjustment After Spinal Cord Injury: A 15-Year Study.** Krause JS, reprinted from *Arch Phys Med Rehabil* 73:564-568, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

Research on changes in adjustment after spinal cord injury (SCI) has produced mixed results. Whereas cross-sectional research has suggested that adjustment declines with increasing age, but improves with greater time since injury, longitudinal research has suggested that some limited positive changes in adjustment occur over an 11-year period. The purpose of the current study was to identify the stability of adjustment over a 15-year period after SCI. One hundred thirty-five participants with SCI completed Life Situation Questionnaires (LSQ) in both 1974 and 1989. *T*-test comparisons were made of five adjustment scales and 15 individual items. The results suggested several positive changes in adjustment during the 15 years including increased sitting tolerance, more years of education, greater satisfaction with finances and employment, and higher percentage of persons working. Decreases were noted in the number of hospitalizations and the number of days hospitalized. Given the average number of years since injury (9.3 years in 1974; 24.3 years in 1989), the results suggest that adjustments will at worst be stable, and at best will improve significantly with time.

**Lower Limb Amputee Survival.** Stewart CPU, Jain AS, Ogston SA, reprinted from *Prosthet Orthot Int* 16:11-18, 1992.

A total of 1710 primary amputees have been studied over a 25 year period and their survival time has been calculated. These were all consecutive primary lower limb amputees admitted to the Dundee Limb Fitting Centre during the period 1965-1989. Overall, the median survival was 4 yr 9 mth for the below-knee amputee (1019 patients) and 4 yr 3 mth for the above-knee amputee (586 patients). The vascular related amputees had an overall median survival of 4 yr.

In the two decades 1970-1979 and 1980-1989 there were significant differences between the survival time of the below-knee and above-knee amputee. The survival of the amputee has increased

during the two decades from 3 yr 6 mth to 6 yr 6 mth ( $p > 0.001$ ). For the first decade male above-knee and male below-knee amputee median survival was 3 yr 1 mth and 3 yr 11 mth respectively and for the second the survival was 5 yr 9 mth and 6 yr 11 mth for these levels of amputation.

For 1970-1979 no significant differences were found between male and female peripheral vascular disease (PVD) and diabetes mellitus related amputee survival. For 1980-1989 significant differences were found between PVD related male above-knee amputees (3 yr 10 mth) and male below-knee amputees (6 yr 7 mth) ( $p > 0.01$ ). Similar results were found for the female patients.

Operative mortality was found to be 5% over the period 1975-1989 which compared favourably with previous studies.

**Lower Limb Biomechanics Related to Running Injuries.** Heil B, reprinted from *Physiotherapy* 78:400-406, 1992.

The purpose of this paper is to discuss the biomechanics of the subtalar joint and to link abnormal alignment at this joint to the development of overuse running injuries. The concept of subtalar joint neutral is introduced and a method of finding this position is explained. Normal running gait is examined in three phases: heelstrike, pronation and resupination. The meaning of ground reaction force is considered in relation to various foot types. The biomechanics of abnormal subtalar joint motion are related to common overuse injuries; knee pain, iliotibial tract syndrome, shin splints, Achilles tendinitis, plantar fasciitis and hallux valgus.

**Mortality After Spinal Cord Injury: A Four-Year Prospective Study.** Kruase JS, Kjorsvig JM, reprinted from *Arch Phys Med Rehabil* 73:558-563, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

Research has suggested that mortality after spinal cord injury (SCI) is correlated with lower levels of social and vocational activities and lower life satisfaction. The purpose of this study was to use prospective data from a 1985 SCI follow-up study to identify predictors of survival status four years later. In 1985, responses to the revised Life Situation

Questionnaire were obtained from 347 participants with SCI. Survival status was ascertained in 1989; 89% ( $n = 22$ ) were deceased. Multivariate ANOVA was used to compare the surviving and deceased participant groups using the 1985 data. Results suggested that survivors had superior adjustment on many of the variables tested in 1985. In particular, the survivors were more active, rated their adjustment as better, were more satisfied with many areas of life, and reported fewer problems (especially with emotional distress). Recent medical history (ie, nonroutine doctor visits and hospitalizations) was not related to survival. This study reaffirms the importance of psychologic, social, and vocational variables as predictors of survival. A call is made for rehabilitation psychologists to address tough issues (eg, substance abuse) and to thoroughly study more specific health behaviors as they relate to survival after SCI.

**Motor Recovery of the Upper Extremities in Traumatic Quadriplegia: A Multicenter Study.** Ditunno JF, Stover SL, Freed MM, Ahn JH, reprinted from *Arch Phys Med Rehabil* 73:431-436, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

Clinicians need to know recovery of neurologic function in the upper extremities after traumatic quadriplegia to prognosticate function in self-care, to determine the effectiveness of various interventions, and to develop a comprehensive rehabilitation plan. This study was undertaken to determine the extent of recovery of key muscles of the arms in motor complete quadriplegic subjects. The hypothesis stated that patients with some motor power (grades 1.0 to 2.5/5) in muscles in the zone of partial preservation would recover at an earlier time and to a greater extent than those with no motor power (grade 0/5). One hundred fifty subjects, C4, C5, and C6 motor complete, were entered in the study within one week of injury from four centers. Serial muscle examinations of the biceps, wrist extensors, and triceps on the right and left sides were performed up to 24 months after spinal cord injury. The pattern of recovery in the key muscles of the 67 subjects with some motor power in the zone of partial preservation of grade 3/5 was significantly greater than the 83 subjects with no motor power

(68% to 82% vs 14% to 36%,  $p < .001$ ) at three to six months postinjury. The plateau of the median manual muscle test score determined the extent of recovery and reached grade 4/5 in subjects with some motor power at three to six months. The pattern of recovery revealed more subjects with some motor power improved to grade 3/5 at all intervals earlier than those with no motor power ( $p < .005$ ). Recovery continued in those muscles with no motor power from the nine- to 24-month interval, increasing from 41% to 64% ( $p < .05$ ). Since most quadriplegic patients are discharged four to five months postinjury, these findings indicate that many patients have not achieved full motor recovery at discharge. It is urged that patients be reevaluated at regular intervals subsequent to discharge to determine if they have reached a functional grade to muscle strength for the purposes of self-care training, reassessment of equipment needs, and eligibility for reconstructive surgery or functional aids, if indicated.

**Postural Reorganization Following Lower Limb Amputation: Possible Motor and Sensory Determinants of Recovery.** Geurts ACH, Mulder TW, Nienhuis B, Rijken RAJ, reprinted from *Scand J Rehabil Med* 24:83-90, 1992.

Postural control was assessed in persons with a unilateral lower limb amputation before and after their rehabilitation. The centre-of-pressure fluctuations during quiet upright standing on a dual-plate force platform were registered with and without visual information in order to identify relevant determinants of balance restoration. In addition, static (weight distribution) as well as dynamic (control activity) asymmetry characteristics were examined. Besides a small improvement in balance control with full visual information (fore-aft sway,  $p < 0.06$ ; lateral sway,  $p < 0.05$ ), there was a major decrease in visual dependency (fore-aft and lateral sway,  $p < 0.05$ ) indicating a somatosensory re-integration process. Postural asymmetry in comparison with matched control subjects was most apparent and only significant in dynamic terms and remained constant across rehabilitation. It is concluded that after a lower limb amputation a central reorganization of postural control takes place, in which sensory determinants of motor recover may play a critical role.

**Primary Orthotic Treatment of Ruptured Ankle Ligaments: A Recommended Procedure.** Pwipp H, Schievink B, reprinted from *Prosthet Orthot In* 16:49-56, 1992.

The results of a study after 1 and 2 years of a prospective randomised trial of operative versus conservative treatment of ankle ligament rupture, demonstrated that purely functional orthotic therapy is the method of choice. This relates both to patient need and economical considerations. The trial demonstrated that without an operation it was possible to achieve a high degree of mechanical stability, a reduction of work disability time down to 3 weeks and full sports capability within 3 months. Consequently, and as a result of the trial, the only remaining surgical indications would seem to be dislocations of the foot and ankle, ankle ligament rupture with additional intra-articular pathology, and second-stage injuries or re-ruptures.

The joint-stabilising function of the prototype splint developed in this study was improved on the basis of experimental investigations, using a Y-shaped leather band (designated CALIGAMED), which is available in 6 sizes for right and left ankle.

**Prosthetic Management of Hemicorporectomy Patients: New Approaches.** Smith J, Tuel SM, Meythaler JM et al., reprinted from *Arch Phys Med Rehabil* 73:493-497, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

Functional outcome with hemicorporectomy prosthetic management has improved little in the last 20 years. Patient expectations for independence, comfort, and cosmesis have been disappointed with traditional bucket designs. This report describes the prosthetic management of a paraplegic patient who underwent hemicorporectomy at T12 secondary to complications from a lumbar ependymoma. Four successive prostheses were developed using foam and resin combinations, computer-assisted pressure monitoring, and interdisciplinary team feedback regarding design and fabrication. A total-contact bucket with removable liner was created, allowing management of the ileal diversion and colostomy. Prosthetic legs were attached to improve wheelchair balance and cosmesis. In his final prosthesis, the

patient's function and appearance was equivalent to a well-rehabilitated midthoracic spinal cord trauma patient. Sitting tolerance exceeded 12 hours a day. Each prototype is discussed, including design, materials, fabrication process, patient acceptance and functional independence, and complications.

**Psychological and Sociological Theories Concerning Adjustment to Traumatic Spinal Cord Injury: The Implications for Rehabilitation.** Hammell KRW, reprinted from *Paraplegia* 30:317-326, 1992.

During the past decades many healthcare professionals have turned their attention to describing the process of adjustment to traumatic spinal cord injury. Extensive review of the literature concerning adjustment is examined, together with an analysis of the effect which these theories have upon the healthcare provider who interacts with the client.

Traditional rehabilitation has had the objective of teaching physical skills to such patients in order to achieve the highest possible level of independence. This paper challenges the rehabilitation team to broaden this concept of successful outcome. 'Living' requires more than physical survival.

**Relationship of Life Satisfaction to Impairment, Disability, and Handicap Among Persons With Spinal Cord Injury Living in the Community.** Fuhrer MJ, Rintala DH, Hart KA, et al., reprinted from *Arch Phys Med Rehabil* 73:552-557, 1992. (©1992 by the American Congress on Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation.)

The level and correlates of the life satisfaction of persons with spinal cord injury who are residing in the community were investigated. One hundred men and 40 women were chosen randomly from a cohort of 640 person with spinal cord injury residing in a 13-county area in southeast Texas. The mean Life Satisfaction Index-A (LSIA-A) was lower than reported previously for persons in the general population. The LSIA-A was not correlated significantly with chronologic variables, the ASIA Total Motor Index Score, or a self-report version of the Functional Independence Measure. The LSIA-A was associated positively with self-assessed health, perceived control, and social support, as well as with the Social Integration, Occupation, and Mobility

dimensions of the Craig Handicap Assessment and Reporting Technique. From the standpoint of an augmented version of the World Health Organization model of disablement, the life satisfaction of persons with spinal cord injury appears to be influenced, albeit indirectly, by selective aspects of their social role performance (handicap), but not by their degree of impairment or disability.

**Risk Factors for Cardiovascular Disease in Chronic Spinal Cord Injury Patients.** Krum H, Howes LG, Brown DJ, et al., reprinted from *Paraplegia* 30:381-388, 1992.

To establish whether the reported increased cardiovascular (CV) morbidity in spinal cord injury (SCI) patients is due to increased levels of established CV risk factors, we assessed overall CV risk in 102 consecutive patients aged 25-64 by calculation of a 'risk factor score' (RFS) derived from the MRFIT study (age, diastolic blood pressure (DBP), total cholesterol (TC) level, cigarettes/day, sex), obtaining a percentile position amongst an age and sex matched peer group from the 1983 Australian Risk Factor Prevalence Study. Chronic SCI patients had a very low overall percentile position of risk of  $26.03 \pm 15.06$  (mean  $\pm$  S.D.) and those patients with SCI for greater than 10 years had only a slightly higher risk position of  $33.16 \pm 29.66$ . The low relative risk in SCI patients was due mainly to significantly lower DBP levels ( $67 \pm 13$  mm hg), as TC levels ( $5.38 \pm 1.60$  mmol/L) and cigarette consumption (31% smokers, mode 11-20/day) were similar to the control population ( $83 \pm 12$  mmHG,  $5.68 \pm 1.2$  mmol/L, 28% smokers, mode 11-20/day, respectively).

As other known risk factors such as lipoprotein cholesterol fractions were not included in the RFS index, these were measured in 327 consecutive SCI patients. HDL cholesterol levels, which are negatively correlated with CV risk, were significantly lower in SCI patients ( $1.12 \pm 0.30$  mmol/L) compared to controls ( $1.35 \pm 0.35$  mmol/L) and those patients more than 10 years post SCI had still lower levels ( $1.02 \pm 0.40$ ).

These data suggest that the reported increased incidence of CV disease in SCI patients is unexplained by increases in BP, TC or smoking. However, low HDL levels may contribute to CV risk and

the role of other risk factors such as increased vascular reactivity remain to be established.

**Running Gait Impulse Asymmetries in Below-knee Amputees.** Prince F, Allard P, Therrien RG, McFadyen BJ, reprinted from *Prosthet Orthot Int* 16:19-24, 1992.

In running, large gait asymmetry is expected due to the inability of the foot prosthesis to comply with the kinematic demands and produce a powerful plantarflexion moment. In this work, interlimb asymmetry in below-knee (BK) amputee running gait was assessed for one rigid and three flexible keel prostheses, using vertical and anteroposterior ground reaction forces and respective impulses. Nine BK amputees and 6 controls participated in this study. The running speed was monitored by two light sensitive detectors while the ground reaction forces were measured with a Kistler force plate. Between the prosthetic side and the sound limb the impulse indicator showed greater asymmetry than the force. Interlimb asymmetry was very much present in all types of prosthesis tested but is less pronounced in the flexible keel prosthesis. In the latter, the asymmetry may be associated with the force-time history modulation rather than its magnitude alone. Generally, the impulses better describe interlimb asymmetry and the forces allow a greater discrimination between prosthetic foot types.

**Running Shoe Design and Selection Related to Lower Limb Biomechanics.** Heil B, reprinted from *Physiotherapy* 78:406-412, 1992.

The purpose of this paper is to discuss running shoe construction, and to review current research into running shoe design. Information from the reviewed literature is correlated to produce a list of features to consider when selecting shoes for differing lower limb biomechanics.

**A Self-Administered Hip-Rating Questionnaire for the Assessment of Outcome after Total Hip Replacement.** Johanson NA, Charlson ME, Szatrowski TP, Ranawat CS, reprinted from *J Bone Joint Surg* 74-A:587-597, 1992.

The hip-rating questionnaire was developed for the assessment of the outcome of total hip replace-

ment. The purpose of this study was to evaluate its reproducibility, validity, and responsiveness. The questionnaire uses a 100-point scale in which equal weight is given to the domains of global or over-all impact of arthritis, pain, walking, and function.

Ninety-eight patients were enrolled in the prospective study and have been followed for at least three months; sixty-two patients have been followed for six months; and forty-two patients have been followed for one year. Reproducibility was tested with the use of the kappa statistic in fifty patients whose condition was stable clinically, and it was found to be good or excellent both for individual questions and for the total score.

The validity of the questionnaire was assessed by comparison with the scores from a six-minute walking-distance test and arthritis impact-measurement scales. The result of the six-minute walking-distance test correlated with the patient's response concerning walking distance on the hip-rating questionnaire. The score for pain from the hip-rating questionnaire correlated well with the total score for pain from the arthritis impact-measurement scales, and the total score from the hip-rating questionnaire correlated well with the total score from arthritis impact-measurement scales.

The score on the hip-rating questionnaire was responsive to the change in the clinical condition of the patient, as indicated by a favorable index of responsiveness. The results of the questionnaire were sensitive enough to demonstrate differences among treatment groups with relatively small sample sizes.

This questionnaire has the characteristics of a useful instrument for assessment of outcomes, such as that after an operation.

#### **The Social and Economic Outcome After Upper Limb Amputation.** Kejlaa GH, reprinted from *Prosthet Orthot Int* 16:25-31, 1992.

This paper reports a study of 66 upper limb amputees in County Funen, Denmark who were visited in their homes by the author. The purpose of the study was to evaluate for the same period of time the social and economic outcome for a population of upper limb amputees compared with the normal population.

The number of amputees investigated corresponds to the annual number of persons becoming upper limb amputees in Denmark. The aetiology of regis-

tered amputees also corresponds to the Danish Amputation Register.

The amputees had become "better placed" in the social system after amputation independent of prosthetic use. The mean age of the amputees corresponded with the age where people reach their best social grouping. Their social migration quotient was higher than the background population and reflected the amputees better income and housing conditions. The reasons for these surprising results must be the high grade social system in a sophisticated industrial country. None of the amputees were required to pay for rehabilitation or prosthetic supply.

A lower divorce rate for the amputees was explained by a symbiosis between the amputees and their partners to protect their future existence. Only 14% lived alone.

Those who had their sexual debut after amputation were 3 years later in sexual experience than the rest of the amputees because of difficulties during the maturing process.

#### **Steadiness in One-Legged Stance: Development of a Reliable Force-Platform Testing Procedure.**

Goldie PA, Evans OM, Bach TM, reprinted from *Arch Phys Med Rehabil* 73:348-354, 1992. (©1992 by the American Congress on Rehabilitation and the American Academy of Physical Medicine and Rehabilitation.)

Postural steadiness in one-legged stance has potential for evaluation of unilateral injuries and disorders, but any test protocol must be demonstrated to be both feasible and reliable. A testing protocol for using a force platform to measure steadiness in one-legged stance with eyes opened and eyes closed was successfully developed, and its within-session retest reliability was investigated in a group of 24 young, healthy subjects. Strategies were used to minimize the loss of data for trials in which the subjects incurred significant loss of balance from the one-legged position. The performance scores examined were the standard deviation of the three orthogonal force components and the two horizontal center of pressure (CP) coordinates averaged over four consecutive five-second trials. The retest coefficients for all test conditions were substantially improved compared with testing protocols reported earlier. Retest reliability was higher for performance

scores based on force measures than for performance scores based on CP measures. The difference was statistically significant in two of the stances, with a similar trend in the other two stances. Further, factor analysis showed that force measures were the best predictors of steadiness in one-legged stance. Analysis of variance failed to detect any systematic effect for leg preference or laterality on steadiness in one-legged stance with eyes opened or eyes closed in the healthy subjects with no history of injury ( $p > .05$ ). The test protocol described enables the development of clinical or experimental trials with repeated-measures design using the subject's nonaffected leg as a control.

**Vocational Decision Making by Sixty Spinal Cord Injury Patients.** Crisp R, reprinted from *Paraplegia* 30:420-424, 1992.

Sixty persons with spinal cord injury completed the *My Vocational Situation* (MVS) questionnaire developed by Holland, Daiger and Power. The MVS was designed to identify problems related to vocational decision making, ie lack of vocational identity, lack of occupational information, and the presence of environmental or personal barriers to a chosen occupational goal. As expected, more problems were reported by unemployed persons than by employed persons, and by those who reported lower levels of psychological well being. MVS scores were not mediated by age, time since injury or severity of injury.

## BOOK REVIEWS

by

Joan Edelstein, M.A., P.T.

**Joint Structure and Function: A Comprehensive Analysis**, 2nd edition, by Cynthia C. Norkin and Pamela K. Levangie. Philadelphia: F.A. Davis, 1992. 512 pp. Illustrated.

Kinesiology is the basis of much of rehabilitation. Thus, a broad-based textbook is a necessary component of professional education. Norkin, director of the School of Physical Therapy at Ohio University, and Levangie, of the Department of Physical Therapy at Boston College, have revised their popular text, principally by updating research findings and adding two chapters: one on the thorax and chest wall by Linda Crane of the University of Miami, and one on the temporomandibular joint by Jan Perry, Chair of the Department of Physical Therapy at the Medical College of Georgia.

The authors preserve the same organization that served so well in the first edition, starting with basic concepts in biomechanics. They then highlight joint structure and function, followed by salient features of muscles. The heart of the book is composed of a series of chapters on various bodily segments, including the vertebral column, thorax and chest wall, temporomandibular joint, shoulder, elbow, wrist and hand, hip, knee, and ankle-foot. Each topic is presented in the same format, beginning with an outline of the chapter. Chapter objectives follow that alert the reader to the skills which should be achieved, such as the ability to define special terminology, describe pertinent functional anatomy, compare various structures within the complex, and draw action lines of the muscles and the moment arm for each one. There follows discussion of the structure and function of the components of the region, and, depending on the site, a brief presentation of musculoskeletal pathology. Throughout, the book is illustrated by exceptionally clear line drawings and diagrams.

Norkin and Levangie devote their final two chapters to posture and gait. Increasing the useful-

ness of the book are sections relating to stair gait and running. The authors recommend that students become familiar with the terminology coined by earlier investigators of gait to name points in the gait cycle, and with the designations introduced at the Rancho Los Amigos Medical Center that denote duration. In the new edition, the chart of ranges of motion in each subphase reflects the excursions reported by Rancho Los Amigos which differ slightly from those of other laboratories. Although the text on the preceding page cautions that the angular values relate to the joint position at the end of the phase, the table would have been more useful had this warning appeared in the legend. Particularly confusing is the listing of knee position at initial contact as zero degrees, when it has been established that the knee must flex quickly to absorb the shock that occurs when the limb strikes the floor. Inclusion of specific values for energy consumption and the table summarizing transverse rotations through the cycle improves the chapter, as do the accompanying sketches. The authors retain the portions describing the effects on gait of several neuropathies, paralysis, and limb asymmetries.

Altogether, the new edition of *Joint Structure and Function* is a most useful text for the student in physical therapy and in other rehabilitation disciplines. Having used the first edition in a kinesiology course earlier this year, my students and I agreed that Norkin and Levangie conveyed key issues in an understandable fashion. Clinicians will also find the book to be a handy reference.

**Adaptability of Human Gait: Implications for the Control of Locomotion**, edited by Aftab E. Patla. New York: Elsevier Science Publishers, 1991. 456 pp. Illustrated.

An international perspective on walking is the special attribute of *Adaptability of Human Gait: Implications for the Control of Locomotion*. Aftab

E. Patla, Professor at the Department of Kinesiology, University of Waterloo, Ontario, has assembled a cadre of 32 experts from Canada, France, Germany, Italy, Japan, Sweden, the United States, and Yugoslavia to consider many factors which influence gait.

The first section, by Patla, establishes the premise of the volume, namely the concern with how walking is generated and regulated. Patla contends that successful locomotion requires 1) production of a basic locomotor rhythm which can support the body against gravity and propel it in the intended direction, 2) equilibrium control of the moving body, and 3) adaptation of these movements to meet the environmental demands and goals of the walker. Sections 2 and 3 concern the role of proprioception, vestibular function, and vision to the modulation of gait. Section 4 describes the adaptability of the central nervous system and infant stepping. In Section 5, the authors, Aurelio Cappozzo from Rome, and Ronald F. Zernicke, et al., from the University of California at Los Angeles, discuss the biomechanics of normal gait. Modeling of gait control and robotics are considered from several viewpoints in the next two sections.

Of particular interest is the penultimate section, Rehabilitation of Locomotor Abilities. Gunnar Jansson of the University of Uppsala, Sweden, details how blind children and adults may capitalize on reflected sound to locate objects. Electronic travel aids have not yet increased the spatial perception very much as compared with the traditional long cane and guide dog. James Gage and Sylvia Ounpuu from Newington Children's Hospital, Newington, CT, relate surgical intervention to the correction of gait abnormalities, especially in children with cerebral palsy. They show how instrumented gait analysis aids the surgical decision-making process by documenting abnormalities in all planes and by demonstrating the cause of the deviation through the use of electromyography, video recordings, and kinetic data. Viewing a similar patient population from another perspective, Carol Richards et al., from McGill University, Montreal, relate gait analysis to physical therapy treatment strategies. Dejan Popovic, from the University of Belgrade, Yugoslavia, presents strategies for functional electrical stimulation in improving the gait of patients with upper motor neuropathies.

Patla concludes the book by synthesizing what is

known about the control of walking in an aptly titled "Janus Perspective." His work contributes much to our understanding of the neurologic control of gait. As is often the case with multiauthored books, the effectiveness of presentation varies considerably. The abstract introducing each chapter is a helpful feature. Some authors have been generous in their use of references. The index and illustrations are minimal. This book is not for the novice who seeks a basic presentation of the phases, kinematics, and kinetics of gait. Those who wish to pursue investigation of gait control will find much background material in this book.

**Gait Analysis: Normal and Pathological Function,** by Jacquelin Perry. Thorofare, NJ: Slack Inc., 1992. 556 pp. Illustrated.

*Gait Analysis: Normal and Pathological Function* is unquestionably the most comprehensive reference relating to normal and abnormal walking patterns. Its author, Jacquelin Perry, MD, an orthopedist and former physical therapist, is the Chief of Pathokinesiology at Rancho Los Amigos Medical Center, Downey, CA. She pioneered one of the first instrumented motion analysis laboratories in the country. The wide ranging book reflects Perry's ongoing experience with patients with poliomyelitis, rheumatoid arthritis, and amputations.

The book is organized into four sections. The first deals with the fundamentals of the gait cycle, phases of gait, and locomotor functions. Perry introduced the concepts of walking tasks, namely weight acceptance, single limb support, and limb advancement. The second section is concerned with normal gait from a segmental approach. Perry presents the vector pattern, muscle control, and functional interpretation of the ankle-foot complex, knee, hip, and torso, as well as the arm, then integrates the total lower limb function through the subphases of gait. She has expanded the language of gait analysis by coining the terms initial contact, loading response, mid stance, terminal stance, pre-swing, initial swing, mid swing, and terminal swing. Although other investigators designate the same events by different terms, such as foot-flat, heel-off, and toe-off, Perry presents a strong case for her terminology.

The third section relates to pathological gait. Following a general discussion of the effects of deformity, muscle weakness, sensory loss, pain, and

impaired motor control, Perry analyzes deviations at the ankle and foot, knee, hip, and pelvis and trunk. Especially worthwhile are the clinical examples illustrating the effects of contracture, weakness, and control dysfunction. With the increasing popularity of gait laboratories, the fourth section is most timely. In it, Perry describes the merits and drawbacks of observational gait analysis, instrumented motion analysis, dynamic electromyography, force plates, and objective stride analysis, indicating on what circumstances each is most appropriate. The final chapter summarizes many studies on energy consumption conducted at Rancho Los Amigos by R. L. Waters, MD. The end features include a list of abbreviations and acronyms, a glossary, and an index. The book is lavishly illustrated with photographs, charts, and excellent line drawings.

Altogether, Perry has performed a signal service

for the rehabilitation community by bringing into one volume her many years of work pertaining to the ways in which people walk. Although one may cavil with some of the terminology, and find slight variation in some of the angular values, there is no disputing the biomechanical and pathomechanical explanations. Some aspects of gait are not emphasized, such as the development of walking in children, the changes in gait attributable to aging, and the alterations employed when one walks on sloping or irregular terrain. Even so, the book should be immensely useful to clinicians. *Gait Analysis: Normal and Pathological Function* belongs in the library of every clinical and academic rehabilitation department and any other facility concerned with understanding how people walk and helping them move more easily.