UNE, 1962

ORTHOPEDIC & PROSTHETIC APPLIANCE JOURNAL

The Journal of the Limb and Brace Profession

ASSEMBLY SPEAKER—The Hon. Barry Goldwater, Senator from Arizona, will be the featured speaker at AOPA's 1962 Assembly, October 14-17, at the Ramada Inn, Phoenix, Arizona. (See p. 110.)

publisher: American Orthotics and Prosthetics Association

Official Notice

The 1962 National Assembly of Orthotics and Prosthetics will be held October 14-17 at the Ramada Inn in Phoenix, Arizona. The Assembly is sponsored by the American Orthotics and Prosthetics Association, and the Annual Business Meeting of the Association is one of the Assembly events.

Herbert J. Hart, manager of Hittenberger's at Oakland, California, has been named Program Chairman. Working with him will be this group of Association members from Arizona: Clyde Aunger, Phoenix, Assistant to the Chairman and in charge of local arrangements; Frank Sheridan, Vice-Chairman of Special Devices; Edward L. Jachowski, Audio-Visual Aids Chairman; Karl Kean and Bill Hammon, both of Tuscon, Arizona.

A feature of the Assembly will be the special display of Special Devices and gadgets, presented by members of the Association. Mr. Erich Hanicke of Kansas City, Missouri, will again be in charge of arranging this display.

A total of 50 booths will display prosthetic and orthotic supplies. Arrangements for this group of exhibits is in charge of Mr. William Scheck, Chairman, Oak Park, Illinois and Mr. Benedict Pecorella, Vice-Chairman, Buffalo, New York.

WHO MAY ATTEND

The Assembly is open to all who are interested in the rehabilitation of the orthopedically handicapped. Information about registration fees and details of the program may be obtained by writing to Mr. Lester A. Smith, Executive Director, the American Orthotics and Prosthetics Association, 919 18th Street, N.W., Washington 6, D. C.

BUSINESS MEETINGS

The Annual Business Meeting of the American Orthotics and Prosthetics Association will be held October 14th and 17. The American Board for Certification will hold its official Business Meeting on October 16th.

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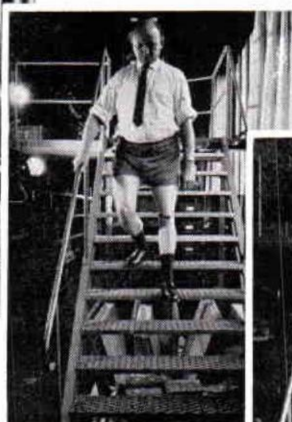

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The *Orthopedic and Prosthetic Appliance Journal* is issued four times a year—in March, June, September and December. The 1962 subscription price payable in advance is five dollars a year, for delivery anywhere in the Western Hemisphere. The subscription rate elsewhere is six dollars a year.

Publication does not constitute official endorsement of opinions presented in articles. The *Journal* is the official organ of its publisher, The American Orthotics and Prosthetics Association (formerly Orthopedic Appliance and Limb Mfrs. Assn.) and of the American Board for Certification. All correspondence should be addressed to the Editor of the *Orthopedic and Prosthetic Appliance Journal*, 919 18th St., N.W., Washington 6, D. C.

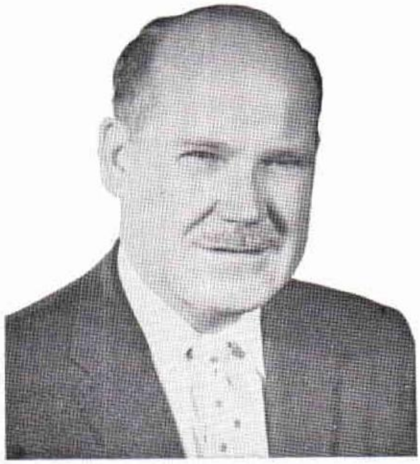
SUPPLIERS' INDEX—JUNE, 1962

The National Orthotics & Prothetics Assembly

An Invitation to Readers of the Journal

By

President Fred Quisenberry



Since many readers of the JOURNAL are not members of the Association, but have an equally strong interest in the orthopedically disabled, I welcome this opportunity to tell these readers something about the National Orthotics and Prosthetics Assembly.

The Assembly is much more than the annual convention or meeting of the American Orthotics and Prosthetics Association. It is primarily the technical and professional session of the Orthotists and Prosthetists, but with program features of interest generally to the medical profession and to rehabilitation workers. This is why the Assembly in recent years has had an increasing number of physicians and non-members in attendance and this is why the following brief "rundown" of plans is published:

1. *What the Convention is:* The National Orthotics and Prosthetics Assembly is an annual convention dealing with rehabilitation of the orthopedically handicapped through appliances.
2. *When:* October 14-17, 1962.
3. *Where:* The Ramada Inn, located in Phoenix, Arizona, at 38th Street and East Van Buren Streets, on U.S. Highway 60.
4. *Who May Attend:* All persons concerned with the orthopedically handicapped may attend upon payment of the registration fee. Information about registration, program, room reservation cards, etc., may be obtained by writing to: AOPA, 919 18th Street, Washington 6, D. C.
5. *Program*: The Technical program featuring new developments in prosthetics and orthotics is being arranged under the direction of Herbert Hart, C.P.O., Oakland, California.
6. *Technical Exhibits:* Over 40 booths will display the latest in devices and in orthopedic and prosthetic supplies. Information about these displays and the availability of exhibit space may be obtained by writing to the Exhibits Chairman: Mr. William Scheck, Scheck & Siress, 1141 Madison Street, Oak Park, Illinois, or to AOPA Headquarters, 919 18th Street, N.W., Washington 6, D.C.

I hope this brief report will assist readers of the JOURNAL in making their plans to attend the assembly. They may be sure of a warm welcome at the National Orthotics and Prosthetics Assembly.

The Effects of Bracing in Reduction of Contractures and Improvement of Function in Long Standing Cases of Hemiplegia*

By JAMES A. HOWARD, Ph.D., HAROLD B. WARREN, M.D., and ROBERT TITUS, O.T.R.

Southwestern Mental Health Center, Luverne, Minnesota, and Community Rehabilitation Industries, Inc., Long Beach, California

Function improvement in long-standing cases of hemiplegia has traditionally been considered unlikely. At the point of patient discharge to home care, or to vocational rehabilitation centers, gains in physical function are usually considered maximal. Perhaps this implicit assumption is an unfortunate generalization. It is to this problem that this paper addresses itself.

Considerable progress in development of both static and functional upper extremity braces has been made on the West Coast during recent years. Pioneering work of the Orthotics Section of Rancho Los Amigos Hospital of Los Angeles County, and the Upper Extremities Clinics of the Medical Center of the University of California at Los Angeles has opened new questions regarding the possibilities of bracing to prevent deformity and to increase function with a wide variety of spastic and flaccid paralysis cases. In some of these, quite dramatic results have been obtained (1).

Typically, such cases are under the direct supervision of Physical Medicine and Rehabilitation Departments of the hospitals, and are at the peak of function through the work of therapists. In cases which have not had such services available, or in cases of long-standing dysfunction long after hospital discharge, very little has been attempted.

In the course of a research program to determine the industrial employment potential of hemiplegics (3), conducted under Office of Vocational Rehabilitation sponsorship, evaluation of hemiplegic clients for transitional workshop training at Community Rehabilitation Industries, Inc., included the evaluation of these clients in terms of potential functional restoration through bracing and prosthetics application. Eight cases have thus far been sufficiently followed to permit report.

Evaluation Procedure for Bracing Hemiplegics

Following entry to the workshop training program, and within thirty days of the time of entry, each subject was evaluated by an orthopedist. This evaluation had, as a primary purpose, the determination of potential effect of bracing, particularly as it might increase function of the paralyzed or paretic side. Prior medical information regarding range of motion, flexion, spasticity and type and extent of prior treatment, as well as an adult modification of Katz' "Survey of Physical Capacities," (4) was also evaluated.

* This investigation was supported, in part, by a research grant from the Office of Vocational Rehabilitation, Department of Health, Education and Welfare, Washington, D.C.

For those cases considered capable of potential benefit, prescription for braces was written, and the appliances secured. Those showing severe and unreduced contractures, flail arm, wrist drops and other hemiplegic residuals from damage to the central nervous system were fitted with various types of braces.

Reevaluation of the cases was done at/or before six months' intervals, both to describe effect and to modify prescriptions. In cases where muscle size changes and flexion shifts required, adjustments and services were obtained from qualified orthotists.

Case Descriptions and Results Obtained

Case I *Anamnesis:* Male, Negro, age 43, former stevedore, ten years post onset from CVA, right hemiplegic. Residuals: forearm 118° elbow flexion,wrist 135° pronation, fingers tightly clenched, definite edema of wrist and hand at entry. Systems review essentially negative except CNS and musculo-skeletal.

Prescription: Long opponens splint with metacarpophalangeal extension stop and interphalangeal extensor assists. Brace applied July, 1958. *Six Months' Reevaluation:* Nearly complete elimination of forearm flexion contracture, partial reduction of wrist drop, fist opened sufficiently to admit 1" diameter tube when brace removed. Finger spasticity much reduced although still carried in flexion when not wearing brace. Edema much reduced.

One Year Reevaluation: Additional gains to above. Subject can use right hand to hold objects up to 2" diameter with or without brace. No evidence of edema.

Case I. Drill Inspector Al Johnson

Case II *Anamnesis:* Female, Caucasian, age 47, housewife, fifteen years post onset of left hemiplegia sequela to cranial surgery. Forearm 120° elbow flexion, drop wrist with slight radial deviation. Fingers in such tight flexion that nails must be cut short to avoid lacerating palmar surface. Systems review negative except CNS and musculo-skeletal. Finger stretch reflex grossly hyperactive.

Prescription: Long opponens brace with metacarpophalangeal extension assist. Brace fitted September, 1959.

Six Months' Evaluation: Current appliance of questionable value. Difficult for subject to apply due to hyperactive stretch reflex of left hand. Flexor intensity breaks down plastic finger slings of extension assists. Tolerance for appliance 2-4 hours daily because of severe pain. Suggests possible use of night splint to reduce contracture prior to second attempt to use long opponens brace. Progress is difficult to evaluate at this time.

Case III *Anamnesis:* Female, Caucasian, age 28, ceramics decorator, 5 years post onset of right hemiplegia from CVA, 160° elbow flexion, tremor, range of motion restricted, wrist 150° pronation, some spastic flexion of fingers. Capable of finger extension (three extension-flexions prior to tetanus), but unable to grasp objects in right hand. Some muscle atrophy.

Prescription: Long opponens, metacarpophalangeal extension stop and interphalangeal extensor assist. Brace applied June, 1958.

Six Months' Reevaluation: Muscle development such that three expansive adjustments have been made. Wrist no longer in flexion, tremor reduced and finger extension markedly improved. Can now grasp, lift and hold objects in involved hand. Finger extensions prior to tetanus 85 in rapid succession.

One Year Evaluation: Small but definite improvement over ratings of six months in all categories. Tremor now infrequent and minor, and involved hand customarily used in assists and routine work activities.

Case IV *Anamnesis:* Female, Caucasian, age 49, teacher, right hemiplegia subsequent to CVA at age 45, arm primarily flail with contractures in forearm and hand muscle groups. Elbow 150° flexion, wrist drop, fingers in deep flexion. Hand cannot admit small diameter tube without forcing fingers open.

Prescription: Long opponens brace, finger extension assists, metacarpophalangeal extension stop. Brace applied January, 1959.

Six Months' Reevaluation: Contracture reduction, wrist drop aided, still unable to use involved hand as other than a holding fixture.

One Year Reevaluation: Now able to pick up small, light objects with involved hand. Wrist drop appears to have been eliminated.

Case V *Anamnesis:* Male, Caucasian, age 21, student, left hemiplegia subsequent to traumatic injury of right cerebral cortex at age 17. Immature and quarrelsome. Wrist flexion to 100° radial deviation, digital deviation, non-uniform finger flexions.

Prescription: Long opponens, metacarpophalangeal stop and thumb positioner, tension plate for finger positioning. Brace fitted May, 1959.

Six Months' Reevaluation: Little or no change noted. Subject uses the brace only rarely and after pressuring by family and workshop staff. Complains of pain in using appliance, and fails to keep appointments for adjustments or refitting. Subject left training and has not been followed—now in unknown status and cannot be located.

Case VI *Anamnesis:* Male, Caucasian, age 45, former army officer. Right hemiplegia subsequent to shell fragment penetration of left motor cortex at age 37. Shoulder dislocation, some active wrist flexion, fingers in flexion, no contractures, anesthesia of entire upper extremity.

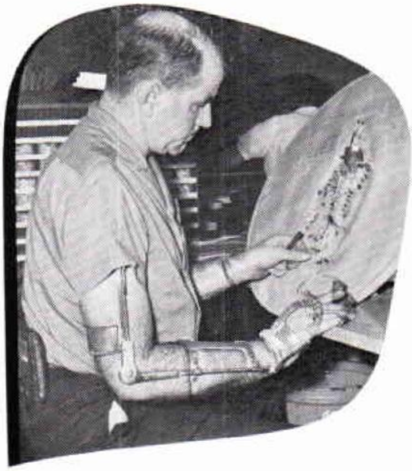
Prescription: Shoulder cap, manual elbow hinge with scapular abduction lock, contralateral, flexion wrist with extensor assist and interphalangeal assists on fingers. Brace applied June, 1959.

Six Months' Reevaluation: Shoulder stabilized, elbow can be locked in functional position, with some use of hand as a helping or holding device. Considerable reduction of shoulder pain. Can tolerate brace for about six hours.

One Year Reevaluation: Continued reduction of shoulder pain. Now able to close thumb and forefingers to grasp small light objects. Brace tolerance 12 hours per day.

Case VII *Anamnesis:* Male, Caucasian, age 32, precision grinder, right hemiplegia subsequent to CVA at age 28, with osteomyelitic complication following surgery, considerable aphasia. Elbow 135° flexion, drop wrist, and finger flexion, mild edema one year post CVA.

Prescription: Long opponens, with metacarpophalangeal tensor assist and strong outrigger finger assists. Brace fitted August, 1958.



Case VI. Former Army Captain J. E. Worrell, now supervisory foreman, electronics division.

Six Months' Reevaluation: Some contracture reduction, with finger extension aided and wrist position improved. Subject can use hand only as a clumsy holding fixture while wearing brace, and no coordination is noted in attempts to use the non-involved hand when involved hand is holding anything—this appears to be reduced when the distance between hands is increased and the subject does not then "ape" the motion of the uninvolved hand with the braced member.

One Year Reevaluation: Wrist positioning now can be accomplished without wearing brace, although there is some residual finger flexion without brace. Independent operation of hand is still quite poor, althrough dysfunction of coordination is reduced. Subject has had several adjustments to accommodate increased muscle size, but no longer tolerates brace as he did during the first period. Attitudinal shifts and a motivation decline seem to be slowing progress of function improvement.

Eighteen Months' Reevaluation: While contractures have been markedly reduced and some gross control in hand use has been achieved, the primary gain has been in prevention of deformity for this subject. Brace is now used only a few hours daily, and subject claims fatigue and discomfort in its use. It is possible that a prescription change to a more functional appliance is indicated.

Case VIII *Anamnesis:* Male, Caucasian, age 43, naval architect. Right hemiplegia with aphasia residuals well compensated subsequent to CVA at age 40. Intensive PT treatment at Rancho Los Amigos managed to greatly reduce spasticity. Shoulder and elbow function good, elbow flexion slight (160°), drop wrist severe and finger flexion strong with thumb disarticulation. Some tremor in use of shoulder and elbow to lift arm. Subject's expectancies for return of physical and mental functioning ability are rated as unrealistically high.

Prescription: Finger driven flexor hinge splint, metacarpophalangeal stop. Brace fitted October, 1958.

Six Months' Reevaluation: Wrist position greatly improved, and some active finger extension return. Thumb disarticulation still a problem. Change of prescription to include ID extension assists and swivel thumb unit.

One Year Evaluation: Slight but continuing progress in use of involved arm, hand and wrist. Thumb swivel effective, and subject can now use hand to grasp objects, although fatigue tolerance in fingers is low, and continual use of fingers is not yet within subject capabilities.

Eighteen Months' Reevaluation: Little or no further change, some additional resistance to fatigue. Subject continues to wear brace many hours daily, but has not accepted reality of ultimate residual limitation.

Discussion

One of the most significant points, in the opinion of the writers, to be developed in this study, was the high proportion of positive responses to bracing in these long-standing cases. The average duration of conditions sufficient to warrant bracing was more than six years, and in several of the cases more than ten years. Within such a time span, losses in the opposing muscle systems were quite severe, but *were not* total atrophies. It is, of course, impossible to specify whether or not a greater return might have been achieved if bracing had not been so long delayed, although the impression gained by comparing these cases on a time since disablement basis is that a high degree of function could have been more easily secured without the delay.

From our examination and follow-up of these cases, the salient point appears to be that reduction of deformity and contractures has had a functional, as well as cosmetic and psychological effect, on the hemiplegic cases. It is, however, a reciprocal effect, especially from a rehabilitation standpoint; with the psychologically difficult cases, response to bracing seemed not only a function of the hours of application, but also of the subject's total concept of himself as a handicapped person, a finding concurring with those of others who have developed prosthetic devices and mechanical appliances of all types for the meeting of physical limitations. (2)

Implications

Perhaps only two aspects of the same conviction are implied in this set of observations. The first implication is that hemiplegic cases should be evaluated for the potential value of functional braces to reduce contractures, prevent deformity of members, and aid function. The second implication is that all hospitals, agencies, and indeed practitioners of all specialties should be aware of the potential contribution of bracing techniques to the management of hemiplegic residuals.

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Congenital Skeletal Limb Deficiencies*

BY CHARLES H. FRANTZ, M.D., GRAND RAPIDS, and
RONAN O'RAHILLY, M.D., DETROIT, MICHIGAN

From the Area Child Amputee Center, Mary Free Bed Guild Children's Hospital and Orthopaedic Center, Grand Rapids, and the Department of Anatomy, Wayne State University College of Medicine, Detroit

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Until the present time, child amputees have been classified as having either non-congenital or congenital amputations. Within the group of congenital amputations, both the so-called true amputation (limb-bud arrest) and the gross limb abnormality are encountered. In the fields of embryology and teratology, limb deficiencies are described with a terminology in which the terms themselves are descriptive as are the implications of these terms. Writers in the field of orthopaedic surgery have failed to adopt a relatively consistent and accurate nomenclature—one which is clear and concise, as compared with the common vague phrase *congenital amputation of the* . . . .

The classification to be presented has been evolved in an endeavor to standardize nomenclature. It does not cover *reduplication* of limbs.

In the past fifteen years, a growing interest in the care of the child amputee has been manifested by the increasing number of amputee clinics that devote their efforts exclusively to the child. These centers have progressively increased the number of patients cared for with single or multiple limb deficiencies or abnormalities. Many of these conditions are bizarre and present problems in prosthetic prescription that cannot be solved by standard prostheses.

Since World War II, the science of prosthetics has advanced phenomenally. Stumps at all levels of amputation can be fitted successfully because of the many mechanical components now available to the prosthetist. Congenital anomalies, however, are a challenge to the orthopaedic surgeon and the prosthetist in that they may be entirely unsuitable for standard prostheses because of gross variations in limb contour, substandard muscle power, and underlying skeletal deficiencies.

The various abnormalities present a frustrating problem to the surgeon who attempts to categorize them, for example, the so-called lobster-claw deformity has no less than ten different synonyms: ectrodactylism, adactyly, oligodactyly, perodactyly, monodactyly, hypodactyly, pincers, claw, crayfish-claw, and crab-claw. All these terms are used to describe partial adactylia.

The term *congenital amputation* is sometimes still used for malformation of a limb formerly thought to be the result of constriction by an amniotic band. However, "most malformations are unaccompanied by amniotic adhesions; and even when these are present, they seldom provide a plausible explanation." [18] Intra-uterine amputations in the late months of pregnancy occur and have been documented.

The relevant literature relating to anomalies has been cited in a previous publication.[13] Certain more recent works are given in the present list of references.

The early development of the limbs has been investigated in detail in the human embryo during the past fifteen years.[14, 15, 16] The upper and lower limbs appear first as small buds of tissue on the lateral body wall at four postovulatory weeks.[14] These buds grow and differentiate rapidly within the ensuing three weeks, and the various regions of the limbs develop in proximodistal sequence. The arm and forearm, for example, appear before the hand, and the thigh and leg before the foot.

The skeletal elements of the limbs are found first as condensations of mesenchyme within the limb buds. These condensations soon chondrify in a definite order and ossification follows. Initial bone formation is found in the clavicle at five postovulatory weeks, in the humerus, radius, ulna, distal phalanges of the hand, femur, and tibia at seven postovulatory weeks, and in the scapula and fibula at seven weeks.

Endochondral ossification in the shaft of a bone occurs generally from one to five weeks after initial bone-collar formation has taken place. By seven weeks, all the skeletal elements of the limbs (with the exception of the clavicle, which has a different mode of development) are present individually as cartilaginous models, some of which have collars of bone in their shafts. The precise time of appearance of the individual mesenchymal condensation, the area of chondrification, and the site of initial ossification in each of the skeletal elements of the limbs have been calculated and tabulated.[15, 16] By seven weeks, the joints are also well advanced and the larger synovial articulations, such as the shoulder and the hip, have begun to show cavitation. By this time, the skeleton is, in general, a replica in miniature of that of postnatal life.

It is clear that anomalies in which the number of skeletal elements is increased (for example, polydactylia and ulnar dimelia) must arise during the first seven weeks of intra-uterine life. At first sight it may seem that, due to failure of a skeletal element to persist in development, a decrease in the number of skeletal parts (for example, radial hemimelia) may arise after, as well as during, this seven-week period. Both descriptive and experimental embryological investigations, however, suggest that the various types of hemimelia arise at a very early embryonic phase.

It is to be noted that the word *postovulatory* refers to the length of time after the last ovulation, that is, the particular ovulation which resulted in the subsequently fertilized oocyte. The first seven postovulatory weeks are known as the embryonic period and the remainder of intra-uterine life as the fetal period. The distinction between an embryo and a fetus is based on the shift of emphasis in development in general from differentiation to growth. Because this distinction is too general to be of practical use, it is necessary to have available an arbitrary indicator. The level of development in the humerus is a convenient gauge of development. The onset of marrow formation in the humerus occurs when the human organism is about thirty millimeters, crown-to-rump length, at seven postovulatory weeks.

Seven descriptive terms are employed in the classification of the anomalies under discussion: *amelia, hemimelia, phocomelia, acheiria, apodia, adactylia,* and *aphalangia.* The first three terms are derived from the Greek *melos,* a limb: amelia means absence of a limb, and hemimelia means absence of a large part (*hemi,* a half) of a limb. Phocomelia, based on the Greek *phoke,* a seal, refers to a flipper-like limb, that is, a hand or foot which is attached more or less directly to the trunk. Acheiria and apodia are from the Greek *cheir*, a hand, and *pous, podos,* a foot. (These roots are found in such familiar words as chiropody and chirurgia; the latter is the Latin form from which the word *surgery*, literally meaning handwork, is derived.) Hence, acheiria and apodia mean absence of a hand and of a foot, respectively. Adactylia means absence of a digit (Greek *daktylos*, a digit) and is here reserved for those cases in which there is absence of the associated metacarpal or metatarsal as well as of the digit. Aphalangia naturally means absence of one or more phalanges.

TABLE I

Classification of Congenital Skeletal Limb Deficiencies*

Terminal (T)

Transverse (-)

1. *Amelia* (absence of limb)
2. *Hemimelia* (absence of forearm and hand or leg and foot)
3. *Partial hemimelia* (part of forearm or leg is present)
4. *Acheiria or apodia* (absence of hand or foot)
5. *Complete adactylia* (absence of all 5 digits and their metacarpals or metatarsals)
6. *Complete aphalangia* (absence of one or more phalanges from all 5 digits)

Longitudinal (/)

1. *Complete paraxial hemimelia* (complete absence of one of the forearm or leg elements and of the corresponding portion of the hand or foot) - R, U, TI, or FI†
2. *Incomplete paraxial hemimelia* (similar to above but part of defective element is present) - r, u, ti, or fi†
3. *Partial adactylia* (absence of one to four digits and their metacarpals or metatarsals) : 1, 2, 3, 4, or 5
4. *Partial aphalangia* (absence of one or more phalanges from one to four digits) : 1, 2, 3, 4, or 5

Intercalary (I)

Transverse (-)

1. *Complete phocomelia* (hand or foot attached directly to trunk)
2. *Proximal phocomelia* (hand and forearm, or foot and leg, attached directly to trunk)
3. *Distal phocomelia* (hand or foot attached directly to arm or thigh)

Longitudinal (/)

1. *Complete paraxial hemimelia* (similar to corresponding terminal defect but hand or foot is more or less complete) - R, U, TI, or FI†
2. *Incomplete paraxial hemimelia* (similar to corresponding terminal defect but hand or foot is more or less complete) -r, u, ti, or fi†
3. *Partial adactylia* (absence of all or part of a metacarpal or metatarsal) : 1 or 5
4. *Partial aphalangia* (absence of proximal or middle phalanx or both from one or more digits) : 1, 2, 3, 4, or 5

* *List of symbols used:*

- transverse
/ longitudinal
: 1, 2, 3, 4, or 5 denote digital ray involved
FI or fi .... fibular
I .... intercalary
R or r .... radial
T .... terminal
TI or ti .... tibial
U or u .... ulnar

A line below a numeral denotes upper-limb involvement, for example, T-$\underline{2}$ represents terminal transverse hemimelia of the upper limb.

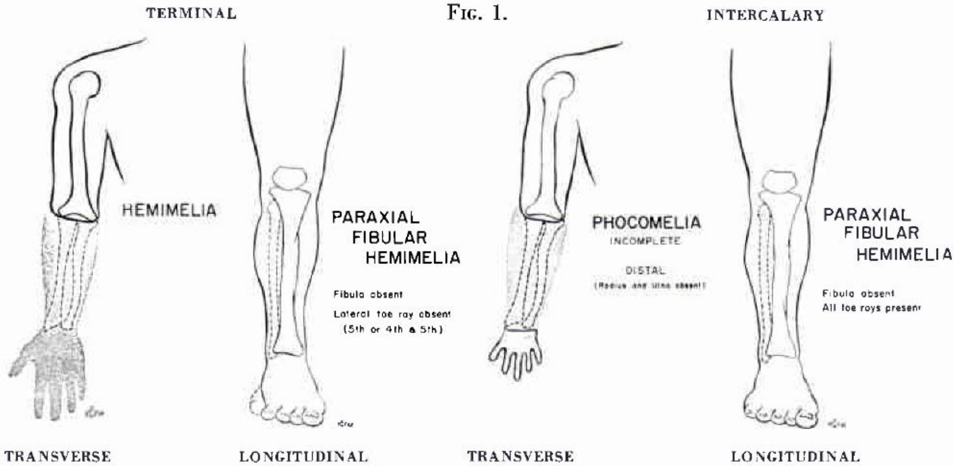
A line above a numeral denotes lower-limb involvement, for example, I-$\overline{1}$ represents intercalary transverse complete phocomelia of the lower limb.

† In capital letters when the paraxial hemimelia is complete, in small letters when the defect is incomplete.

Hemimelia may be complete (when the entire distal half of a limb is absent) or partial (when the greater portion of the distal half is absent). A third category is paraxial hemimelia. The word *paraxial*, meaning beside the axis, has been used in limb deficiencies[13] to indicate that either the preaxial or the postaxial portion of the distal half of the limb is involved. The anatomical term *preaxial*, it may be recalled, refers to the border of a limb on which either the thumb or the big toe is situated, and the term postaxial refers to the opposite border; these two terms are based on the arrangement of the limbs in the embryo at five and one-half postovulatory weeks, when the thumbs and the big toes are both on the cephalic borders of the limbs. Paraxial hemimelia may be radial or tibial (both of which are preaxial) or ulnar or fibular (both of which are postaxial). It is important to note that, by convention, the various subtypes of paraxial hemimelia are named after the absent portion. Thus, radial hemimelia refers to a deficiency of the radial portion of the forearm or of the forearm and hand.

A plan of the proposed classification is presented in Table I. The principles on which this classification is based are as follows. The defects being considered are either *terminal* (T), where there are no unaffected parts distal to, and in line with, the deficient portion, or *intercalary* (I), where the middle portion of a proximodistal series of limb components is deficient but the proximal and distal portions are present. Each of these two main groups may be either *transverse* (denoted by a hyphen), where the defect extends transversely across the entire width of the limb, or *longitudinal* (denoted by a vertical line /), where only the preaxial or postaxial portion is absent and hence the deficiency is longitudinal.

FIG. 1.



Numerals (see Table I) identify subgroups within each of these four categories. A horizontal line (representing the trunk) below a symbol denotes upper-limb involvement; a line above a symbol denotes lower-limb involvement.

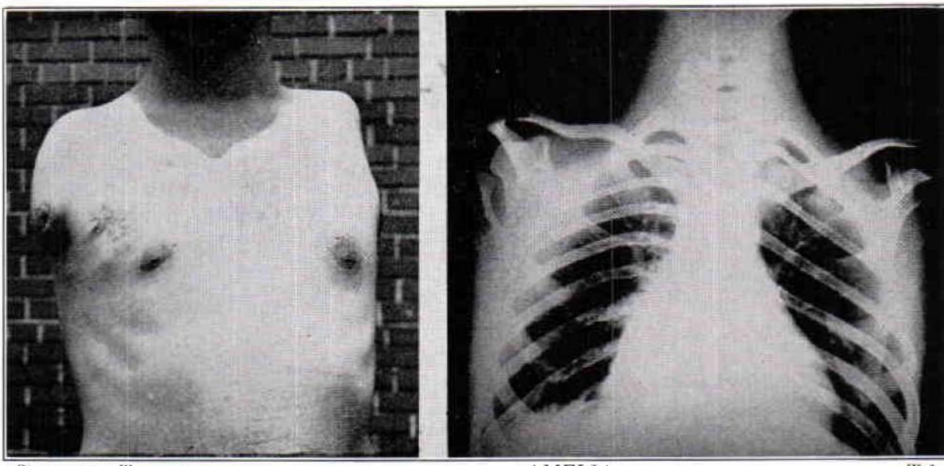
In paraxial hemimelia, the four subtypes (radial, ulnar, tibial, and fibular) are designated by abbreviations. When a capital letter (R, U, TI, FI) are used, the condition is complete, that is, the defective element is completely absent on roentgenographic examination. When lower-case letters (r, u, ti, fi) are used, the condition is incomplete, that is, a portion of the defective element (for example, the radius) is present.

Additional numerals, placed after a colon, denote the digital ray or rays involved. The term *ray* is a convenient designation for a digit, including its metacarpal (or metatarsal) and in some cases, the associated carpals (or tarsals) as well. The thumb, for example, is associated anatomically and developmentally with the trapezium and the navicular. In the case of most of the other digits, however, the relationship to the carpals (or tarsals) is not as clear-cut. It should be stressed that the term *ray* is used here in a purely descriptive sense, without any phylogenetic, or even ontogenetic, implications.

An endeavor has been made to use the internationally accepted *Nomina Anatomica* of 1955 throughout. It may be pointed out that the word *limb* now replaces the pedantic and inaccurately used *extremity* (the upper extremity of the body, as a momentary reflection on the anatomical position will show, is the top of the head).

Use of this classification will allow orthopaedists to designate the various deficiencies accurately. With it we can all speak the same language.

To avoid confusion with deficiencies involving the hand, it is well to keep in mind the *entire* limb: "Think of the arm—not the hand."



TERMINAL TRANSVERSE AMELIA T-1

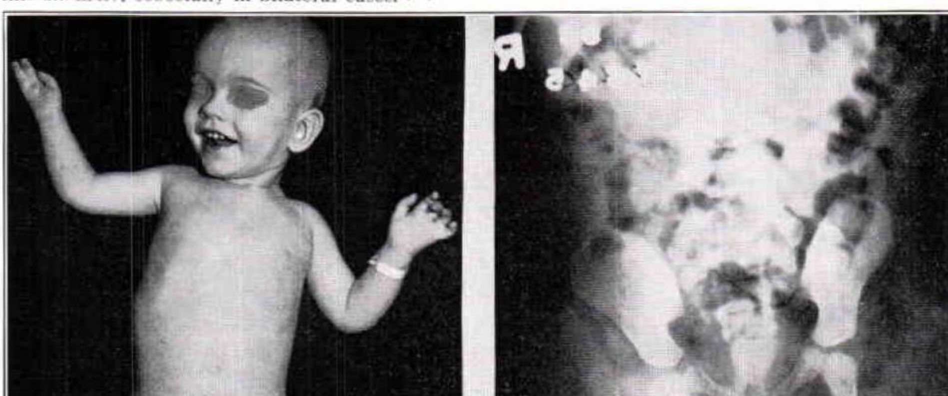
Incidence: Area Child Amputee Center: thirteen cases (nine male, four female) in 300. Seven (54 per cent) bilateral. Birch-Jensen[4] reports 1 in 270,000 births.

Genetics: sporadic abnormality, non-hereditary.

Associated defects: club foot; hare lip; cleft palate; scoliosis; complete phocomelia; distal phocomelia; lower amelia; complete paraxial hemimelia, radial

Note: Area Child Amputee Center has one case of quadrimembral amelia.

Complete absence of the upper limb. There may be a small lobule of fat or dimple on the lateral thoracic wall. Clavicle is present. Shoulder girdle is usually very mobile. There may be accentuation of the shoulder girdle contour from excessive fat. Some cases will present a prominent acromioclavicular joint with little or no subcutaneous fat. Thoracic scoliosis often accompanies this anomaly, especially in bilateral cases.[3, 4, 6]



TERMINAL TRANSVERSE AMELIA T-Ī

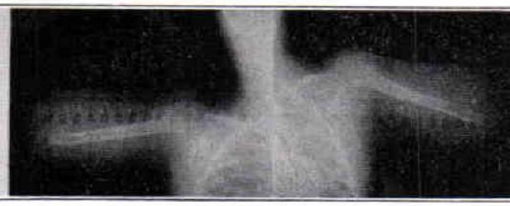
Incidence: Area Child Amputee Center: seven cases in 300. Predominantly male, 5:2. Three (43 per cent) bilateral.

Genetics: sporadic; non-hereditary.

Associated defects: proximal femoral focal deficiency; upper amelia; hemimelia; partial adactylia; complete paraxial hemimelia, ulnar.

Note: Area Child Amputee Center has one case of quadrimembral amelia.

Complete absence of the lower limb. There may be a lobule of fat or there may be a depressed area (pit) on the lateral aspect of the pelvis. The pelvic contour is wide due to accumulation of fat over hip bones.[4, 6]



HEMIMELIA T-2

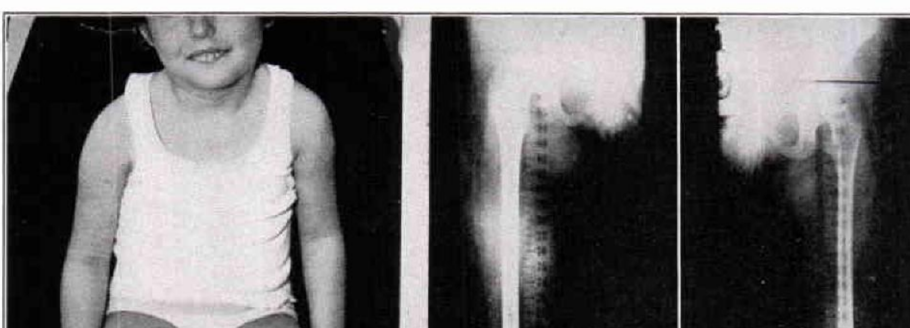
Incidence: Area Child Amputee Center: twenty cases (eleven male, nine female) in 300. Three cases bilateral. There is slight predominance of left unilateral deformities. Birch-Jensen [4] reports nine cases in population of 4,024,000.

Genetics: sporadic; non-hereditary (limb-bud arrest).

Associated defects: amelia; lower hemimelia; partial hemimelia; partial adactylia; complete paraxial hemimelia, fibular or ulnar; proximal femoral focal deficiency; hare lip; cleft palate; heart defect; agnathia.

TERMINAL TRANSVERSE

Absence of forearm and hand—anatomically, an elbow disarticulation with the distal epiphyseal plate of the humerus present. Growth may be deficient in preadolescent age due to the altered functional demand on the humerus. Distal stump end is smooth or dimpled or it presents a small lobule of fat in front of the limb axis.[3, 4, 7, 13]



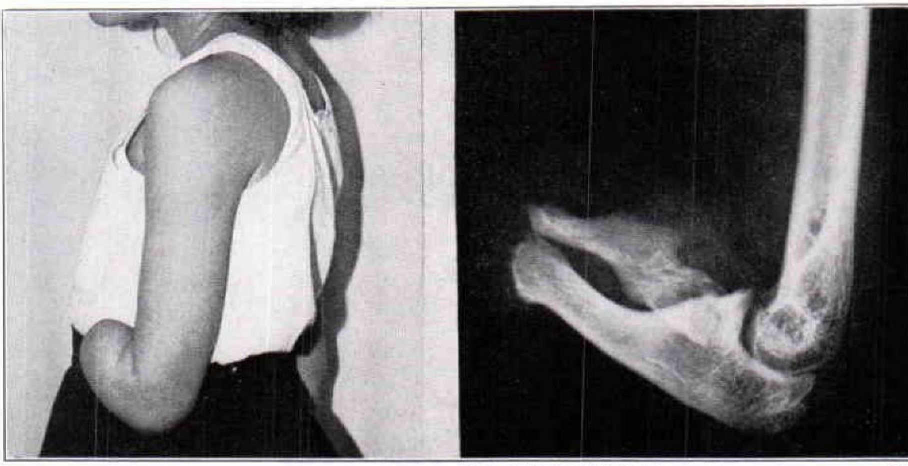
TERMINAL TRANSVERSE — HEMIMELIA — T-2

Incidence: Area Child Amputee Center: twelve cases (seven male, five female) in 300. Five (41 per cent) bilateral.

Genetics: sporadic.

Associated defects: upper hemimelia; partial hemimelia; acheiria or apodia; partial adactylia; complete aphalangia; amelia.

Absence of leg and foot—anatomically a knee disarticulation with the distal femoral epiphysis present. Stumps are conical and capable of end-bearing. There is usually coxa valga. Distally, there may be fat lobules behind the limb axis (popliteal area). In some cases the patella is present and voluntarily movable. The distal femoral epiphysis is apparently more "active" during growth than is the upper limb counterpart, the distal humeral epiphysis.[1, 3, 7, 13]



TERMINAL TRANSVERSE — PARTIAL HEMIMELIA — T-3

Incidence: Area Child Amputee Center: 112 cases in 300. Predominantly female and left-sided; only three bilateral. Birch-Jensen [4] reports 161 cases in population of 4,024,000; female, 3:2; unilateral left, 2:1.

Genetics: sporadic; non-hereditary.

Associated defects: unusual—only ten cases in 112. Syndactylism; partial adactylia; hemimelia; acheiria or apodia; partial aphalangia; club foot; heart defect; hip dysgenesis; agnathia.

Absence of a part of the distal portion of an upper limb. Forearm segment is very short; bone-stump length is less than eleven centimeters. Ulna, olecranon, and trochlea are well developed. Radius is likely to be slightly longer than ulna. Biceps tuberosity may be large and simulate radial bowing. Radial-head development is variable; it may articulate with capitulum or grow lateroproximally beyond capitulum. Skin on stump end may demonstrate small transverse ridge, depressed lobules, or ridge with five or fewer nubbins, some of which may have small finger nails. Usually a strong biceps with excellent elbow flexion power is present. Laterally the elbow is stable but hyperextensible.[2, 3, 4, 7, 12, 13]

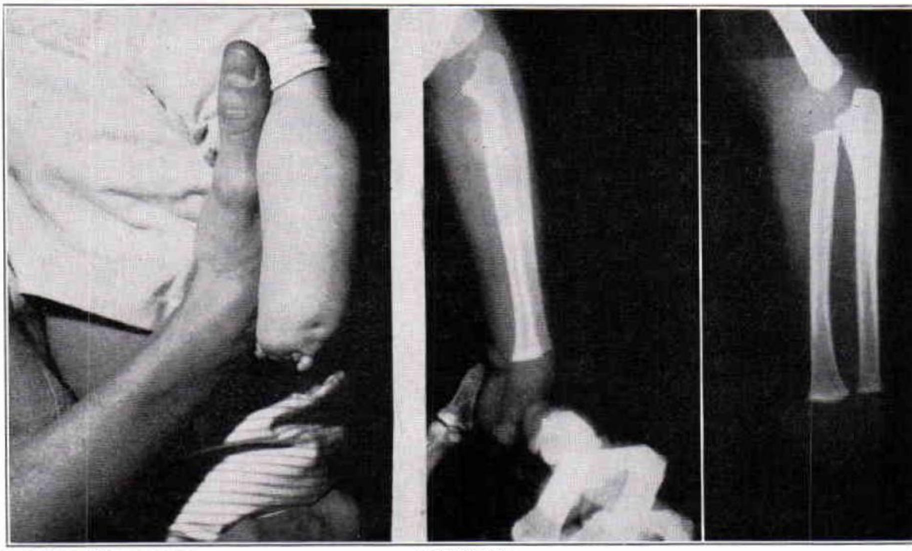
TERMINAL TRANSVERSE — PARTIAL HEMIMELIA — T-3

Incidence: Area Child Amputee Center: twelve cases in 300. Predominantly male, 9:3; one bilateral.

Genetics: apparently non-hereditary; sporadic.

Associated defects: hemimelia; partial aphalangia or adactylia; complete paraxial hemimelia, fibular; agnathia.

Absence of a part of the distal portion of a lower limb—anatomically a below-the-knee stump. Proximal tibial epiphysis is present with normal contour. Distal end of tibia may form a spike. There is no distal tibial epiphysis. Contour of stump may be symmetrical or deviated slightly in varus. Circular skin depressions are sometimes seen distally (ectodermal deficiency). Fibula may be absent (see T/1 FI).[3, 7, 13]



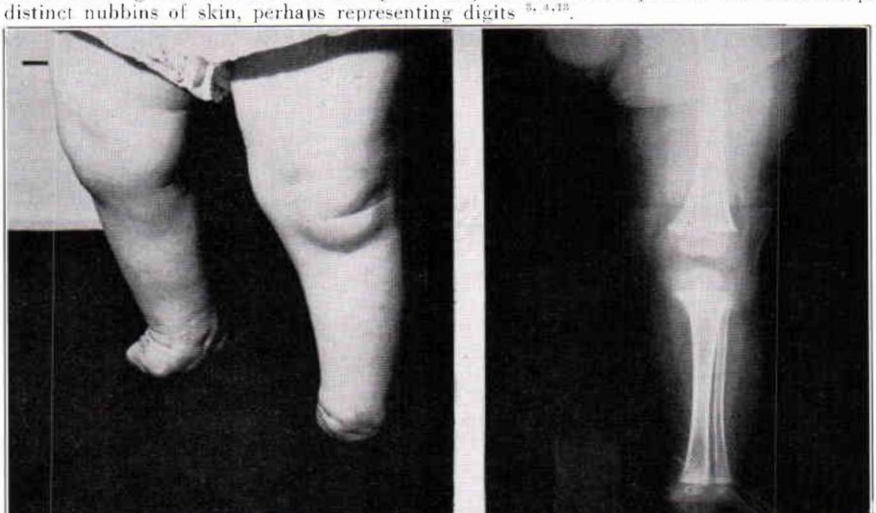
TERMINAL TRANSVERSE — ACHEIRIA — T-4

Incidence: Area Child Amputee Center: twenty-four (ten males, fourteen females) in 300 cases. Three bilateral. Predominantly left unilateral (62.5 per cent). Birch-Jensen[4] reports fifty-four cases in population of 4,024,000; 60 per cent left unilateral.

Genetics: great majority sporadic; possibly a recessive lesion.

Associated defects: apodia; complete aphalangia; hemimelia; partial hemimelia; radiohumeral synostosis; metatarsus varus; agnathia; hare lip; cleft palate; complete paraxial hemimelia, radial.

Absence of the hand—anatomically a wrist disarticulation with the distal epiphyses of the radius and ulna present. Pronation and supination are usually present; occasionally there is a distal radio-ulnar cartilaginous bar. Skin on stump end may demonstrate depressed transverse dimple or less distinct nubbins of skin, perhaps representing digits [3, 4, 13].



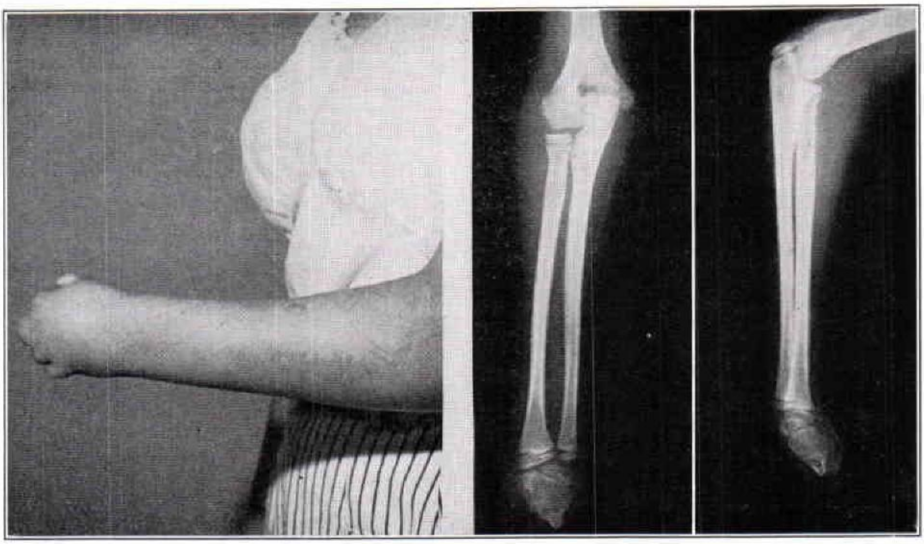
TERMINAL TRANSVERSE — APODIA — T-4

Incidence: Area Child Amputee Center: six cases in 300. Equal sex distribution.

Genetics: apparently sporadic; non-hereditary.

Associated defects: acheiria; partial hemimelia; hemimelia; complete adactylia; complete paraxial hemimelia; fibular; hare lip; cleft palate.

Absence of foot—anatomically an ankle disarticulation with the distal epiphyses of tibia and fibula present. Stump is fully end-bearing. Skin on plantar surface is cornified as on the normal heel. There is an anterior skin crease on the stump end. Some degree of abnormal tibial torsion may be present[3, 7, 14].



Terminal Transverse COMPLETE ADACTYLIA T-5

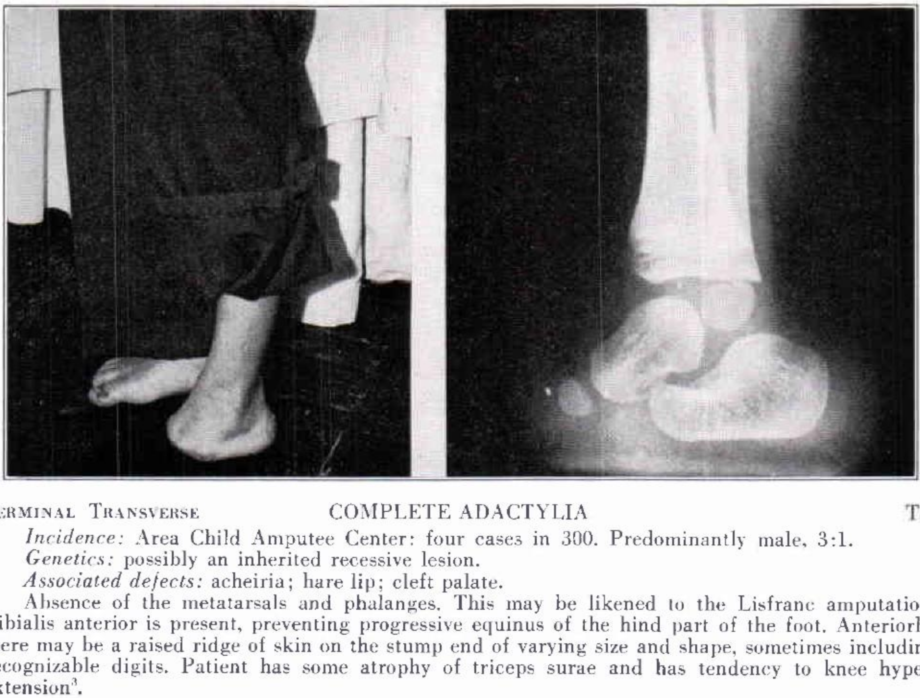
Incidence: Area Child Amputee Center: seventeen cases in 300. Predominantly male, 12:5, no bilateral.

Genetics: great majority sporadic; possibly an inherited recessive lesion.

Associated defects: rare. Complete paraxial hemimelia, fibular.

Synonym: mitten-hand.

Absence of the digits including absence of the metacarpals and phalanges. The carpals may vary in number and configuration; they may be fused *en masse*. Flexion at the wrist is possible. The hand segment may be an oval flipper or demonstrate rudimentary representations of digits which appear as a ridge or as individual small digits.[3, 4, 13]



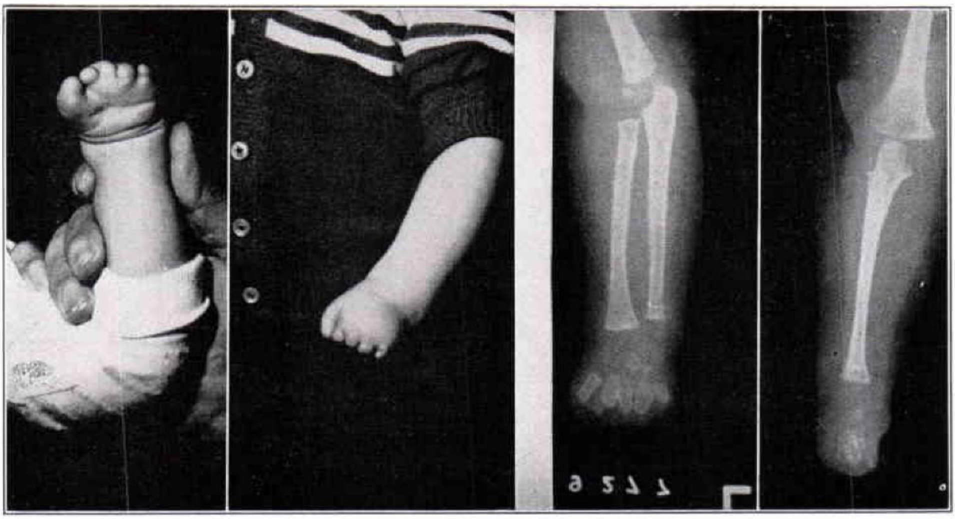
Terminal Transverse COMPLETE ADACTYLIA T-5

Incidence: Area Child Amputee Center: four cases in 300. Predominantly male, 3:1.

Genetics: possibly an inherited recessive lesion.

Associated defects: acheiria; hare lip; cleft palate.

Absence of the metatarsals and phalanges. This may be likened to the Lisfranc amputation. Tibialis anterior is present, preventing progressive equinus of the hind part of the foot. Anteriorly, there may be a raised ridge of skin on the stump end of varying size and shape, sometimes including recognizable digits. Patient has some atrophy of triceps surae and has tendency to knee hyperextension[3].



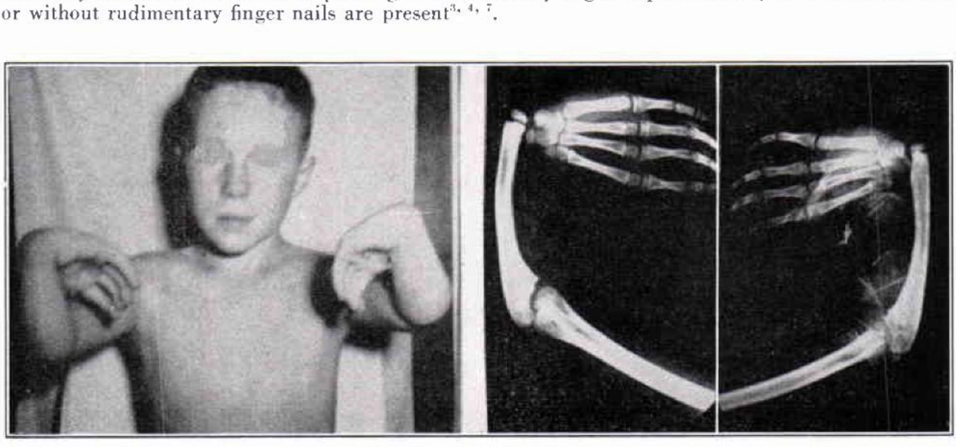
TERMINAL TRANSVERSE — COMPLETE APHALANGIA — T-6

Incidence: Area Child Amputee Center: eight cases in 300. Predominantly male, 5:3. Equally divided right and left unilateral; no bilateral cases. Area Child Amputee Center reports no lower-limb counterparts in this series of patients.

Genetics: probably sporadic; non-hereditary—may be recessive.

Associated defects: radio-ulnar synostosis.

Absence of the phalanges. Metacarpals are present, but they may be attenuated. Hand appears relatively broad due to deficient phalanges. Rudimentary digits represented by skin nubbins with or without rudimentary finger nails are present[3, 4, 7].



TERMINAL LONGITUDINAL — COMPLETE PARAXIAL HEMIMELIA: RADIAL — T/1 R

Incidence: Area Child Amputee Center: six cases in 300. Predominantly male, 4:2. Three (50 percent) bilateral. Birch-Jensen [4] reports seventy-three cases in population of 4,024,000, with associated defects in 40 per cent of the cases. O'Rahilly found numerous cases reported by nine authors through 1951[13].

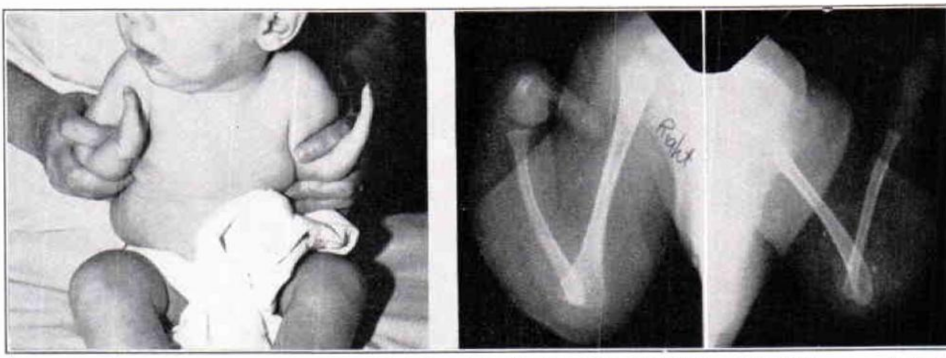
Genetics: usually sporadic; sometimes hereditary—dominant or recessive.

Associated defects: acheiria; partial aphalangia; complete paraxial hemimelia; radial or tibial; proximal femoral focal deficiency; amelia; radiohumeral synostosis.

Synonyms: radial defect; arrest of development; absence of radius; aplasia of radius; hypoplasia of radius; clubbed hand.

Note: This lesion is more prevalent than the Center's statistics reflect; this anomaly is not seen in amputee clinics, but rather in general orthopaedic clinics.

Absence of the radius and radial ray in the hand. There is a short, strong ulna, which may be bowed. The hand is radially deviated. The thumb (first ray), scaphoid, and trapezium are absent [4, 6, 13].



TERMINAL LONGITUDINAL COMPLETE PARAXIAL HEMIMELIA: ULNAR T/1 U

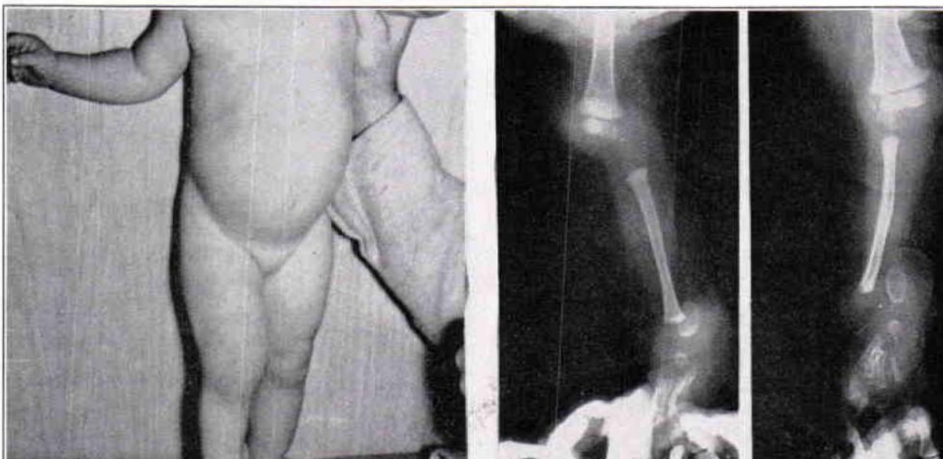
Incidence: Area Child Amputee Center: six cases in 300. Predominantly male, 4:2. One bilateral. Birch-Jensen[4] reports nineteen cases in population of 4,024,000, most often unilateral. O'Rahilly found numerous cases reported by five authors through 1932.

Genetics: apparently not inherited; may appear in families who have an accumulation of joint lesions.

Associated defects: hemimelia; partial adactylia; complete paraxial hemimelia, ulnar (Intercalary Longitudinal).

Synonyms: monodigital arm; monodigital hand; absence of the ulna.

Absence of the ulna. The radius usually articulates with the capitulum. The distal radial epiphysis is present. One digit is present which is unstable in the metacarpophalangeal joint but has flexion power. The pisiform is always present. In the majority of cases, the hamate, triquetrum, and capitate are absent. The forerm cannot be extended beyond 90 degrees of elbow flexion. Further flexion of the elbow is complete but with deficient power. [3, 4, 13, 14]



TERMINAL LONGITUDINAL COMPLETE PARAXIAL HEMIMELIA: TIBIAL T/1 TI

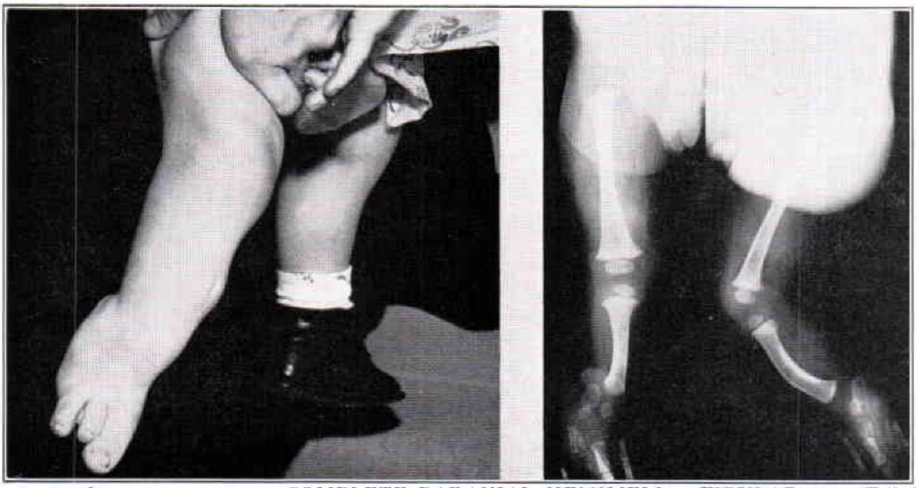
Incidence: Area Child Amputee Center: three cases (two males, one female) in 300. All bilateral.

Genetics: ? sporadic.

Associated defects: partial aphalangia.

Note: the patient illustrated has right-sided tibial hemimelia; the plantar surface of the foot is in inversion.

Complete absence of tibia. The below-the-knee segment of the limb is short. There is a flexion deformity of the knee. The foot is in varus and rotated to place the plantar surface medially. The fibula may be luxated dorsally and proximally toward the popliteal fossa. The calcaneus and talus may be fused to each other and sometimes to the navicular as well. The great toe may be absent or rudimentary. Metatarsals 1, 2, and 3 may be absent. Note that the patient illustrated has no bone elements for the first ray[1, 3, 13, 14].



TERMINAL LONGITUDINAL COMPLETE PARAXIAL HEMIMELIA: FIBULAR T/1 FI

Incidence: Area Child Amputee Center: twenty-six cases (nineteen males, seven females) in 300. Twelve (46 per cent) right-sided unilateral. Coventry and Johnson[5] report twenty-nine cases. Thompson and associates[17] report thirty-one cases. Kruger and Talbott[11] report sixty-one complete fibular absences in forty-seven patients.

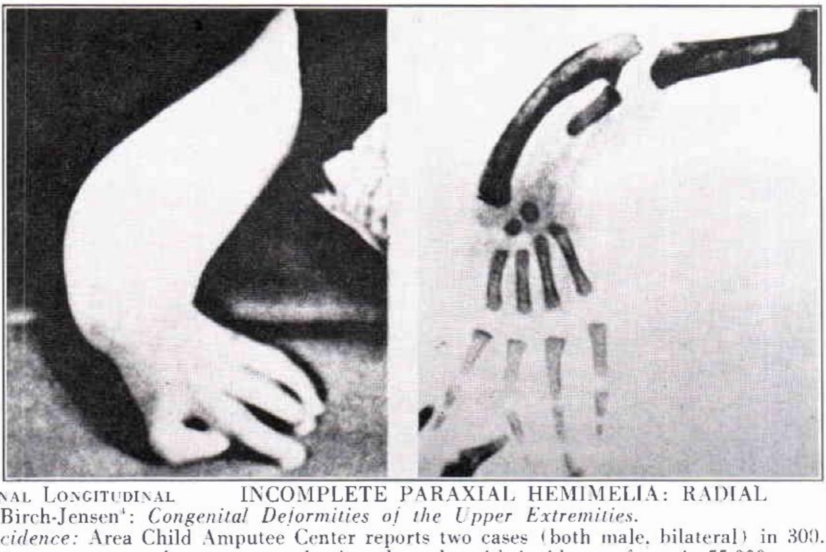
Genetics: recessive, possibly sporadic.

Associated defects: proximal femoral focal deficiency; partial adactylia; complete adactylia; hemimelia; apodia; incomplete paraxial hemimelia, radial; complete paraxial hemimelia, ulnar; partial hemimelia.

Synonyms: kyphosis of tibia; absence of fibula.

Note: proximal femoral focal deficiency, a major lesion, is often accompanied by this abnormality (Amputee Center statistics show 67 per cent).

Complete absence of fibula. The below-the-knee segment is short. Anterior bowing of tibia is present with a skin dimple at the apex of the tibial bow. The distal tibial epiphyseal plate is deficient. There is an equinovalgus deformity of the foot with one or two lateral toe rays absent. The calcaneus may be posterior and above the distal tibial epiphysis. Tarsal fusion may occur. Talus and cuboid may be absent. A fibrous band representing the fibula may be encountered at operation[1, 3, 5, 9, 11-13].



TERMINAL LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: RADIAL T/2 r

From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

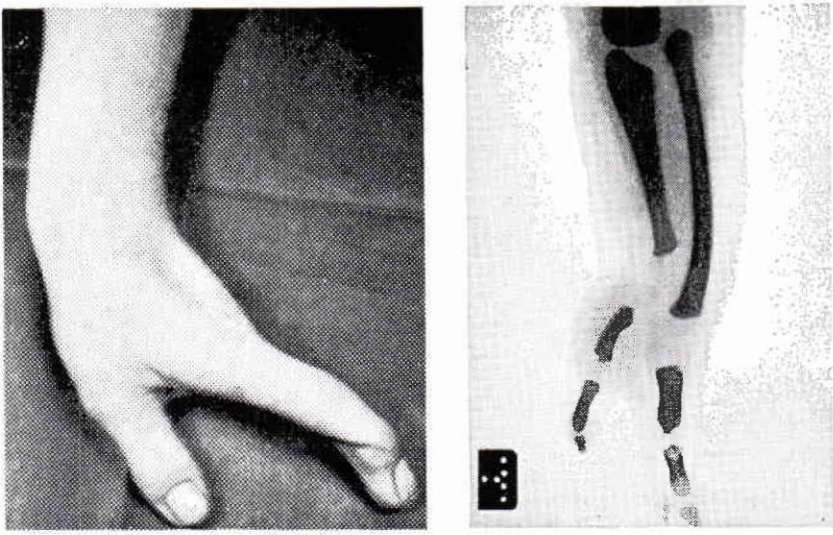
Incidence: Area Child Amputee Center reports two cases (both male, bilateral) in 300. Birch-Jensen [4] reports twenty-four cases, predominantly male, with incidence of one in 55,000.

Genetics: very small hereditary incidence; great majority sporadic.

Associated defects: many and varied. Most of Birch-Jensen's cases with accompanying defects were concentrated in a small group of patients. Sixty per cent of his patients with this deficiency had no accompanying anomalies. Aplastic anemia may be encountered with this defect.

(Legend continued from previous page)

This resembles paraxial hemimelia, radial (complete), T/1 R, except that a portion of the radius exists, usually proximally. Note that in this deficiency the thumb (first ray) is absent. Clinically this deficiency may be similar to the complete condition (T/1 R), but roentgenographic examination differentiates them, revealing presence or absence of a part of the radius[3, 4, 13, 14].



TERMINAL LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: ULNAR T/2 u

From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

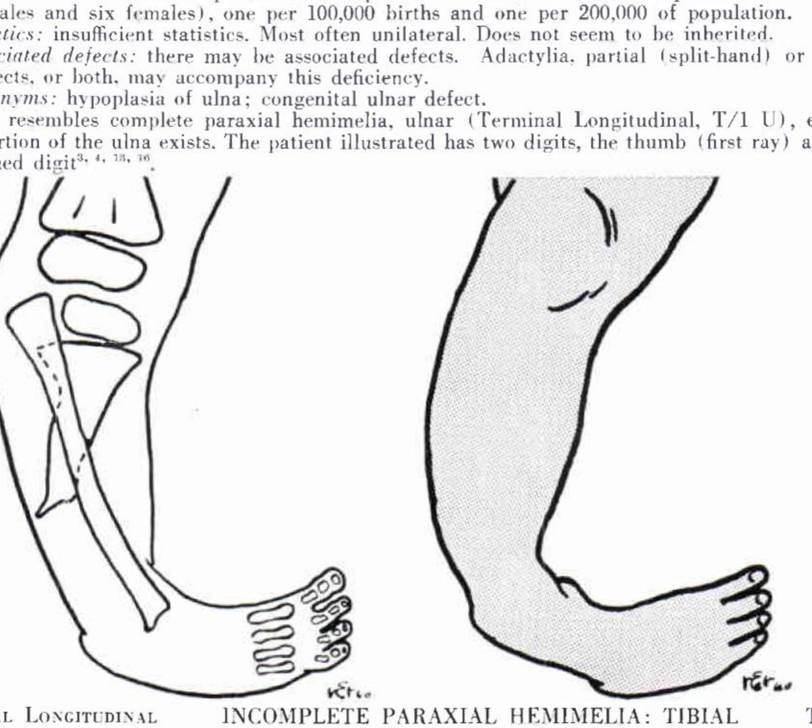
Incidence: Area Child Amputee Center reports no cases. Birch-Jensen[4] reports fourteen cases (eight males and six females), one per 100,000 births and one per 200,000 of population.

Genetics: insufficient statistics. Most often unilateral. Does not seem to be inherited.

Associated defects: there may be associated defects. Adactylia, partial (split-hand) or lower limb defects, or both, may accompany this deficiency.

Synonyms: hypoplasia of ulna; congenital ulnar defect.

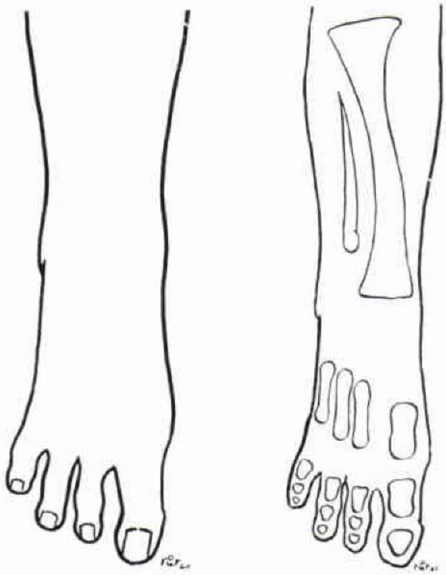
This resembles complete paraxial hemimelia, ulnar (Terminal Longitudinal, T/1 U), except that a portion of the ulna exists. The patient illustrated has two digits, the thumb (first ray) and an unidentified digit[3, 4, 13, 16].



TERMINIAL LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: TIBIAL T/2 ti

Incidence: no clear-cut cases reported in the literature.

This deficiency resembles complete paraxial hemimelia (Terminal Longitudinal, T/1 TI) except that a portion of the tibia is present. The foot is inverted and the great toe (first ray) is absent[1, 3, 13, 14, 19].



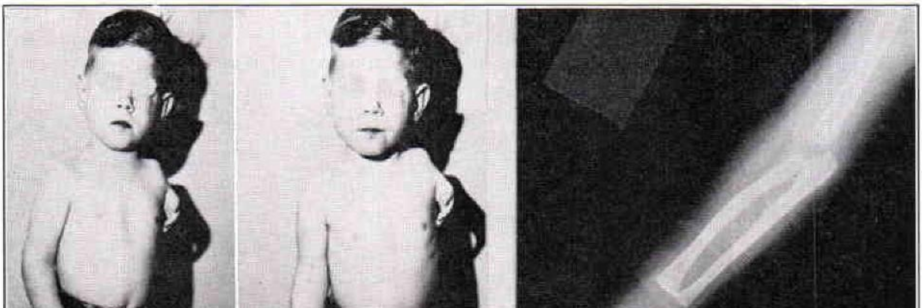
TERMINAL LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: FIBULAR T/2 fi

Incidence: no clear-cut cases reported in the literature.

Genetics: probably parallels paraxial hemimelia, fibular (complete, Terminal Longitudinal, T/1 FI), which is recessive and possibly sporadic.

Synonyms: incomplete ossification of fibula; kyphosis of tibia.

Clinically this resembles complete paraxial hemimelia, fibular (T/1 FI). Roentgenographic examination differentiates the two conditions, revealing a portion of the fibula to be present or absent. Note that there are four digits; the fifth is absent. If all toes were present this would be incomplete paraxial hemimelia, fibular (Intercalary Longitudinal, 1/2 fi) [1, 3, 5, 9, 11, 13]



TERMINAL LONGITUDINAL PARTIAL ADACTYLIA T/3

Incidence: Upper Limb: Area Child Amputee Center: seventeen cases (involving divers rays) in 300. Predominantly male 11:6. Usually unilateral. Birch-Jensen[4] reports eighty-five cases.

Lower Limb: Area Child Amputee Center: six cases (four males, two females) in 300.[3, 4, 13, 15]

Genetics: generally sporadic; a few cases may be recessive (inherited).

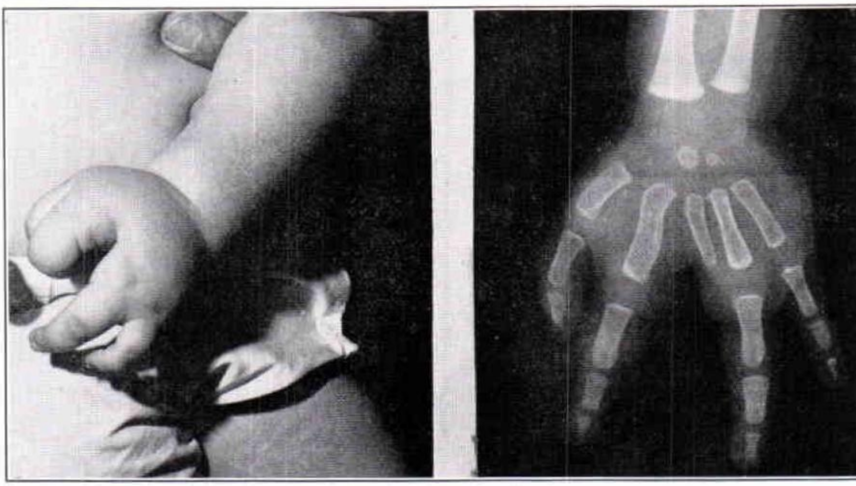
Synonym: synbrachydactylism.

Associated defects: proximal femoral focal deficiency; amelia; hemimelia; complete phocomelia; distal phocomelia; complete paraxial hemimelia, fibular or ulnar; partial hemimelia; hare lip; cleft palate.

(Legend continued from previous page)

Note: patient illustrated presents T/3:1. The left upper limb is intercalary transverse complete phocomelia (I-1).

Absence of one to four digits in the hand or foot along with their metacarpals or metatarsals.



TERMINAL LONGITUDINAL PARTIAL APHALANGIA T/4

Incidence: Upper Limb: Area Child Amputee Center: ten cases (six males, four females) in 300; divers rays involved. Usually bilateral. Birch-Jensen[4] reports fifty-six cases (involving the third ray) in population of 4,024,000.

Lower Limb: Area Child Amputee Center: three cases (all female; two bilateral) in 300, involving divers rays.[4, 13, 15]

Genetics: most cases apparently spontaneous. When inherited, condition is *dominant.*

Associated defects: proximal femoral focal deficiency; paraxial hemimelia, fibular or radial; partial or complete aphalangia; partial hemimelia; apodia; dysplastic hip.

Synonyms: ectrodactylism; adactylia; oligodactyly; perodactyly; monodactyly; hypodactyly; pincers; claw; crayfish claw; crab claw; lobster claw.

Absence of one or more phalanges from one to four digits. In the hand the rays may deviate and form a cone-shaped cleft, thus dividing the hand into two parts; there may be syndactylism of fingers on either side of cleft.

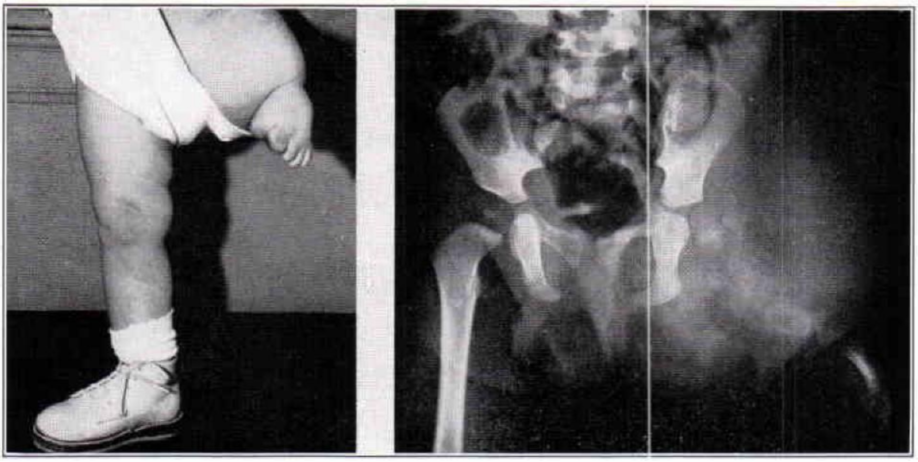
INTERCALARY TRANSVERSE COMPLETE PHOCOMELIA I-1

Incidence: Area Child Amputee Center: six cases in 300. Equal sex distribution. Two bilateral. Birch-Jensen[4] reports five cases (not regionally classified as to complete, proximal, or distal) in population of 4,024,000.

Genetics: insufficient statistics.

Associated defects: amelia; incomplete adactylia; distal phocomelia; arthrogryposis. Note: skeletal deficiencies usually are not symmetrical when bilateral.

Absence of the proximal portions of the upper limb. The hand is attached to the trunk and rests in the coronal plane. There may be deficient rays of the index to little finger inclusive. Digits are in flexion. Flexion power may be sufficient to be functional. Extension power of digits is very poor. Syndactylism may be present; by roentgenographic examination small, undifferentiated bone segments may be recognized[3, 4, 6, 7, 13].



INTERCALARY TRANSVERSE

COMPLETE PHOCOMELIA

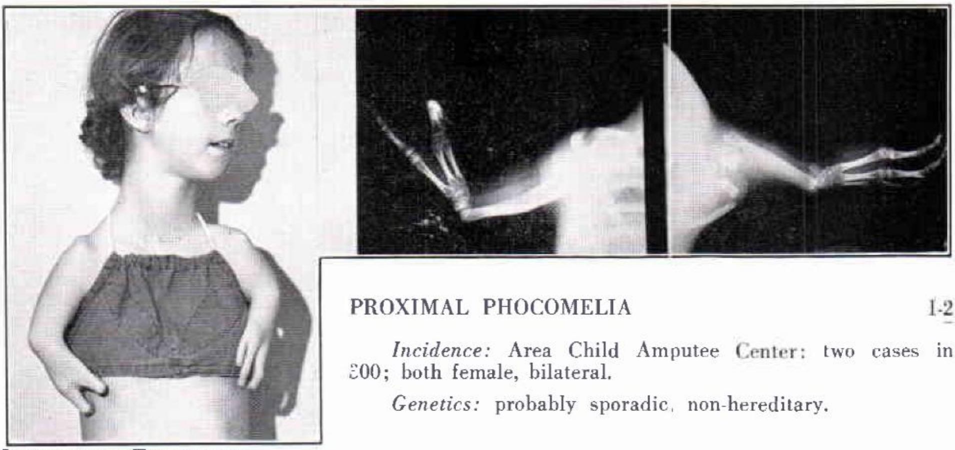
I-1

Incidence: Area Child Amputee Center: five cases in 300. All male; one bilateral.

Genetics: insufficient statistics.

Associated defects: partial adactylia; hip dysplasia; proximal femoral focal deficiency; complete paraxial hemimelia, fibular.

Absence of the proximal portions of the lower limb. Foot is attached to trunk wall. Toe rays may be absent. Flexion of the toes is possible but not extension. Roentgenographic examination shows that tarsals may be absent or present in varying degrees. Acetabulum may be nonexistent; its roof index may measure 15 degrees[3, 7, 13].



PROXIMAL PHOCOMELIA

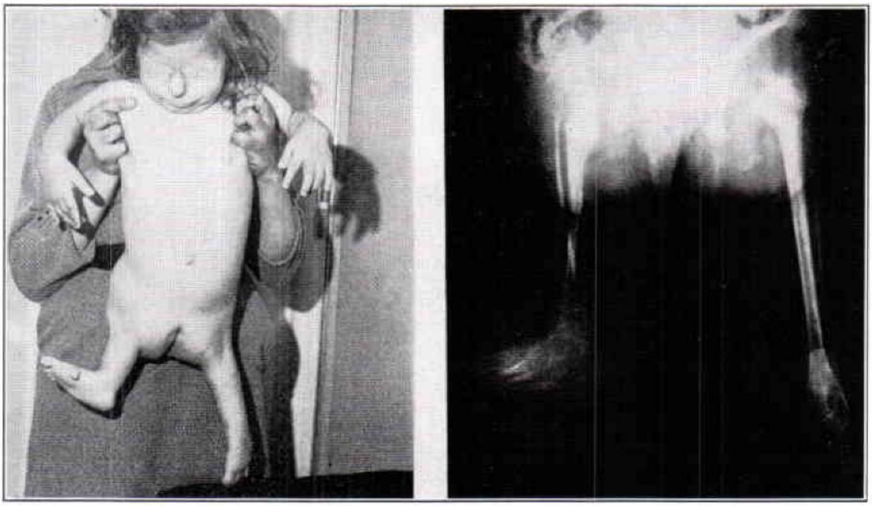
I-2

Incidence: Area Child Amputee Center: two cases in 300; both female, bilateral.

Genetics: probably sporadic, non-hereditary.

INTERCALARY TRANSVERSE

Absence of the humerus (the proximal segment of the arm). The patient illustrated demonstrates absence of the radius. Roentgenographically, the forearm here has an ulna. Shoulder girdles are atrophic. All joints are unstable. Hands flex on the arm with fair power, but are deficient in extension. Intrinsic muscle function in the fingers is deficient; they flex but lack extension. Finger rays vary in number.[3, 4, 6, 7, 13]



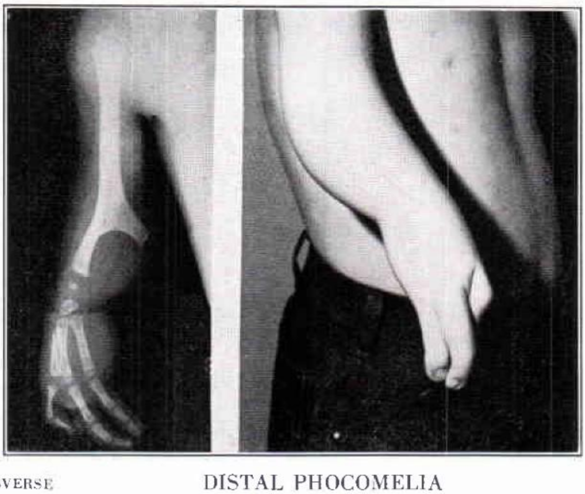
INTERCALARY TRANSVERSE PROXIMAL PHOCOMELIA I-2

Incidence: Area Child Amputee Center: two cases in 300. Both bilateral.

Genetics: probably sporadic, non-hereditary.

Associated defects: radiohumeral synostosis; cleft palate; complete paraxial hemimelia, fibular or ulnar.

Absence of the femur. The proximal ends of the tibia and fibula rest close to the external surface of the ilium. There is no acetabulum. The junction of the tibia and ilium is very unstable and incapable of weight-bearing. Ligaments if they exist are relaxed. The leg can be rotated much like the hands of a clock[3, 10, 13].



INTERCALARY TRANSVERSE DISTAL PHOCOMELIA I-3

Incidence: Area Child Amputee Center: ten cases in 300. Predominantly male, 7:3. Three bilateral.

Genetics: sporadic; non-hereditary—may be recessive.

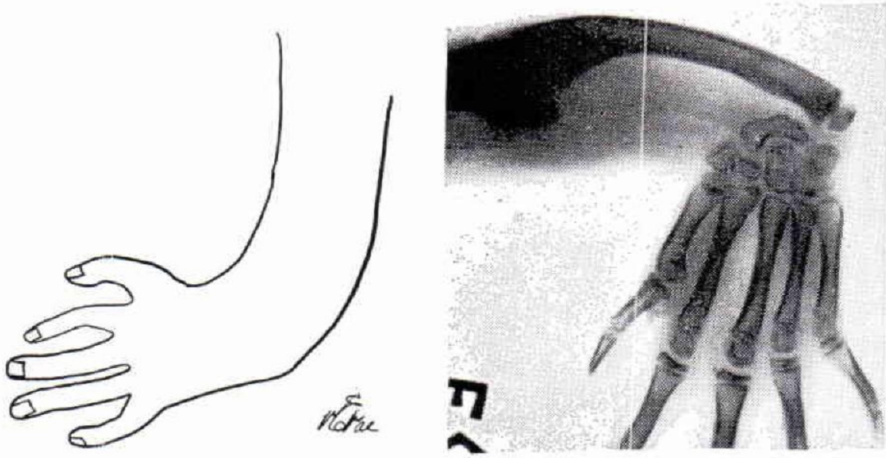
Associated defects: partial adactylia; amelia.

Absence of radius and ulna. The arm is short. Finger rays vary in number. There is good flexion power of the wrist and fingers. Carpohumeral joint is quite stable. Shoulder abduction is limited. Roentgenographic examination usually reveals that the distal end of the humerus is forked. This may represent distorted condylar development.

Lower Limb Counterpart (I-3):

Incidence: Area Child Amputee Center: one case, male, bilateral.

Associated defects: complete phocomelia; amelia[4, 7, 13].

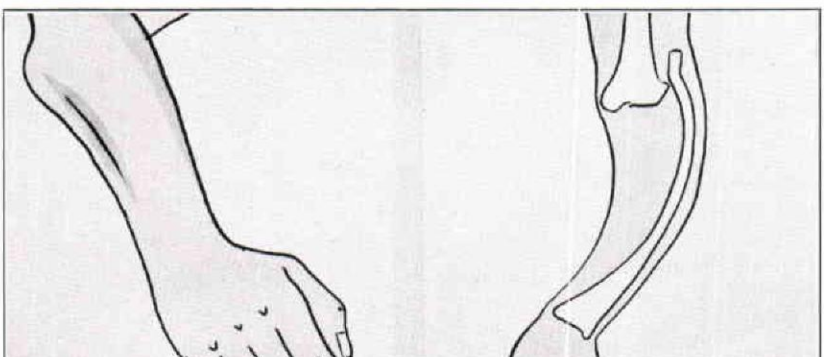


INTERCALARY LONGITUDINAL — COMPLETE PARAXIAL HEMIMELIA: RADIAL — I/1R

From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

Incidence: Area Child Amputee Center reports one case in 300. Female, unilateral. Birch-Jensen[4] includes this deficiency in his presentation of radial defects and aplasias.

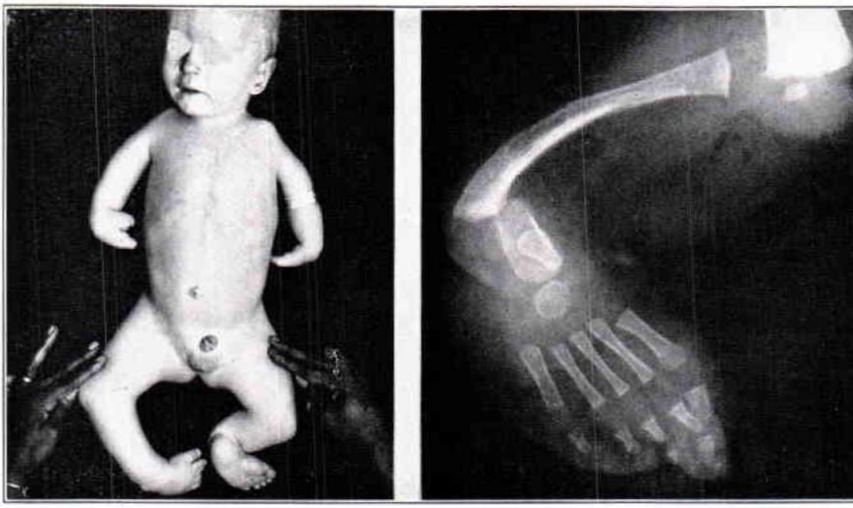
This deficiency resembles complete paraxial hemimelia, radial (Terminal Longitudinal, T/1 R), but demonstrates a complete hand with five digits[4,6,13].



INTERCALARY LONGITUDINAL — COMPLETE PARAXIAL HEMIMELIA: ULNAR — I/1 U

Incidence: Area Child Amputee Center: one case (male, unilateral) in 300.

This deficiency resembles complete paraxial hemimelia, ulnar (Terminal Longitudinal, T/1 U), but the hand is complete with five digits[3,4,13,14].



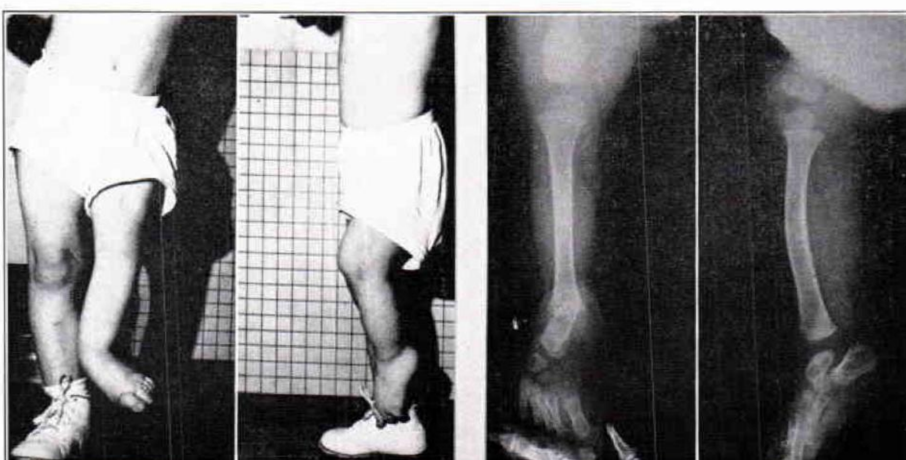
INTERCALARY LONGITUDINAL — COMPLETE PARAXIAL HEMIMELIA: TIBIAL — I/1 TI

Incidence: Area Child Amputee Center: three cases in 300 (two males, one female; no bilateral).

Genetics: sporadic; possibly hereditary; non-recessive.

Associated defects: complete paraxial hemimelia, radial; microtia.

The tibia is absent. There are five toe rays, indicating that the foot is not involved. Otherwise this anomaly skeletally parallels complete paraxial hemimelia, tibial (Terminal Longitudinal, T/1 TI)[3,7,13].

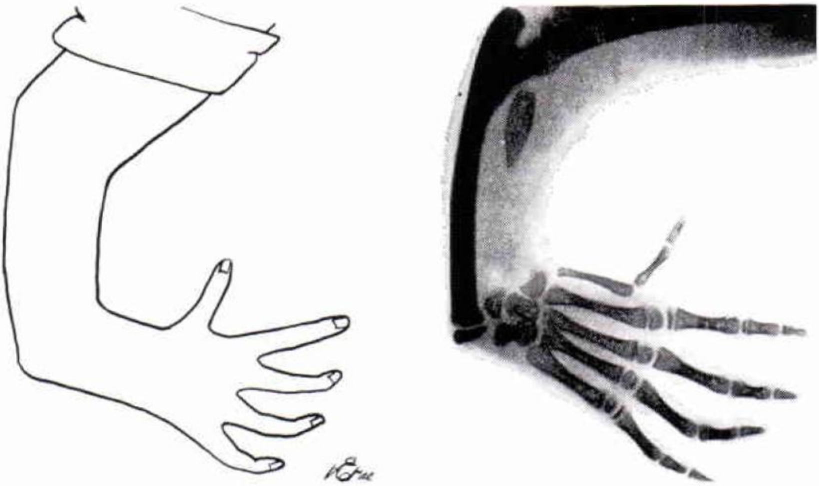


INTERCALARY LONGITUDINAL — COMPLETE PARAXIAL HEMIMELIA: FIBULAR — I/1 FI

Incidence: Area Child Amputee Center: ten cases in 300. One bilateral; six males, four females.

Genetics and associated defects: see Terminal Longitudinal, Complete Paraxial Hemimelia, Fibular (T/1 FI).

The fibula is absent. This deficiency differs from Terminal Longitudinal Complete Paraxial Hemimelia, Fibular (T/1 FI), in that there are five digits, indicating normal skeletal components in the foot. The foot sometimes rests in valgus[1,3,5,9,11,13].

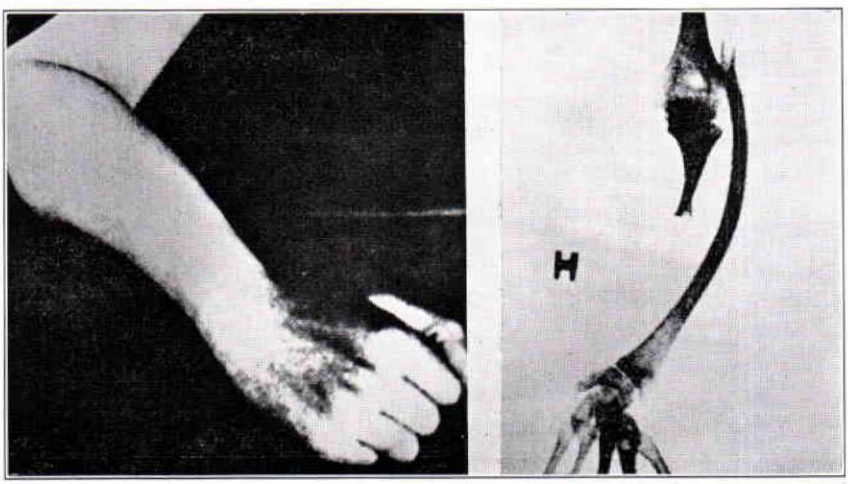


INTERCALARY LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: RADIAL I/2 r

From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

Incidence: Area Child Amputee Center reports no cases. Birch-Jensen[4] includes this deficiency in his presentation of radial defects.

This deficiency differs from Incomplete Paraxial Hemimelia, Radial (Terminal Longitudinal, T/2 r) in that there are five digits[3,4,13,14].

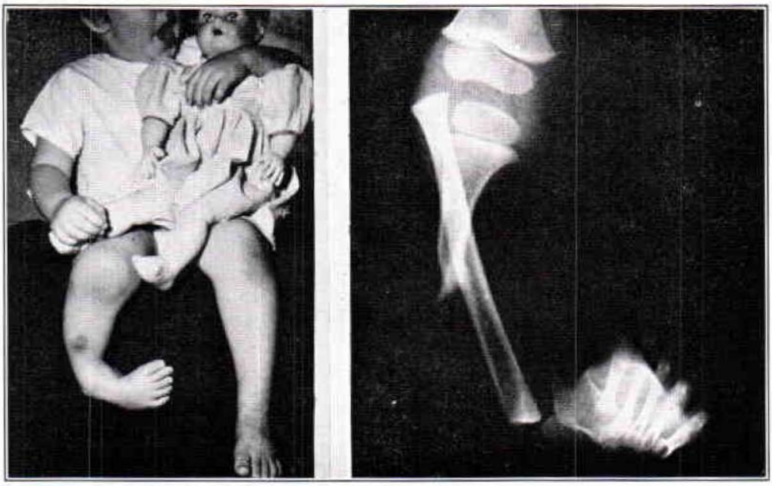


INTERCALARY LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: ULNAR I/2 u

From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

Incidence: Area Child Amputee Center reports no cases. Birch-Jensen[4] classifies this among deficiencies with ulnar defects.

Clinically this appears to be a ventrally bowed forearm with apparent luxation of the elbow and a defect on the ulnar side of the forearm. Five digits are present. Roentgenographic examination discloses a portion of the ulna to be present (see Incomplete Paraxial Hemimelia, Ulnar; Terminal Longitudinal, T/2 u)[3,4,13,15].



INTERCALARY LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: TIBIAL I/2 ti

Courtesy of Chestley L. Yelton, M.D., Lloyd Noland Hospital, Fairfield, Alabama

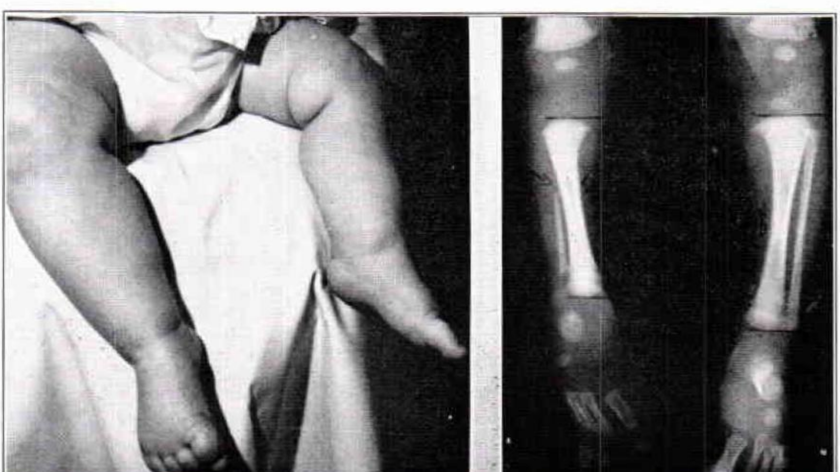
Incidence: Area Child Amputee Center: three cases (one male, two females) in 300.

Genetics: insufficient knowledge.

Associated defects: proximal femoral focal deficiency; complete paraxial hemimelia; radial; partial adactylia; partial aphalangia.

Synonym: delayed ossification of the tibia.

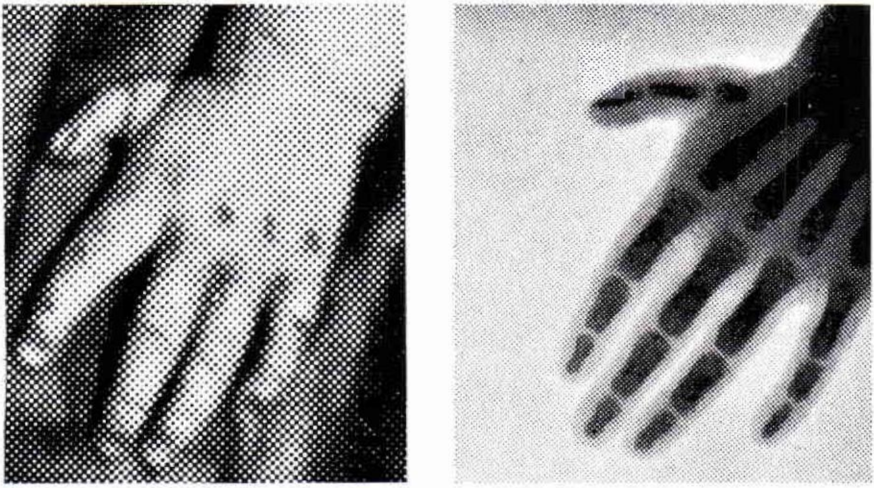
This differs from Complete Paraxial Hemimelia, Tibial, in that a portion of the tibia (usually proximal) is present, with a complete or incomplete proximal tibial epiphyseal plate. If there were fewer than five digits, this would be a terminal longitudinal defect.[1, 3, 13, 14, 19]



INTERCALARY LONGITUDINAL INCOMPLETE PARAXIAL HEMIMELIA: FIBULAR I/2 fi

Incidence: Area Child Amputee Center: one case (female) in 300.

This differs from Complete Paraxial Hemimelia, Fibular (I/1 FI), in that roentgenographic examination reveals a portion of the fibula to be present, usually distally. If there were fewer than five toes, this would be a terminal longitudinal defect[1,3,5,9,11,13].



INTERCALARY LONGITUDINAL PARTIAL ADACTYLIA I/3

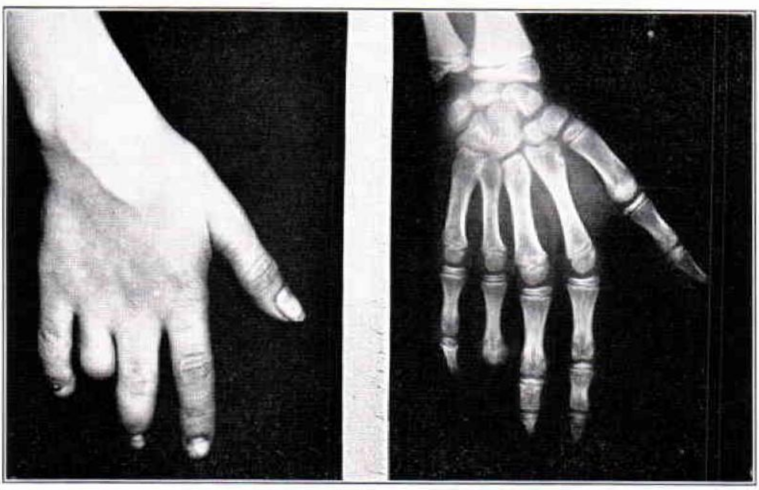
From Birch-Jensen[4]: *Congenital Deformities of the Upper Extremities.*

Incidence: Area Child Amputee Center reports no cases. Birch-Jensen[4] classifies this deficiency with radial defects and aplasias (nineteen cases: reported population incidence is one in 55,000).

Genetics: may be inherited and dominant, but the great majority is not inherited.

Synonym: floating thumb.

Absence of all or part of a metacarpal or metatarsal. The styloid process of the radius, the scaphoid, and the trapezium are usually either absent or small. The hand illustrated shows this deficiency in the thumb ray, the so-called floating thumb. This type of deficiency is not seen in amputee clinics[4,13].



INTERCALARY LONGITUDINAL PARTIAL APHALANGIA I/4

Incidence: Area Child Amputee Center: two cases in 300. Birch-Jensen[4] reports forty-one cases in population of 4,024,000.

Genetics: sporadic in majority of cases; when inherited it is dominant.

Synonyms: ectrodactylism; hypophalangia.

Associated defects: lower hemimelia; partial hemimelia.

Absence of the proximal phalanx or middle phalanx, or both, from one or more digits. In the hand illustrated only the little-finger ray is intercalary; note that the distal phalanx is present as is the finger nail (the ring-finger ray is T/4:4—the distal phalanx is absent)[4,13,15].

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NOTE: This study was done under the aegis of Carleton Dean, M.D., *Director*, Michigan Crippled Children Commission.

The authors wish to express their appreciation to Shirley Furgerson for her great help in compiling cases and statistics and to Richard Rae for his extensive photographic work.

Plastic Foams in Prosthetics

By OTTO ROTHMAN
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New York, N. Y.

In prosthetics, as in many other fields, plastic materials were quickly adopted as soon as their usefulness was recognized, not just as a substitute for other materials, but also as a supplement in places where no other material would function as well. The plastics industry is comparatively young; not much headway was made until the start of World War II. Since then giant strides were made with the discovery of new polymers in chemical laboratories annd the improvement of fabrication processes. Everybody knows of the revolution the plastic fibers have produced in the textile industry. At first they were a poor substitute for natural fibers, but now they are in many cases superior in a number of physical properties.

Plastic foam has built a niche of its own in its short rise to prominence. Its many uses in industry would require pages to enumerate. In prosthetics the use of foam got a start about four years ago, when it was first utilized as a convenient substitute for wood. With the continued improvement of the material and perfection of better manufacturing techniques, foam is sure to find ever wider application in the artificial limb program.

It might be well now to pause for some technical explanations, lest some readers get confused by the term "plastic foam." Foam brings to mind to many people the soft, spongy material such as is used in upholstery and mattresses. That it is, but this is only one kind of foam. As manufactured today, foam comes in many different varieties and densities, running the entire gamut from very soft and flexible to quite rigid.

Plastic foams can be produced from different chemicals, such as polyurethane, vinyl, polystyrene, polyethylene, phenolics, silicones, epoxies, or chloroprene (neoprene). The raw material that is mostly used is polyurethane. Urethanes are based upon isocyanate resins. When isocyanates are reacted with "active" hydrogens such as occur in polyols—glycols, polyesters, polyethers, or castor oil, for example—they form addition polymers, among which is urethane. When a polyol, together with some water, a catalyst, and an emulsifier is mixed intimately with the required amount of diisocyanate, polymerization and gas-forming exothermic reactions proceed at the same time, yielding a gel structure in which the evolved gas is trapped. The cured material is a urethane foam.

The molecular structure of the polyol determines whether the urethane foam will be flexible or rigid. The most important factor in determining the rigidity of a foam is the hydroxil-rich compound used in its production, which group includes diverse chemicals such as the aforementioned polyols. It is not surprising to find such a wide spectrum of rigidity that is potentially available for these cellular products. Even within a certain type of rigidity it is possible to vary the physical properties. Thus, one can make flexible foams that are resilient and also flexible foams which have high energy absorbing properties. In addition, the density of each type can be varied from above 60 lb./cu. ft. to below 2 lb./cu. ft. Considering a "six pound" density foam, it can vary in resilience from a firm foam to a very soft one. The firm foam will support the weight of a man without crushing, whereas the soft one can be balled up by handling and will slowly return to shape in a period of minutes. It is seen, therefore, that polyurethane foam can not be regarded as a single entity, but rather as a broad class of materials from which it is possible to select individual foams to fit a desired application.

Foam, in its different forms, has many properties which make it desirable for use in artificial limbs. It is easily fabricated; it has a high strength-to-weight ratio; it resists wear; its shrinkage and resilience can be controlled; it resists bacteria and fungi; it can be made fire-retardant or self-extinguishing; it is easily cleaned and is not affected by soap, detergents and most solvents.

Flexible foam finds most applications in cushioning, as for instance in the Total-Contact Socket (Figure 1). Here a shaped pad is foamed inside

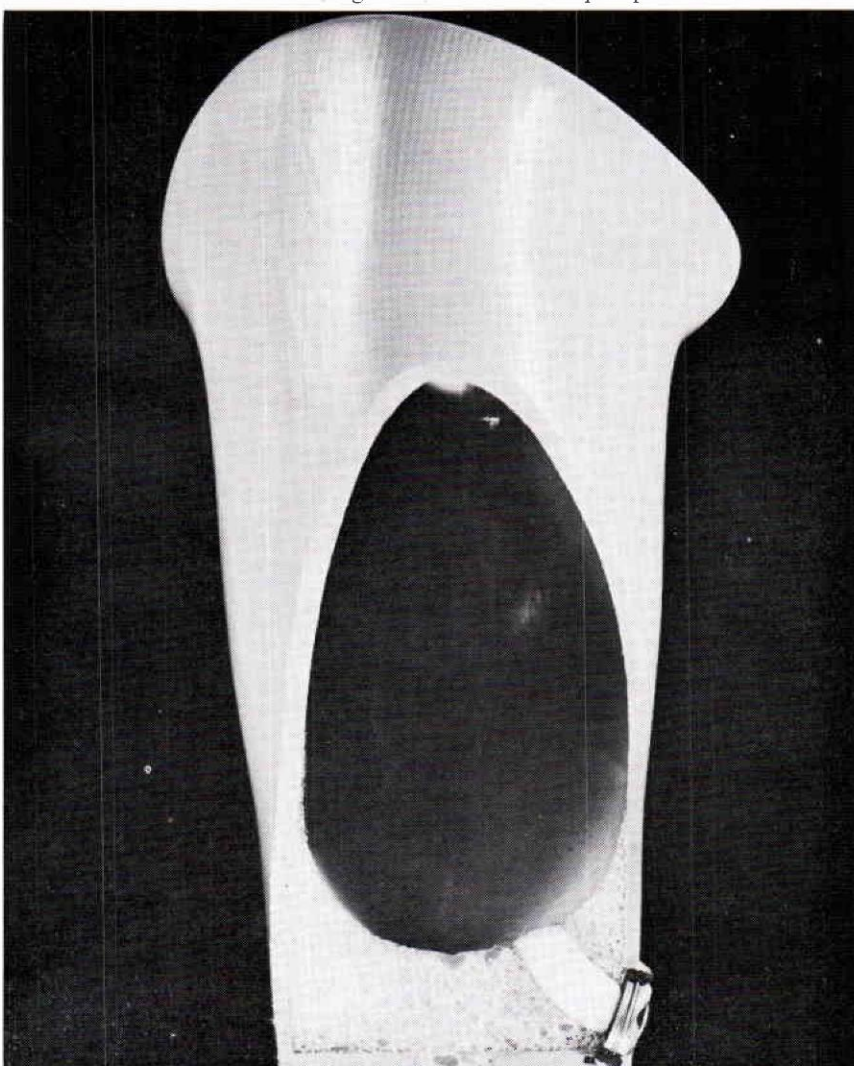


Figure 1. Cutaway section of the Total-Contact Socket, showing the flexible foam liner.

the socket, so that close contact is provided between the stump-end region and the soft socket bottom. During the weight-bearing phases of prosthetic use, the forces acting against the stump-end are compensated by the rather free compression of the foam material, providing an even distribution of contact. During the swing phase the intimate contact pressure is lessened but maintained, and by this alternating action a genuine massaging of the stump-end takes place, which works for improvement of the circulation in this stump region.

Another use is in the soft-wall socket. Here, the complete inner socket liner is made of flexible material, a construction which first of all allows the stump muscles to expand, aiding thereby the action of the muscle pump through the elastic counter-pressure of the socket walls; secondly, the pressure-sensitive bone contours are softly bedded in. This liner is part of a socket technique which often makes is possible to do away with the conventional thigh-lacer and mechanical joints for the below-knee prosthesis.

The ideal socket-liner should have varying degrees of flexibility; stiffer at weight-bearing areas, more flexible where only padding is desired. Also needed is a suitable coating that will do two things: provide a perfect cosmetic finish, and seal the cells. If the cells are open, the foam acts like a cheese grater on the stump. It is hoped that these problems will be solved before long.

As another example, in the polyester functional orthesis to aid persons with paralyzed hands and wrists, the layer of material next to the patient's skin is one-eighth inch foam. The foam helps eliminate the problem of discomfort from pressure over the bony prominences in the extremely atrophied hand where little muscular padding is present.

The ability of flexible foam to absorb energy or shock is put to good use in the SACH foot. Besides absorbing impact in the heel and simulating plantar flexion, the flexibility in the rest of the foot is designed so that it simulates normal toe break (Figure 2). When properly constructed, the foot will show little toe curl after millions of flexion cycles. It is readily molded to any shoe last desired; its fleshy feel is an advantage cosmetically.

Lately, shank covers for hydraulic legs are being made out of foam. These serve not only as a cosmetic cover, but also as a cushion to protect the mechanism. They can be pigmented to any flesh color desired, from fair caucasion to dark negroid. Flexible foam is also used in padding and fillers in other prosthetic and orthopedic appliances.

Rigid foam has found different but equally useful applications. Its most prominent use is in the substitution for wood. Wood was, and still is, used extensively in the production of sockets and shanks, feet, and as a filler material. Balsa wood is used as a filler between the ankle block and the below-knee socket because of its lightness. Willow wood, poplar, or basswood are used for the A/K socket because of their strength. At the present time, wood is still preferred over foam because the wood carving technique has been mastered by limbfitters, whereas the foam molding technique is still new. Also, wood is finished more readily than is foam.

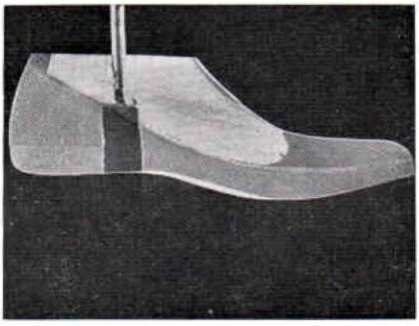


Figure 2. Longitudinal section of the Bock SACH foot. The three different foam layers of the sole, heel and upper foot are clearly seen.

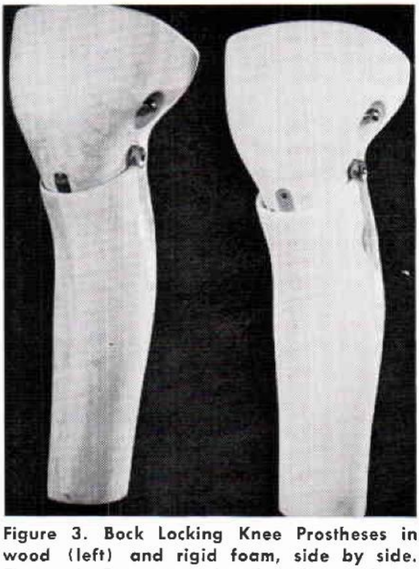
The strength of the foam in comparison with wood is still largely an unknown quantity. As is common to the general field of plastics, there is a paucity of physical data relative to the rigid foams discussed here. Most of the data have been obtained from core samples and, hence, may not be a realistic measure of the physical data desired. An approximate comparison is given in the following tabulation (properties of basswood, willow wood and poplar are somewhat similar):

	Basswood	*Balsa Wood*	*Rigid Urethane Foam*	
			Med.	*Low*
Density, lb./cu. ft.	23	8	23	8
Moisture content, % by weight of oven-dry specimen	5-12	12	1	8
Tension perpendicular to grain, max. tensile stress, lb./sq. inch	350	180	800	230
Compression parallel to grain, max. crush. stress lb./sq. inch	3800	2000	1200	230

These figures are taken from Wood Handbook 72, U. S. Department of Agriculture, and Modern Plastics Encyclopedia.

In general it can be said that, on an equal density basis, rigid foam is somewhat stronger in tension and considerably weaker in compression than wood. It therefore becomes necessary to reinforce the foam in areas under compression.

The advantage of foam over wood is that foam lends itself readily for mass-production, in contrast to the slow process of carving each individual wood shank or knee block. With a mold and the liquid resin material, the model can be readily reproduced in the factory. The mixing is done in batches as needed, and according to the density desired. In newer methods,



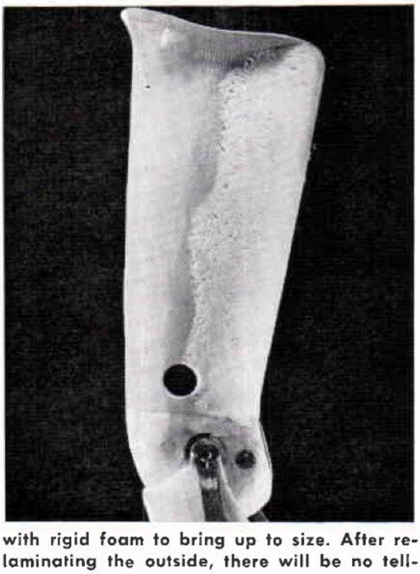


Figure 3. Bock Locking Knee Prostheses in wood (left) and rigid foam, side by side. Figure 4. Posterior side of socket built up with rigid foam to bring up to size. After relaminating the outside, there will be no telltale mark to show the alteration.

the "one-shot" polyether foaming system has contributed to production economies. Based on the use of a new combination of catalysts, this system eliminates much of the pre-mixing required in earlier methods and simplifies curing requirements. Foaming can be complete in as short a time as 3 minutes.

Another advantage is that foam will not absorb moisture, while wood has a tendency to do so. Wood has to be stock-piled, seasoned, and in certain areas dehumidified. With foam, the storage of two or three containers with the component mixtures is all that is required. If sufficient quantity is involved, the cost of the mass-produced foam article could be well below that of the wooden counterpart. If modifications have to be made, the same tools used for woodworking can be used on rigid foam. On such items as shanks and knee blocks, there is no problem with the cutting of the outer skin or coating since the final prosthesis must be plastic coated anyway. A commercial knee-shank system, done in both wood and foam, is shown for comparison, before coating, in Figure 3.

Rigid foam can easily be used as a filler to bring undersized limbs up to size, as shown in Figure 4. It is also used as filler in arm prostheses.

Foams, both rigid and flexible, lend themselves readily to application by spray technique. Internal-mixing guns give a uniform foam equal in properties to many machine-mixed foams. Applications such as impervious coatings, insulating, padding, and building-up of undersized parts, suggest themselves for this technique. All the potential uses have by no means been explored as yet in the field of prosthetics or orthotics.

As can be seen, plastic foam is quite a versatile material. Not all the problems in connection with it have been solved. Fabricating techniques need to be perfected, and closer control must be found for obtaining desired densities. Precautions must be taken in handling, especially in spraying, as the fumes act as an irritant to the mucous membranes. All in all, however, foam materials have taken a firm hold in prosthetics. Besides the many good properties of foam, the techniques for its use allow sufficient saving in labor to more than compensate for a higher material cost over the conventional materials such as wood.

Publications Received

The Division of Engineering and Industrial Research, Annual Report 1960-61, (National Academy of Sciences-National Research Council) Washington, D. C.

This well-written report describes many activities of the National Research Council in the field of Engineering and Industrial Research. Of special interest to readers of the *Journal* will be the report of the Committee on Prosthetics Research and Development, pages 149-158.

Copies of the publication are limited; it may be borrowed from the Headquarters Library of the American Orthotics and Prosthetics Association.

The Impact of an Anomalous Child on Those Concerned with His Welfare*

By LILA L. BEAL, M.S.W.

Child Amputee Prosthetics Project, Department of Pediatrics University of California Medical Center, Los Angeles, California

All of us have had the experience of feeling opposite emotions about a single occurrence, individual, or anticipated event. This is a normal human response which in psychological terms is known as feeling ambivalent. It is something that occurs whenever we are faced with a situation that is new and unfamiliar.

At the Child Amputee Prosthetics Project every staff member has had the experience of talking with and observing the reactions not only of the amputee patient, but of those who come into contact with him in his everyday life—parents, relatives, friends, teachers, therapists, doctors, prosthetists, and last, but not least, ourselves. Self-examination is always the hardest to perform but it can result in rewarding knowledge of attitudes and feelings that influence how and why we react in a certain manner toward a given individual or situation and why they in turn react as they do toward us. It helps us to know why we can have a sincere desire to help correct a deformity which either nature or later traumatic events have imposed upon an individual and at the same time, feel repulsed or otherwise uncomfortable about the condition. From our contacts and observations we have learned a great deal about the impact an anomalous child has on those who are concerned with his welfare. By examining the major crisis periods that occur in the

* Presented at the Annual Convention of The National Society for Crippled Children and Adults, Nov. 17-21, 1961, Denver, Colorado.

life of an amputee child, we have gained a better understanding of what his life will be like as an adult in our society. We know from experience that the way in which the crisis is handled will determine to a large extent the kind of adjustment the child will make to his disability.

One of the most profound shocks that a human being ever experiences is the trauma of being born. At no other time can the human body withstand such drastic environmental changes such as heat exchange, circulation change and extreme pressures. But nature prepares for these physical insults by providing us with the necessary mechanisms to insure survival, in most cases. Nature does not prepare us for the emotional shock of observing or being informed that the child was born with an observable anomaly that is of a chronic, irreparable nature. From the information given to us by parents concerning how they felt at the time this occurred, two themes are repeated enough to be considered significant: 1) they felt entirely alone with their problem, and 2) that nothing could be done for the child.

When these feelings are examined it becomes clear that they stem from several sources. The shock of having produced an anomalous child brings forth immediate feelings of guilt, shame, failure and, in some cases, repulsion. With all of this, there may be an added wish that the child will not live. Parents who can be given immediate help from someone who has professional knowledge about their child's problem stand a much better chance of finding healthy ways of dealing with these feelings than parents who are left to grope alone with their overwhelming disappointment.

The question often arises as to how much help parents feel they were given by the attending medical staff at the time when their child was born. The answers vary from no help at all to a sincere gratefulness that the physician or other para-medical staff gave them the kind of support and understanding they so desperately needed. Unfortunately, we find that in the majority of cases, the reactions of the medical personnel parallel the reactions of non-professional people who become touched by this unexpected turn of events. Why does this happen? In few instances does the reason seem to stem from a lack of concern for a fellow human being. To the contrary, the most frequent cause seems to come from our natural desire to avoid pain—either for ourselves or others. When we know that a situation is going to produce tears, self-recriminations and other expressions of emotional disturbance, the easiest way to avoid it is to make ourselves unavailable through any number of ways—"There are so many other patients to care for," "Someone else can do the job better than I." etc. Another equally effective way to avoid having to cope with parental feelings is to stiffle them with platitudes such as, "Time will erase your sorrow" or "You should be glad that it's his arms and not his mind."

The most important contribution that can be made at this time is to keep the channels of communication open and free of harmful attempts to conceal feelings which the family thinks are unacceptable. When parents can be helped to understand why they feel as they do toward the child and know that it is out of their concern for him as a human being burdened with an extra load to carry through life that they may wish he would not live, they are enabled to come through the shock with as little permanent scarring as is possible. The longer they carry their feelings locked tightly within them, the more severe and irreparable the damage. An example of this is the mother who several years after the birth of a child with multiple anomalies is unable to allow him out of her sight (except when attending a special school) for fear that something may happen to him. It was only recently that she was able to tell us that after he was born and she was informed of the deformities, she was placed in a room by herself. Over and over the thought "Couldn't they get rid of it" repeated itself in her mind. Years later we see her defending herself from the guilt which this thought produced by being pathologically concerned about the child's health. At this point, the prognosis for any appreciable change in this mother's behavior is extremely poor.

One of the ways the Child Amputee Prosthetics Project has attempted to reach parents at the time of crisis is through early referral to and subsequent contact by either the physician and/or the social worker on the Project staff. At times, the therapists have also been involved. By early referral we mean seeing the parents before the mother and baby leave the hospital. However, this type of referral constitutes a small portion of our patient load. In the majority of cases several months, even years have gone by before the patient is brought to us for evaluation and on-going treatment for the disability. In the meantime, whatever professional ameliorative help has been given has usually come from the private physician, perhaps a therapist connected with another rehabilitation setting, a social worker in another agency, the child's teacher, the prosthetist in private industry or any combination of these resources.

What happens when parents come to us seeking help for their child? What transpires between parent and the helping person that will influence whether or not the help that is offered will be effective? In considering these questions, we must keep in mind what any of us think about when faced with a new situation. When talking with parents, and the child if old enough, recalling our own feelings about something that is unfamiliar will eliminate much of the misunderstanding that takes place because people are not able to adequately communicate their concerns to one another through words.

Parents often look upon medical and allied professions with awe. They feel that it is not permissible for them to ask questions or if they were to ask, that their questions would make them look stupid. This is especially true when we use the short-cut of professional jargon which serves to confuse rather than clarify what is being said. By encouraging parents and/or the patient to ask questions, we are often able to learn much more about how we can best begin to help them than if we proceed without knowing what it is about the disability that bothers them most. Related to this is the question of "Will I be liked?" Many times an individual refrains from asking a question that could be interpreted in a negative way for fear that in so doing, they will not be liked or accepted. When it is made clear that the individual has a right and a respons:bility to ask questions, much of the tension is relieved.

Sometimes a simple explanation can prevent a parent or child from acting on the basis of false ideas. We recently had contact with an eleven year old youngster who was petrified with fright when her parents brought her to the Project for evaluation. During the course of the interviews, it was discovered that when she was six years old the parents had taken her to a prosthetics shop from which she ran screaming and begged them not to take her back. The parents interpreted this as merely her desire not to wear a prosthesis and pursued it no further. It was not until just prior to our seeing the family that the youngster admitted that her fears had been based on the idea that the prosthesis would be sewn to her. Years later she is unable to accept a prosthesis despite having now been given correct information.

We know from experience that people have different ways of expressing their feelings. Some withdraw into silence or monosyllable answers which do not reveal what is troubling them. In this instance, we must listen for what the person is not saying through his refusal to speak. Others become quite aggressive in their attack upon either the professional competency of the person rendering a service or on the tangible substitute which is made to replace the missing limb. Every prosthetist has experienced the situation of having a parent or child who is never satisfied with a prosthesis. After checking it over from a functional standpoint the prosthesis is shown to be working correctly and still the complaints continue. It is difficult to remember in these situations that the individual's complaints are not really directed at the prosthetist. They exist because the parent or the patient has never accepted the need for a mechanical substitute for the missing limb. Therapists have almost universally had the experience of dealing with parents who for one reason or another can never seem to keep the therapy appointments. Social workers are familiar with the mother who can find time to serve on the Boards of several agencies serving handicapped groups but makes no attempt to secure rehabilitative services for her own child.

These are but a few examples that can be cited as evidence that what people say they want and what they are really looking for are often two different things. People need to have time to wrestle with their decisions when doubts remain and a lack of conviction about the recommended program or device continues to plague them. It has been our experience that unless they are permitted to think over what is involved in a prosthetics program for themselves and the child, ill-timed or unwise decisions may result. An invitation for the family to go home, think about what they have seen and heard, and come back at a later time, has proven a valuable method of helping them reach a decision that will be consistent with what they want for the child.

We have made a beginning in learning how we can devise a program that will best serve our patients' needs. We have much more to learn. It is our hope and goal that through continued research, service and education we will produce new techniques and devices, attain greater proficiency through treatment in helping our patients to meet their own needs, increase general knowledge about child amputees and their problems and thereby attain our combined goal of patient habilitation.

Physical Therapy for the Pre-School Child Amputee*

By H. LORRAINE OGG, R.P.T.

Child Amputee Prosthetics Project, Department of Pediatrics, University of California Medical Center, Los Angeles, Calif.

It is my purpose to clarify the responsibilities and tasks performed by the physical therapist for the clinic chief or physician to assist him in making his decisions for the best treatment programs for child amputees.

Briefly, the therapist works in four primary areas. These are: evaluation of developmental status; assisting parents in understanding the physical limitations of their children and guiding them in assisting the child through his different stages of development; the prevention of deformities and promoting the maximum use of all motor power which is so important during pre-fitting of the prosthesis; and lastly, the actual training in the use of the prosthesis.

The primary purpose of evaluating developmental status is to make sure that the prosthesis is prescribed at the proper time. Locomotor status gives the most useful clue for determining this time. On the basis of clinical experience in the Child Amputee Prosthetics Project, prescription for the lower extremity prosthesis is made when a child begins to show a desire to stand. Experience has not been long enough to prove whether this is really the most satisfactory stage for prescription of a prosthesis or not, but only through the systematic and detailed collection of data can this be proven.

A record form for pre-locomotor evaluation has been devised, listing the stages of head control, sitting posture, prone progression and transition from sitting to standing. The performance of the child is graded on the

* Presented at the Annual Convention of The National Society for Crippled Children and Adults, Nov. 17-21, 1961, Denver, Colorado.

basis of whether he can or cannot perform an activity, or if he is in a stage of transition from one phase to another. The child is re-evaluated at regular intervals.

Information gathered as a result of these evaluations assists the physician in programming treatment for the child and assists the parents with their management problems. The physician's prescription may instruct the physical therapist to give home instructions to the parents for play activities and toys which tend to stimulate the child to perform at his maximum level. Parents can be steered away from extremes of over-protection or insistence upon premature independence by the child. The prescription may also request instructions for stretching or the use of special equipment to prevent deformities.

Parent contact with the therapist before prosthetic training begins can be valuable for the parent and therapist alike, affording an opportunity to prepare and plan for approaches to the training program. Integration of the training program into the family activities is the result of planned pre-prosthetic care. It is more evident, when the therapist is aware of the home and its facilities, what activities should be emphasized during formal treatment sessions and what activities should be emphasized at home.

Early contact with the family and child through pre-prosthetic care thus prepares the way for training with the prosthesis. The child does not have to become acquainted with strange surroundings and people in addition to adjusting to a new limb. The family will have been prepared for their role and the total program will be better integrated.

Training with the lower extremity prosthesis must be geared to the level of maturation of the child. Equipment must be kept at the minimum and the environment without clutter and confusion. A table, a few small chairs, and some toys placed strategically or presented at opportune moments for motivation and interest are usually sufficient equipment.

Harnesses, parallel bars, stabilizers and standing tables have not been used for the treatment or instruction of the toddlers or children beginning to use a prosthesis at their normal time for learning to walk. The harness, stabilizers and standing tables force them to balance under restriction and in positions where balance is difficult to obtain or maintain. The usual methods of teaching adults gait in parallel bars requires reciprocal arm and leg motion. The majority of these children have not yet reached that stage of locomotor development.

Basic control motions of the prosthesis must be thoroughly understood by the therapist because this information must be imparted to the child by the child's experience with the limb and this is not an easy task. These control motions must be integrated into activities which promote standing balance and later reciprocation. For example, the control motion of the Canadian Hip Disarticulation prosthesis is basically a sudden tilting of the pelvis which causes the hip joint of the prosthesis to flex and thus the series of motions which comprise the swing phase of the prosthesis are set in motion. Secondly, when the patient sits down solidly in the socket of this type of prosthesis with his weight properly centered over the joints of the leg, his hip and knee are so aligned that the leg will not buckle and he will be able to stand on the leg.

How is the child of one year taught to perform control motions which are difficult to describe and which appear to be unnatural to his normal pattern of development? At the present time this can be done by placing the child in an upright position and moving his trunk into a position of stability over the leg so that he can begin having the experience of standing and balancing on the leg. He may need a solid object to hold onto for support or he may take the hands of the therapist at the level of his chest to hold for support as it is needed. Later he can be moved through the motions which cause the hip and knee to break as in beginning to walk. The child will learn balance and reciprocation by trial and error. He must also be placed in a situation which makes his need to walk reasonable and necessary. Since play is his world of work, play is the most logical means by which his interest in walking can be inspired. He should be expected to lose his balance and to fall, just as any other child does when learning to walk.

The length of time that training takes for the pre-school child varies, but in general it is surprisingly short. Initial training sessions are preferably scheduled daily for two weeks. The time may take less than this or, in cases of very complicated problems, may require as long as a month. Training does not stop after the initial intensive training period, but continues until the child is functioning at the maximum efficiency of his ability. Regular checks are made of the child's progress until he reaches his full growth. There are always periods when re-training is needed and when the prosthesis must be changed or a new one prescribed.

In summary, the physical therapist has an important role under the direction of the physician in the evaluation of developmental status, preparation of the child and parents for training, and finally in the training program for the successful use of the prosthesis.

In Memoriam

LOUIS P. MONFARDINI, Vice-President and Sales Manager of The Florida Brace Corporation, of Orlando, Florida, died June 6, 1962, at his home. Mr. Monfardini became ill while attending the meeting of Region VII, of the American Orthotics and Prosthetics Association, in Houston, Texas, in March. He is survived by his widow, Mrs. Dolores Monfardini, also an official of the Company, and three children.

LOUIS P. MONFARDINI

Mr. Monfardini had been associated with the Florida Brace Corporation for several years and had attended many medical meetings and meetings of AOPA. He served as Membership Chairman of the Association for the year 1960-61. During his term as Membership Chairman, fifty-five new members were enrolled. In recognition of his services, the 1961 Orthotics and Prosthetics Assembly adopted a resolution of appreciation.

Harnessing Methods for Children with Above Elbow Amputations

By HARRY E. CAMPBELL, C.P.

Child Amputee Prosthetics Project, Department of Pediatrics, U.C.L.A. School of Medicine, University of California at Los Angeles.

The tendency of the above elbow prosthesis harness to shift and rotate during use is a major deterrent to comfort and optimum function. This instability of the harness can become a primary cause of prosthesis rejection, particularly among young children.

The apparent need for a more stable harness for above elbow prostheses led the author, as part of his work with the Engineering Artificial Limbs Project of the Department of Engineering at the University of California at Los Angeles, to design a new harness, incorporating what were considered to be the best features of several above elbow harnessing devices already in existence. This new design, a chest strap harness, is being used by numerous prosthetists throughout the country, and has also been adopted for use by the Child Amputee Prosthetics Project at the University of California at Los Angeles.

In adapting this harness design to meet the substantially different needs of children, certain major considerations became apparent: not only must the device be smaller without sacrifice of efficiency, but the more diffuse, more gross physical activities of the child, as contrasted to the better directed and infinitely more precise movements of adults, must be considered. In addition, the small body surface areas and delicate contours of the child pose difficult design problems. The shoulder of a young child, for example, does not provide an area large enough or sufficiently well-developed to hold a conventional harness strap.

This new harness, which has proved to be highly satisfactory even with very young children, consists of the following components:

1) A *chest strap*, which is anchored near the posterior lateral proximal rim of the socket, passes over the shoulder and across the chest, under the axilla and across the back, re-crossing the shoulder to fasten on the anterior lateral proximal rim of the socket.

2) A *back strap*, which is fastened to the chest strap posteriorly near the axilla and anchored to the control attachment strap at the inferior angle of the scapula.

3) An *over-shoulder strap*, which runs from the back strap over the shoulder to the deltopectoral triangle area, where it is folded, laid across the chest to the midline, and anchored to the chest strap. (This over-shoulder strap is also folded posteriorly to form the back strap.)

4) An elastic *front suspension strap*, which is anchored at the anterior fold of the over-shoulder strap and attached to the medial anterior portion of the prosthesis, above the turntable.

5) An *elbow-lock billet*, anchored at the anterior fold of the over-shoulder strap and attached to the elbow-lock cable.

6) A *control attachment strap*, secured at the posterior fold of the over-shoulder strap and attached to the terminal device cable hanger.

Method of Fabrication

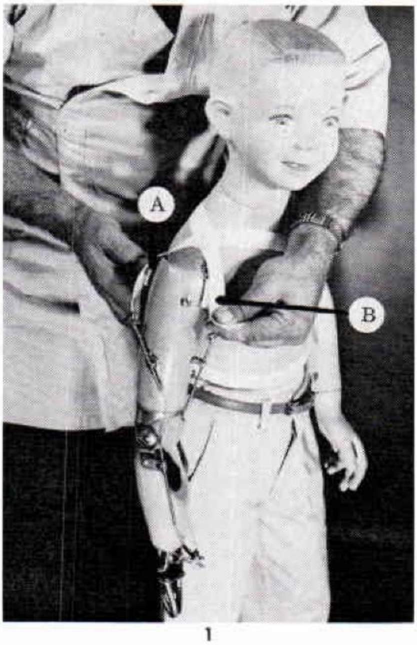
Step 1: One-inch webbing is placed from point A (Figure 1) near the lateral posterior proximal brim of the socket, over the shoulder and across the chest, under the axilla and re-crossing the shoulder on the amputated side to fasten at point B (Figure 1) near the anterior lateral proximal brim of the socket. Sufficient webbing should be allowed for a loop at each end to strengthen the snap fasteners. (Clamps may be used throughout the entire measuring and fitting procedure.)

Step 2: The over-shoulder strap (which must be long enough to be folded posteriorly to form the back strap, and anteriorly to join the chest strap at the midline) is placed as illustrated in Figure 2. (For the average 6-year old child, allow about 10 inches of webbing for the back strap portion and 8 inches for the anterior fold.)

Step 3: Clamp the over-shoulder strap at point C (Figure 2). Fold the anterior portion of the over-shoulder strap as shown in Figure 3, at about the deltopectoral triangle area. Secure the end of the folded portion to the chest strap at approximately the midline of the amputee.

Step 4: At this anterior fold, secure a piece of elastic webbing about 8 inches long (Figure 4). Exert a slight pull on the elastic webbing and fasten it to the anterior medial portion of the prosthesis just above the elbow turntable. This elastic webbing, under slight tension, insures the return of the elbow-lock alternator.

Step 5: A piece of half-inch webbing, fitted with an adjuster, is used for the elbow-lock billet. The webbing is attached to the elbow-lock cable hanger and secured at the anterior fold of the over-shoulder strap next to the elastic webbing used in Step 4 (See Figure 5).



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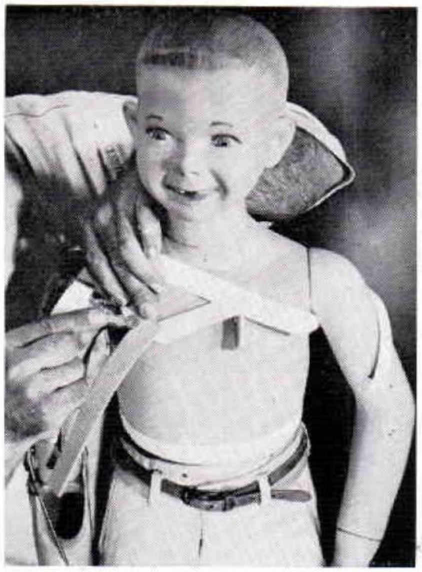

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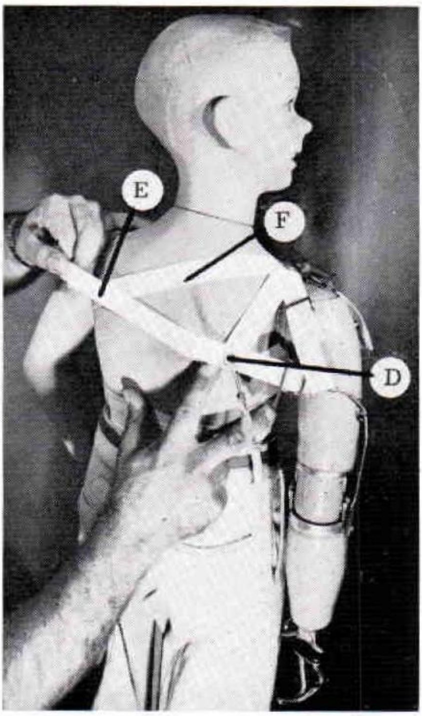

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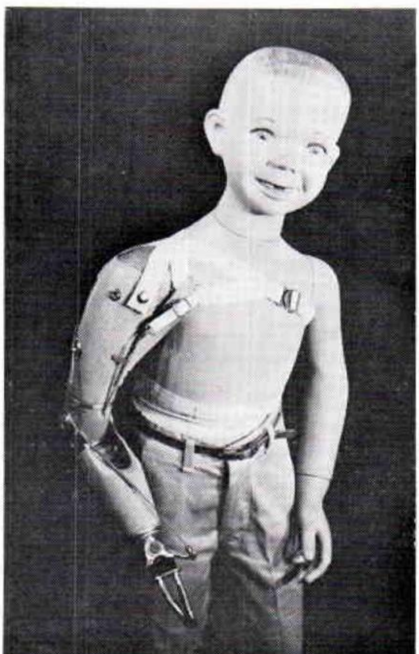
Step 6: Posteriorly, fold the over-shoulder strap at the point just above the inferior angle of the scapula (Figure 6) and secure it to the posterior aspect of the chest strap, near the axilla.

Step 7: The control attachment strap, fitted with an adjuster, is attached to the terminal device cable hanger, and secured to the posterior fold of the over-shoulder strap at point D (Figure 6).

Step 8: The back strap (from point D to point E, Figure 6) limits the freedom of arm movements, but gives greater excursion and power for a short stump. The back strap can be positioned along the posterior aspect of the chest strap between points E and F (Figure 6). The closer it is moved to F, the more freedom it allows—but with lessened excursion and power. The same increase in freedom (again with lessened excursion) can be achieved by raising the fold (point D, Figure 6). To determine the best placement of the back strap and the fold of the over-shoulder strap, all straps should be clamped in place and the amputee directed to operate the control. Observation of prosthesis function will indicate proper placement of the back strap.

Step 9: Remove the harness and box stitch at all points which have been clamped. The point of intersection of the chest and over-shoulder straps (point C in Figure 2) is both box and cross-stitched.

Step 10: An adjustable buckle is inserted anteriorly near the mid-point of the chest strap (Figure 7) for easy removal of the prosthesis.



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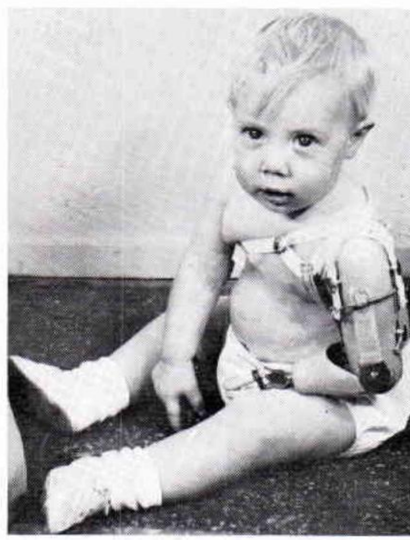


A Child fitted at 10½ months with an elbow disarticulation prosthesis, 12-P Dorrance hook and passive operation.

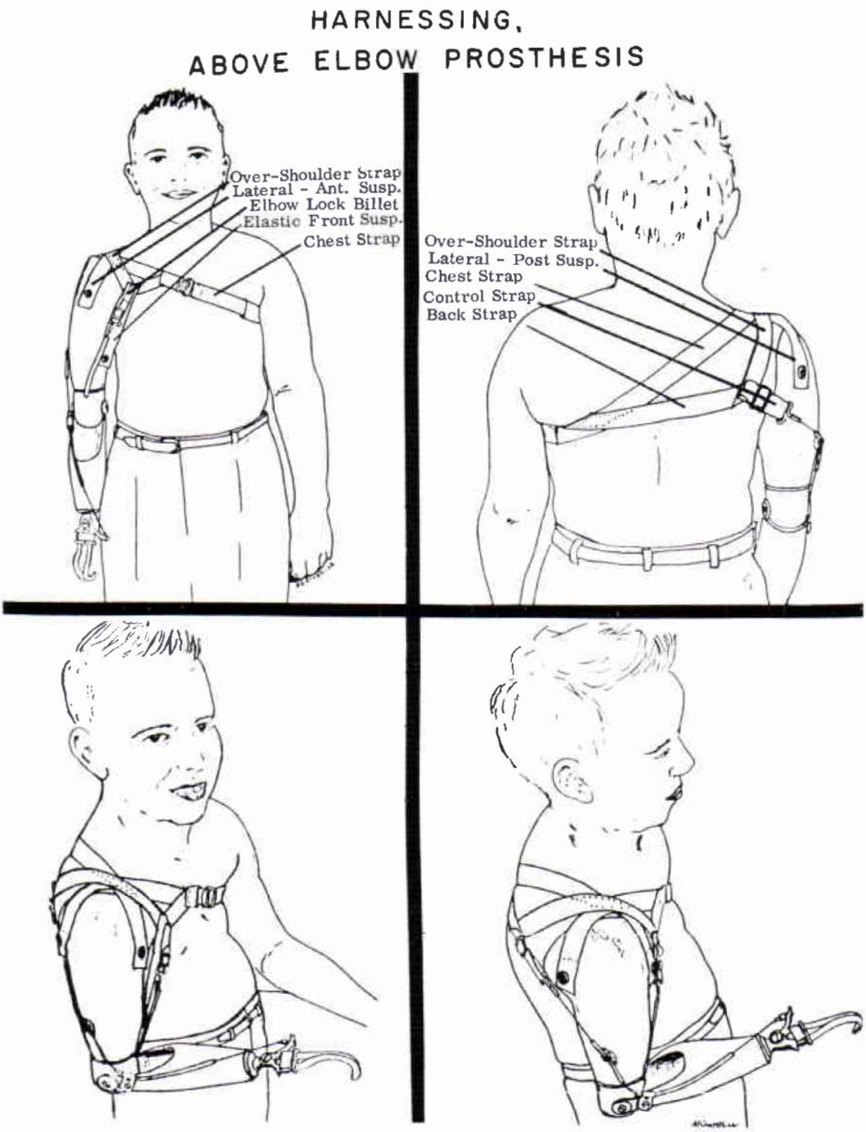
Harnessing For The Very Young Child

Dr. Craig Taylor and Dr. Hilde Groth of the Biomechanics group in the Department of Engineering at the University of California at Los Angeles have made a study of harness strap size for children, and on the basis of their findings have recommended that the half-point of the surface area growth in the child's development be the criterion for the change in strap width. Therefore, at approximately the time when the child reaches a weight of 50 pounds, the harness webbing is changed from ½-inch to 1-inch width (except on the elbow-lock control, for which ½-inch webbing is used). Although ¾-inch or ⅝-inch webbing may be used, fitttings for the ½-inch and 1-inch webbing are more readily obtainable (at least in the Los Angeles area) and their use has become standard practice at the Child Amputee Prosthetics Project.

Because the very young child (up to 18 months of age) has not developed skills involving any high degree of muscular coordination, he cannot be expected to operate the terminal device or the elbow lock actively. These devices are ordinarily operated by therapist, parent or by the child using his normal upper extremity.

Since the passively operated prosthesis has no control cable for terminal device operation, an elastic strap is used instead of the control attachment strap to maintain balance of the harness.

When the child has reached a point in his neuromuscular development



(20-30 months of age) where active operation of the terminal device can be expected, a control cable is added.

Because the amount of force and excursion possible at this age is very limited, the child generally cannot accomplish forearm flexion, and so a Bowden cable arrangment is applied. When the child develops sufficient force and excursion, the Bowden cable is exchanged for a standard above elbow cable mechanism. The elbow lock is generally activated at 24 to 36 months of age. At first the child may prefer to continue using the other hand, but with training usually becomes adept at active forearm flexion very quickly.

LETTER OF APPRECIATION RECEIVED FROM GERMANY

The following letter of thanks for a set of the two volumes of the Orthopaedic Atlas has been received at the Washington office of the Association:

"Dear Mr. Director Smith:

"On the occasion of the German Orthopaedic Congress at Weisbaden Mr. Porten handed over in behalf of your order two precious special books to the German Professional-Orthopaedic School.

"We are very glad to receive that present, which is a sign for a professional harmony. With many thanks we affirm that these books will not stay only in the bookcase, but will be used by our rising professional generation.

"We wish that the connection between the American and German orthopaedic branches and centres will be steady, in openmindedness and friendship. We thank you very much.

"We also would like to take this opportunity of asking you about the following matter:

"With great interest we have heard much of your work from Mr. Porten, especially about the admission of orthopaedic study by universities. It would be a great help for us in our endeavours, if you will kindly assist us by permitting us to study your corresponding education records and by informing us about the kinds of courses given. We are very interested in the structure, subjects, timetables, possibilities for diploma, and the teacher-team of your centre.

"It would be harder for us to start the same way; however, we would be very thinkful if we could learn by your education rules.

"On behalf of our managing committee, directors and co-workers we thank you for your cooperation,

Yours Very Truly,
Om. Uhlig, Leiter
Bundesfachschule

Above Knee Prosthetic Socket Approaches

REPORT OF THE A/K STUDY COMMITTEE, UNIVERSITY COUNCIL ON ORTHOTIC AND PROSTHETIC EDUCATION

In May 1961, the university prosthetics and orthotics education programs formed an organization which has come to be known as "UCOPE," or University Council on Orthotic and Prosthetic Education. This group arose out of a recognition of a need for closer cooperation and coordination of courses between the three universities. With distances of at least a thousand miles between the schools, it is not surprising that the courses being taught at each center might diverge, at first in minor details, and as more time passed, in broader areas of instruction. Apparently, this is what has taken place in a few instances, particularly in the courses devoted to above-knee prosthetics which have now been in existence for six years.

As a first approach to resolving these divergences, UCOPE, at its meeting in Miami in October, 1961, compared and analyzed both the schedules and examinations for the A/K prosthetists' course. This analysis pointed toward several differences in teaching, which, it was felt, could be resolved only through discussions between the technical people who instruct in these courses. UCOPE thereupon appointed a committee consisting of the chief prosthetist instructors from each university, John Bray of UCLA, Ivan Dillee of New York University, and Blair Hanger of Northwestern University, and as chairman, Norman Berger of New York University, who would act as administrator and reporter. This Study Committee met for the first time in February, 1962, in Los Angeles for the specific purpose of exploring in detail the thinking and teaching at each of the three universities with regard to A/K fitting and alignment. This report is a summary of the findings and decisions of the Committee.

Early in the Committee's discussions, it became apparent that the primary differences in techniques and procedures being taught at the three centers were in the areas of socket planning, socket layout, and initial socket shaping. Accordingly, a considerable amount of time and thought was devoted to these matters.

I. *Socket Planning*

There are two different methods currently being taught of establishing a pattern for the socket at ischial level. The first method begins with sets of standard patterns which are modified and corrected on the basis of careful measurement and examination of the stump. We can call this the "pattern modification" approach. The second method consists of determining, again by careful stump measurement and examination, as many of the factors as possible which should be known if a proper pattern is to result. These factors are then incorporated into a pattern by systematic drawing of lines, angles, curves, etc., until the pattern is complete. We can call this the "pattern construction" approach.

In order to carefully explore the significance of these approaches, it was found necessary to work with an amputee subject who was measured and examined by each member of the Committee. Two patterns were then made; one in accord with the "modification approach" and one in accord with the "construction approach." Detailed comparison of the patterns indicated the following differences:

a) The medial lateral dimension is measurably larger with the "construction approach."

b) The rectus femoris channel is significantly deeper and the apex of the channel's curve is more laterally placed with the "modification approach."

c) Using the "modification approach," the angle formed by the posterior side and the medial side is a fairly constant 7°. With the "construction approach," this angle is varied between 6 and 10°.

In attempting to reconcile these differences, it was agreed that the "pattern construction" procedures should be altered so that the medial lateral dimension would be reduced by 3/16" and so that the depth of the rectus femoris channel would be increased by 1/8" increments. Thus, the resulting pattern differences were minimized.

Despite this, there remain some differences in the contours of the socket patterns. It is apparent, therefore, that while progress has been made, additional meetings will be required to effect a more complete reconciliation of the teaching procedures and techniques at the three centers. It seems obvious that future meetings could lead to one of the following alternatives:

All teaching programs could adopt the pattern construction technique;

All teaching programs could adopt the pattern modification technique, or

Additional changes in the two approaches could be decided upon so that the resulting patterns would reveal only functionally insignificant differences.

II. *Socket Layout and Initial Shaping*

The second major area of concern relates to the underlying rationale and the specific techniques for socket layout and initial shaping. As in the socket planning discussions, the Committee once again found that two distinct approaches are currently being taught, which for convenience we can call the "measurement approach" and the "medial wall approach."

A. The Measurement Approach

The measurement approach to layout and initial shaping rests on the fundamental assumptions that socket flexion and adduction angles can be predetermined through measurement on the amputee and that these measured values will represent the socket flexion and adduction angles in the finished prosthesis within 1°. Accepting this basic premise, layout and shaping proceed in a logical fashion. The measured flexion and adduction angles are cut into the socket block, thus establishing the posterior and lateral walls. These, since they will not vary, serve as a foundation for shaping the rest of the socket. The anterior wall is shaped according to the top pattern and a distal pattern, and the socket is brought up to size in accord with a tension analysis chart. This procedure produces a medial wall which maintains contact with the soft tissues throughout the length of the stump. The socket thus has relatively straight lateral and posterior walls with the medial and anterior walls contoured to follow the shape of the stump, and supporting as much stump tissue as possible.

B. The Medial Wall Approach

This approach begins with the cutting into the socket block of a straight medial wall, which then serves as the base or take-off point for stump perimeters as derived from the tension analysis chart. With the medial wall as a constant, the perimeters, in effect, determine the angulation of the lateral wall. The adduction angle, therefore, is not constant since it is dependent upon the perimeter measurements built into the socket. This presupposes that there may well be a need for changes in the adduction angle of the socket during dynamic alignment. The ischial seat may then have to be modified (brought back to the horizontal) and the inside of the socket may also require modification after angular changes during dynamic alignment.

In summary, we can say that the second method (the medial wall approach) assumes the need for significant socket alignment changes during dynamic alignment, which implies that final fitting is completed during dynamic alignment. With the first method (the measurement approach) it is assumed that correct alignment angulations can be built into the socket from the start and that fitting refinements during dynamic alignment are rarely related to flexion or adduction changes.

In attempting to reconcile these divergent approaches to socket layout and initial shaping, the Study Committee members felt that there was little possibility of finding a compromise position. The proponents of each approach were of the opinion that it would take actual experience in the fitting of cases utilizing both approaches before one or the other method could be recommended. The Study Committee, therefore, plans a further meeting which will be a practical working session with amputees. In this way a final decision can be reached as to the comparative merits of each approach. A period of two weeks therefore has been set aside in July, 1962, for this purpose.

Summarizing their experiences the members of UCOPE were of the opinion that a significant start had been made towards the problem of resolving variations in teaching between the three university centers. For the first time, a clear and specific understanding has been achieved of the differences in techniques, and, more importantly, of the underlying rationale and meaning of the differences in terms of socket fit and alignment. The enthusiasm for this kind of interchange of ideas between the three universities was so marked that it is intended to continue with meetings devoted to below-knee procedures and upper extremity procedures, although the differences in teaching here seem much less significant. The importance of this work to the prosthetic industry as a whole and specifically to the American Board of Certification cannot be over-emphasized.

Submitted by:
John Bray, UCLA
Ivan Dillee, NYU
Blair Hanger, Northwestern
Report: Prepared by Norman Berger, NYU

Report on the Application of Alternating Current to the Urinary Bladder Wall of the Dog*

By THORKILD J. ENGEN, C.O.**

INTRODUCTION

The certified Orthotist or Prosthetist represents a unique combination of knowledge and technical skill. With training and experience, he accumulates practical know-how in many areas such as:

Anatomy	Metallurgy
Kinesiology	Plastics
Biomechanics	Electronics
Pathology	Mechanics
Psychology	Tooling and others

Although he may not be an expert in any of these disciplines, he does have an intelligent knowledge of their use and application.

In my opinion, the Orthotist and Prosthetist can be a valuable participant in many types of medical research projects. Many opportunities exist for us to actively contribute to these projects. The compensation for these efforts can be rewarding—personally, professionally, and financially.

The author of the following report had the opportunity to attend a summer course in Physiology. Although the subject is not routinely a concern of the Orthotist, it can demonstrate how his special knowledge can be applied.

During the 1961 summer course entitled "Classical Physiology with Modern Instrumentation" conducted by the Department of Physiology at Baylor University College of Medicine, Houston, Texas, a series of lectures and laboratory experiments demonstrated that smooth muscle would contract when stimulated by a controlled alternating current.

One of the major problems facing patients with spinal cord lesions is the absence of voluntary control and complete emptying of their urinary bladder. As a result of the above-mentioned experiments, it seemed possible that a similar stimulation could be applied to the human detrusor muscle and produce a sustained contraction of the bladder followed by a satisfactory emptying of this organ. To investigate this possibility and to gather preliminary information, several dogs were studied.

METHOD OF STUDY

The dogs were anesthetized with Nembutal, 6%, ½cc per kg. of body weight. A tracheotomy was performed to assure an adequate airway. The dogs were secured on a dog board in a supine position. The bladder of the females dogs was exposed by a linear incision through the abdominal wall

* These experiments were undertaken by the author of this article with the approval of H. E. Hoff, M.D., Professor and Chairman, Department of Physiology, and Dr. L. A. Geddes from the Department of Physiology, Baylor University College of Medicine, Houston, Texas during the summer of 1961.

** Director of Orthotic Department, Texas Institute for Rehabilitation and Research and Clinical Instructor in Orthotics, Baylor University Collge of Medicine, Houston, Texas.

corresponding to the linea alba extending upward approximately 4 inches from the symphysis process. The bladders of the male dogs were exposed in the same manner after partial dissection and lateral retraction of the penis from the abdominal wall. One of the ureters was tied off to prevent normal flow of urine to the bladder. The remaining ureter was cannulated and connected to a strain gauge transducer linked to the Physiograph to record intravesical pressure. The Physiograph was calibrated from 0 to 70 mm. Hg. A pressure bottle filled with saline was incorporated into the system for the purpose of refilling the bladder. The flow was controlled by a three-way stopcock valve.

A monophasic square wave stimulator was used with variable pulse duration ranging from 0.1 to 2 msecs. Frequency range was varied from 0-200 cycles per second and pulse amplitude ranged from 0-130 volts.

Two unipolar needle electrodes were inserted directly into the detrusor muscle at various distances from each other.

SUMMARY OF OBSERVATIONS

The following procedure was carried out on a total of eight dogs, four males and four females.

The first four dogs had been utilized in other physiological experiments and were used in developing the surgical and recording techniques.

In one of these dogs (female), the bladder with intact ureters, urethra, and sphincters was dissected free from the abdominal cavity. Electrical stimulation of the separated organ produced a visible contraction.

In a male dog, the bladder was filled with approximately 150-175cc. of saline. The bladder was stimulated but did not respond, which in later experiments proved to be due to overfilling of the bladder.

The remaining four dogs were used primarily for the purpose of this study. Each animal was prepared as described and the response of each dog was essentially the same. The following observations and recordings were made.

DOG #1 (MALE)

The parameters of stimulation were set at 0.5 msecs. pulse duration and 25 cps. frequency; the voltage was steadily increased from zero to 20 volts. An increase in bladder pressure was noted on the recording device after 7 seconds of stimulation, and at a reading of 15 volts. The pulse amplitude was increased to 20 volts and held constant. Voiding began when the pressure reached 10 mm. Hg. after 8 seconds of maximum stimuli, a rhythmic contraction was recorded and lasted until the bladder was empty. The stimulation was discontinued after 18 seconds. (Figure 1).

On the following experiment, the parameters of stimulation were held constant at 25 cps. and 25 volts. The pulse duration was varied from 0.1, 0.5, to 2.0 msecs. No increase in bladder pressure was noted with the pulse duration set at 0.1 msecs. At the setting of 0.5 msecs., the bladder pressure increased instantly to 18 mm. Hg. (four seconds of stimulus), and voiding began. With the pulse duration set at 2.0 msecs, a rhythmic contraction of the bladder was noted. A maximum pressure of 28 mm. Hg. was recorded at the peak of contraction. The voiding became stronger and lasted until the bladder was empty. The stimulation lasted for 9 seconds. (Figure 1a)

DOG #2 (FEMALE)

On the following experiment, the parameters of stimulation were held constant at 25 cps., 0.5 msecs. pulse duration, and 8 volts. After 20 seconds of stimulus, a contraction of the bladder was noted and after 30 seconds the bladder was empty. A single strong "after-contraction" was recorded (Figure 2).

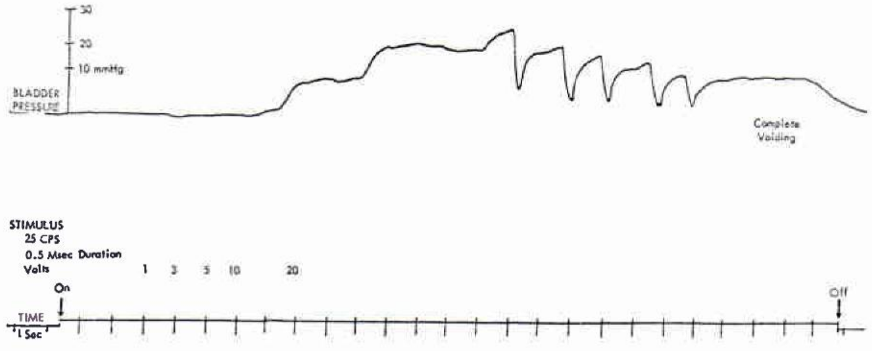


Figure 1

Record obtained on male dog #1 with stimulation at variable voltage. Frequency and duration held contstant.

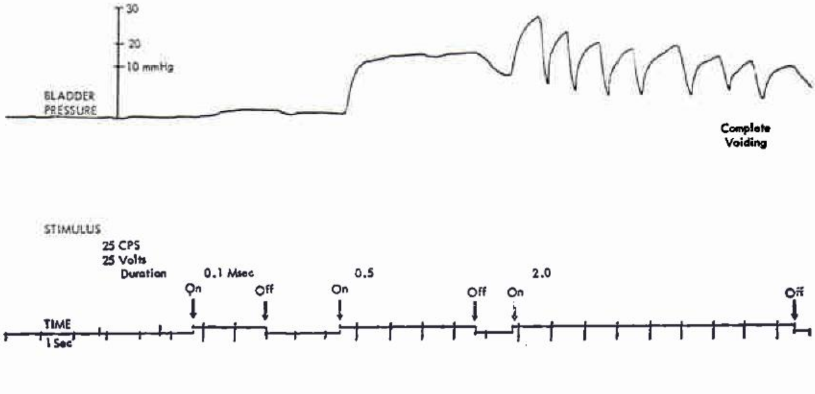


Figure 1a

Record obtained on same dog as Fig. 1 with stimulation at variable pulse duration. Frequency and voltage held constant.

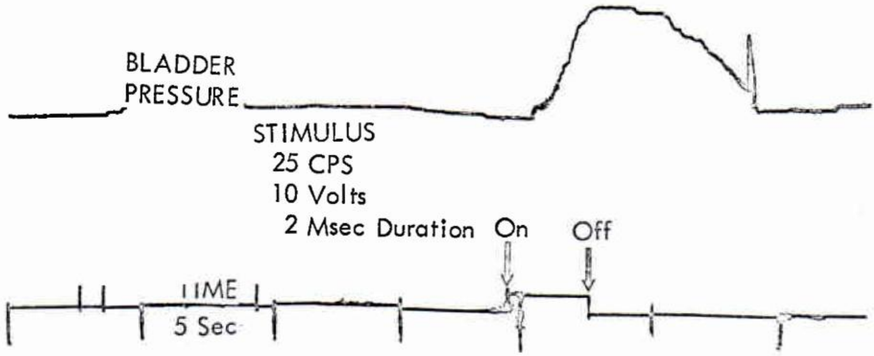


Figure 2

Record obtained on female dog with short period of stimulation at 10 volts and 2.0 MSec Duration

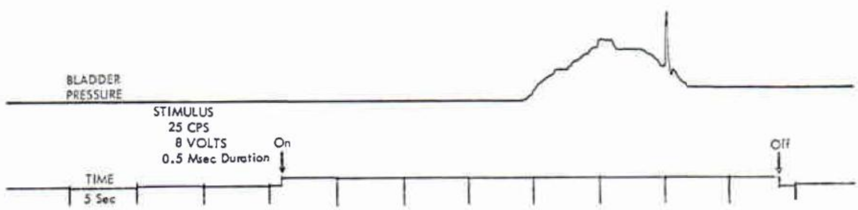


Figure 3

Record obtained on female dog with prolonged period of stimulation at 8 volts and 0.5 MSec Duration

DOG #3 (FEMALE)

The results of this experiment were almost identical to that described in Dog #2. The pulse duration was raised to 2 msecs. and the voltage was set at 10. After 1 second of stimulus, voiding began and lasted for 10 seconds. The stimulation was discontinued after 4 seconds. (Figure 3).

It was interesting to compare the recordings of the female and male dogs. The bladders of the female dogs did not respond to the stimuli in rhythmic contractions as observed in the male dogs.

DOG #4 (MALE)

Plate electrodes were used from a 50 MC receiver and were manually held to the bladder wall. The area of each electrode was one square cm. and each was placed approximately 5 cm. apart. The bladder was then stimulated with a radio frequency transmitter. The bladder was noted to contract when the pulse was modulated by a stimulator at a carrier frequency of 50 MC, producing a flow of fluid. The pulse duration was 2.0 msecs. with a frequency of 25 cps. The carrier power was approximately 1 watt. The separation of the receiver coil to the transmitter coil was in excess of one inch. No record was taken from this experiment.

Five months later, two physicians from the Department of Urology of Baylor University College of Medicine participated in repeating the experiment on a fifth dog (a male). At this time, the fluid injected into the bladder passed through one of the ureters and the other ureter was used for recording the bladder pressure. Each filling and emptying of the bladder was carefully measured.

The bladder was stimulated at different settings and the placement of the electrodes varied. The parameters of stimulation at 25 cps., 2.0 msecs., and 8 to 15 volts, lasted from one to 10 seconds thus initiating contraction of the bladder and producing a flow of urine. Attempts were also made to locate the pelvic nerves in the true pelvis, but were unsuccessful. A laminectomy of L-5, L-6, L-7, and S-1, S-2, S-3 to expose the sacral nerve roots was performed. This was done in an attempt to define those roots which were responsible for reflex micturition. Each root was electrically stimulated, and the response on the part of the bladder was to be detected by any change in the intravesical pressure as recorded on the physiograph. However, this attempt was unsuccessful.

Then transection of the spinal cord at L-6 level was performed so that the bladder was denervated and the dog was in the acute stage of "spinal shock." The bladder was again directly stimulated and now only localized (rather than generalized), contraction occurred.

CONCLUSION

Direct stimulation of the detrusor muscle by an alternating current of the anesthetized, neurologically intact dog was found to produce a strong and sustained contraction of the bladder causing flow of urine and complete emptying. However, preliminary studies on a dog that had transection of the spinal cord indicated that direct stimulation did not result in a sustained and generalized detrusor contraction. The application of this method to solve the problem of lack of complete and controlled urination in the patient with spinal cord lesions may be feasible, but will demand further investigation.

ACKNOWLEDGMENT

I wish to express my appreciation to the following persons for their technical assistance:

Mr. Carter Jordan

Mr. Dave Hickman

Mr. Arnold Moore

Mr. L. F. Ottnat

Mr. Carl Roach

Miss Geraldine Midgley

and to Brantley Scott, M.D., and Emilio Quesada, M.D., for their interest and professional advice.

ADDENDUM

After being exposed to the complex arrangement and function of the internal organs of the dog, it was desirable to reproduce the urinary system in a plastic material. Thus, an attempt was made to duplicate the inside of the bladder, urethra, and vagina in plastic. The result obtained is shown in Figure 4.

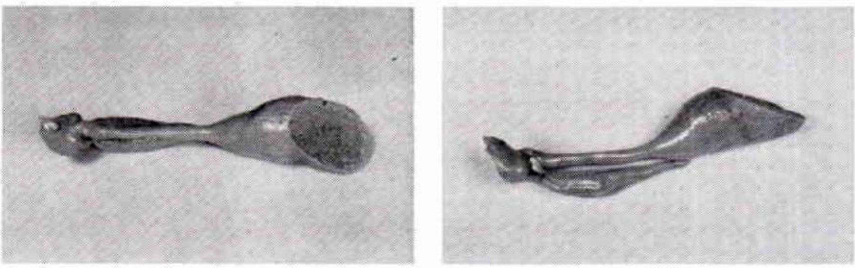


Figure 4

Plastic mold of the urinary system in a female dog.

The mold was produced using the following materials and technique:

Polyester Resin	#4116	85 gr.
Polyester Resin	#4134	15 gr.
Luperco		4 gr.
Naugatuck		7 drops
Pigment		1/10 gr.

After the animal had expired, 50 cc of plastic resin was injected through the ureter using a glass syringe with a #13 gauge needle. The resin was allowed to set at room temperature for 15 minutes. The mold was then removed by dissecting the surrounding tissue.

I have been informed by members of the staff of the Department of Urology that this method could be used as an effective teaching aid to demonstrate the normal and pathological anatomy of the urinary system. This method could also lead to an improvement in the design of cystoscopy tubes, catheters, etc.

AOPA Survey Project Report

By BERTRAM D. LITT

Assistant Director, Survey Project

During the month of May the AOPA Survey of Orthotic Services conducted interviews in approximately 180 civilian facilities located in 88 cities throughout the nation. Selection of the facilities visited was planned so that it was as representative as possible. The primary consideration was distribution of people and medical centers within the nine geographical areas developed last year for the Survey of Prosthetic Services. These areas are; New England, Central Atlantic, Southern, Midwestern, North Central, Rocky Mountain, Texas-Oklahoma, California, and Pacific Northwest. Other factors such as city and shop size, association membership and non-membership, certified and non-certified, private and institutional civilian facilities were included in drawing each sample.

The interviews were conducted by a group of fourteen orthotists traveling in seven two-man teams. The Survey owes a special debt of gratitude to these men, who took time from their business to participate in the survey. All are well trained in terms of experience, and are either certified or plan to take the certification examinations as soon as possible.

The interviewers, whose picture appears below, attended a special training course in mid-April. Two members of the Survey Content Committee, Messers. John Glancy, C.O., of the Children's Hospital Medical Center in Boston, and John A. DeBender, C.O., of DeBender and Co. of Chicago, worked with LeRoy Nattress, Project Director, and Bertram Litt, Associate Project Director, in conducting the training course. The Survey regrets to report that because of illness one of the prospective interviewers who attended the Course, John Retzler, Jr., of New York City, was unable to participate in the field work of the project.

ORTHOTIC SURVEY INTERVIEWERS—Back row, left to right: John Glancy, Richard A. Fitzgerald of Dallas, Loren D. Jouett of Chicago, Robert C. Apitzsch of Pittsburgh, Thomas G. Powell of Richmond, James Fenton of Miami, William B. Smith of Kansas City, Mo., and John DeBender. Front row, left to right: Rich Greene, Jr. of Erie, Pa., Jerry Gillespie of Pensacola, William B. Anderson of Columbus, Ga., Alan Finnieston of Miami, Steve Andrusky of Lynchburg, Robert B. Reid of Miami, Ross Bremer of Clearwater, Fla., and Bertram D. Litt. Leroy William Nattress, Jr., the photographer, and Thomas Bidwell of Madison, Wisc. are not shown.

Biographical Sketches of New Members of AOPA

D. J. BUCK

Darwin J. Buck is owner of the Kansas Brace and Limb Company, located at 3128 East Douglas, Wichita, Kansas.

Mr. Buck began his training for orthopedic work in 1946 while employed by the Charles Cullen Co., Seattle, Wash. During his tenure in the brace field he was also employed with the Hanicke Company of Kansas City, Missouri and the Lester Sabolich Company of Oklahoma City, Oklahoma. In 1954 he went into business for himself. Of special interest to Mr. Buck has been the improvements in existing types of braces; making them as functional and also as comfortable for the patient as possible.

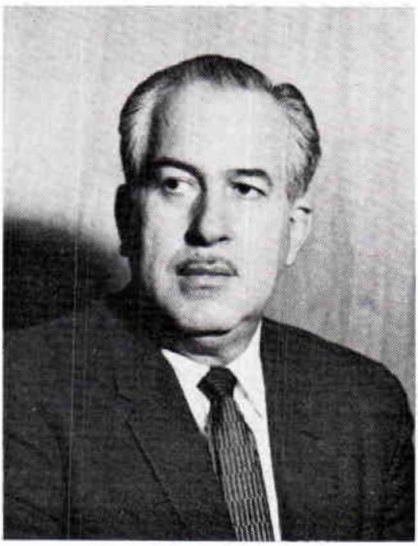
In 1961 he established a branch office in Hutchinson, Kansas to better serve the Western area of Kansas.

Mr. Buck was certified as an Orthotist in 1957 and received his Facility Certification in December 1961.

JAMES D. FERGUSON

The Brace Department of the University of North Carolina School of Medicine was established three years ago, January 1, 1959, via a trust fund to meet adequately the needs of the patients and doctors of the North Carolina Memorial Hospital and School of Medicine with respect to both service and teaching. It is a self sustaining shop offering a full scope of work and services directed by J. D. Ferguson.

Mr. Ferguson came to direct the shop from the Duke University Medical Center where he had eleven years of experience with the orthopedic and prosthetic appliance center. His aim is to offer substantial information and assistance to the field of our orthopedic and prosthetic services which would benefit both the patients and personnel of our profession. Mr. Ferguson feels that his interest and enjoyment of his work makes it an honor to be associated with this profession.



ANTHONY S. VALENTE

Dr. Anthony S. Valente has been appointed vice president, treasurer, director of research & development and member of the board of directors of Mastercraft Medical & Industrial Corp., 94-21 150th Street, Jamaica, N. Y.

Prior to joining Mastercraft, Dr. Valente for 20 years, was employed by J. H. Emerson Co., manufacturers of medical research equipment.

Dr. Valente is an inventor and holder of many patents for medical, electronic and research equipment. He is a pioneer in the introduction of resuscitation equipment, iron lungs and rehabilitation devices. Dr. Valente attended Columbia University.

Functioning as head of research & development for Mastercraft, Dr. Valente will continue the development of "Curvon" a porous plastic material for use by orthotists & prostheticians.

WALLACE WHITNEY

Wallace H. Whitney, C.O., is Supervisor of the University of Kansas Medical Center Brace Shop, located at 39th and Rainbow, Kansas City, Kansas. He became affiliated with the brace shop in 1959, and for the past year he has been supervisor, succeeding Mr. Floyd Childs, C.O. who was supervisor of the brace shop for nine years.

Mr. Whitney started working in the shoe repar and leather goods trade in 1946, and began working in the Orthopedic field with the W. E. Isle Company, Kansas City, Missouri in 1952. He has been certified since 1959, after passing the test for Orthotist, given at St. Louis, Missouri in 1958.

Mr. Whitney with his wife and three boys live at Louisburg, Kansas, commuting daily to the Medical Center.

W. B. GRAY

RONALD DION

W. B. Gray, C.P., Manager of the Southern Limb and Brace Company of Mississippi, Inc., has been in the prosthetic field since 1947 when he became affiliated with the Montgomery Artificial Limb Company under Mr. Paul Smith. Since 1952 he has been associated with the Birmingham Artificial Limb Company, under Mr. Moody Smitherman, and the Snell facility in Memphis. He became manager of Southern Limb and Brace in 1960.

Mr. Gray successfully attended the suction socket school in 1957, the upper extremities course in 1959, and both the below knee and advanced above knee prosthetics courses in 1960. He was certified in 1959.

Ronald Dion is the new manager of Prostheses Orthopediques, Inc., an affiliate of the Winkley Company located at 186, Chemin Ste-Foy, in Quebec. This facility was previously the Laboratoire Auger, at the same address.

Mr. Robert C. Gruman writes that Mr. Dion has had about 9 years of experience in fitting and construction of both braces and artificial limbs. Before going to Quebec, Mr. Dion was in the Minneapolis office of the Winkley Company. At present he is furnishing limbs and braces to the Chicoutimi Clinic, the Quebec Clinic of Rehabilitation, and to private patients in the Quebec City area. He is a foward-looking shop manager, eager to adopt new methods and improvements in orthotics and prosthetics.

New Facilities Certified

By action of the Facilities Committee of the American Board for Certification, the following Facilities have been granted Certification since the publication of the *1962 Registry of Certified Prosthetic and Orthopedic Appliance Facilities.*

CONNECTICUT

Hartford:

STARKEY ARTIFICIAL LIMB CO., INC. — P
32-36 Elm Street — CHapel 7-6544
Wilfred J. Anair, President

ILLINOIS

Chicago:

DREHER-JOUETT, INC. — O
51 West Wacker Drive — RAndolph 6-7633
Loren D. Jouett, C.O.

LOUISIANA

New Orleans:

DELTA LIMB COMPANY — P
4332 St. Charles Ave. — 899-9441
A. J. Scruggs, C.P.

NEW MEXICO

Albuquerque:

NEW MEXICO ARTIFICIAL LIMB CO. — P&O
1027 San Mateo, S.E. — AMherst 8-5624
Kyle H. Parsley, C.O.

OKLAHOMA

Lawton:

LAWTON BRACE AND APPLIANCE CO., INC. — O
103 South 11th Street — ELgin 3-5525
Gerald G. Meyers, C.O.

PENNSYLVANIA

Pittsburgh:

ALBERT T. ROWLEY CO. — P
3602 Fifth Avenue — MAyflower 1-7292
William L. Vansant, C.P.

Scranton:

SCRANTON ARTIFICIAL LIMB CO., INC. — P&O
319 South Main Street — DIamond 4-5026
S. W. Conrad, Secretary-Treasurer

SOUTH CAROLINA

Greenville

GREENVILLE ORTHOPEDIC APPLIANCE COMPANY, INC. — P&O*
516 Arlington Avenue — CEdar 2-0871
William Dewey Friddle, Jr., C.P.O.

*Extension of Title to Include Prosthetics

A Report From the President of the American Board for Certification

Since the early nineteen thirties, there has been a growing awareness among physicians and surgeons of the value of standards in relation to formal training, knowledge of a field, and personal characteristics. It has, within these few years, reached the point that a specialist is *expected* to have passed his specialty board. Such a certification is necessary to establish his competence. It is no longer sufficient for a man to declare himself a specialist; he must be so declared by a competent group of his peers.

As we approach another of the annual examinations for Certification of Prosthetists and Orthotists it is well to look at the role of the Orthopaedic Surgeon in them and obtain his impressions.

In participating in the Certification Examination, the Orthopaedic Surgeon is not judging the applicant for excellence in the technical aspects of orthotics or prosthetics primarily. This can much better be determined through written and practical examinations planned by competent men in the field. He is, rather, judging the candidate as a paramedical specialist, in regard to his appearance, his approach to a group of strange professional men, and his ability to express himself and communicate satisfactorily with the group. To put it simply, the Orthopaedic Surgeon is judging whether the applicant is one with whom he could work and in whose care he would be glad to place his patients for orthotic or prosthetic service.

Ultimately, the Orthopaedic Surgeon is responsible for the handling of his patient, so he must be properly critical of the candidate as a person, as well as of his technical skill, in order to unhesitatingly be a party to certifying him as a representative in your field. The examining Orthopaedic Surgeons desire that the term "Certifee" shall refer only to a top man in the field of Orthotics or Prosthetics.

Roy M. Hoover, M.D., President

To The Ladies:

FROM AOPA'S AUXILIARY

Mrs. Lorraine Scheck
President

Mrs. Elinor Bohnenkamp
Vice President

Mrs. Esther Pava
Secretary-Treasurer

Mrs. Pearl Leavy
Past President

Dear Members:

The time is going by so fast that before we know it we will all be at the Ramada Inn talking to one another instead of writing.

I have received a number of pamphlets about Arizona from Mrs. Margaret Jachowski, the Chamber of Commerce, and the Ramada Inn. They have been a big help in trying to map out a program for the ladies.

Mrs. Frances Aunger is looking into a bus tour that was thoroughly enjoyed by my husband Bill while he was in Phoenix last March. This tour includes the business and residential district, Scottsdale Indian Reservation, the Mormon Temple, Pueblo Grande ruins, and the citrus groves. Mrs. Aunger is also getting information about the possibility of a shopping tour in Scottsdale, with lunch and a fashion show.

Mr. Seifert, manager of the Ramada Inn Hotels, states "you might like to advise the ladies as to the type of clothing to bring." October normally is a very pleasant month in Phoenix and while the days may be bright and warm, the evenings could be chilly. Ladies will need light wraps for evening, such as a sweater or stole. The swimming pool is open, and the ladies may wish to bring swimwear. Mrs. Jachowski says a lot of sport clothes are worn—such as skirts, blouses, shorts, slacks, and jeans. Naturally, for the banquet, your best party clothes!

There are numerous tours to take on your own. These include all sorts of scenic attractions, national and state parks, national monuments, and museums. Don't leave your camera at home!

By the time the next *Journal* comes out we should have more details on what our program will be. With our ladies in Phoenix cooperating so wonderfully, it should be a good one.

Sincerely,

Lorraine Scheck

BOOK REVIEWS

UPPER AND LOWER EXTREMITY PROSTHESES, by William A. Tosberg, C.P. and O. Published by Charles C. Thomas, Springfield, Illinois, 1962—98 pages illustrated. Price $5.75 (may be ordered through any book store). Reviewed by Lester A. Smith.

This new monograph is one of a series entitled, "American Lectures in Physical Medicine and Rehabilitation." It is an ideal introduction to the subject for the physician.

This book would also be of interest to the educated amputee and may be read with pleasure and profit by the skilled prosthetist. It is, of course, not meant to be a bench manual in any way.

It would have usefulness in the facility as a book to use in talking with the new amputee—illustrating to him some of the devices.

The author is an Instructor in Physical Medicine and Rehabilitation at New York University Medical Center, and in charge of their Orthotic and Prosthetic Department (which is a member of AOPA). Typographically, the book reflects the high standards of the publisher.

FUNCTIONAL FASHIONS by Helen Cookman and Muriel Zimmerman. New York, 1961. 80 pp. Reviewed by Susan Hastings, Medical Writer, Prosthetic - Orthotic Education, Northwestern University, Chicago, Ill.

Once out of the hospital gown stage the newly handicapped patient may experience a gnawing worry, "What will I be able to wear?"

In this colorful booklet Miss Cookman, a New York designer, and Miss Zimmerman, an occupational therapist, attempt to provide the answers to such problems as garment closings for persons with limited hand and arm motion, trouser closings for men confined to wheel chairs, blouses and shirts for crutch walkers, and several other annoying clothing worries.

Reactions from persons with varying degrees of disability here at the Rehabilitation Institute of Chicago indicate that while the advice is most helpful, the clothing leaves much to be desired. Attractive wearing apparel can do so much for the mental well-being of everyone. The handicapped individual is no exception.

As for the text the most helpful section is a two-page chart indicating disabilities, dressing problems, and solutions. This material was compiled from observations of patients during dressing practice. While the main text discusses these points in detail, this listing provides a quick reference list for all disabled persons.

The authors advise crutch walkers to wear blouses or shirts having extra material across the shoulders and reinforced arm holes. Side fastening trousers are suggested for men confined to wheel chairs. Other details too numerous to review are included.

There is a section devoted to an analysis of fabrics as far as comfort, durability and care are concerned. Another few pages discuss zippers and Velcro closings as well as some of the standard hook and bar fasteners. The appendix includes a "Sources of Supply" list which should be of great value.

Despite some drawbacks, the authors deserve much credit for their efforts to provide solutions to the irritating problems encountered in dressing by the physically handicapped patient. This is a highly useful publication.

In Memoriam

JOSEPH SPIEVAK

Joseph Spievak, C.P., former President of the Association of Limb Manufacturers, died March 7, 1962 in Akron, Ohio at the age of 69. Mr. Spievak served as the National President of the Association of Limb Manufacturers from October 1935 to 1937. He was a familiar and beloved figure at many national assemblies, and with his close friend Clyde Aunger, they were known as the "Gold Dust Twins," as they were inseparable at meetings.

Mr. Spievak was President of the Youngstown Artificial Limb Company, now known as the Youngstown-Limb Company, which is continuing its operation with William Kaiser, C. P. as Vice President, and Miss Miriam Jack, as Secretary.

Mr. Spievak is survived by his wife and a daughter, Mrs. Virginia Fell.

Max Field, C.P.O., died October 17, 1961, at the age of 63. Mr. Field began his training under the late Walter R. Sievers of Amsterdam Brothers in New York, and later joined the staff of the VA as an orthpedic technician.

Forrest Griggs, CPO, was accidentall drowned near Santa Cruz, California, on March 11 while on a fishing trip with fellow employees. Mr. Griggs had managed the Fresno facility of the C. H. Hittenberger Company and had also been employed in the San Francisco facility of the same company. Mr. Griggs was well described by company officials as "a valued employee who will be greatly missed by all who knew and worked with him."

I. P. BOGGS

I. P. Boggs, owner and manager of the I.P. Boggs Co. of Huntington, W. Va. from 1933 until his retirement in 1959, died April 19 at the age of 78. Mr. Boggs, a B/K amputee himself, had devoted 57 years to the prosthetic field—from 1902 to 1959. During World War I he worked for the Canadian Government.

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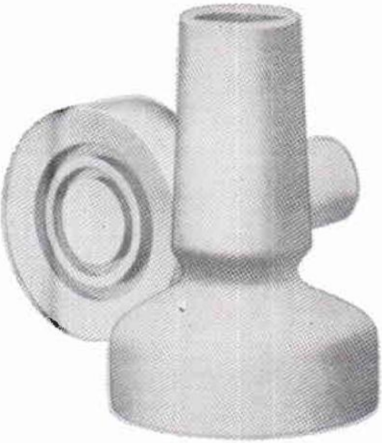

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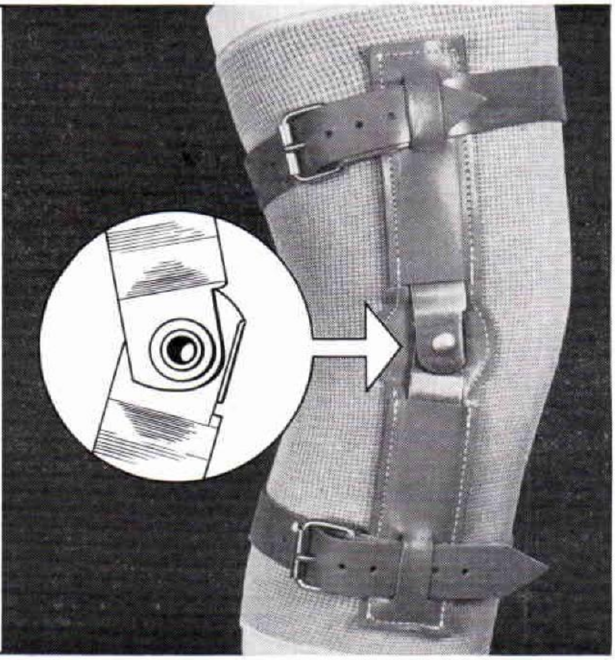

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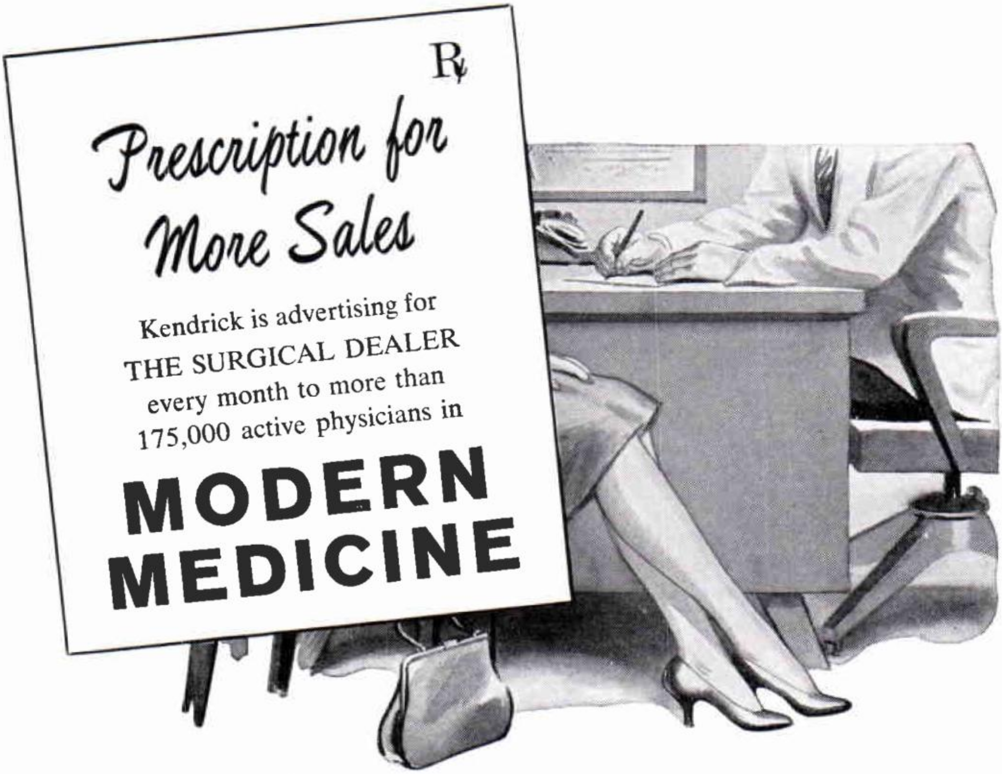
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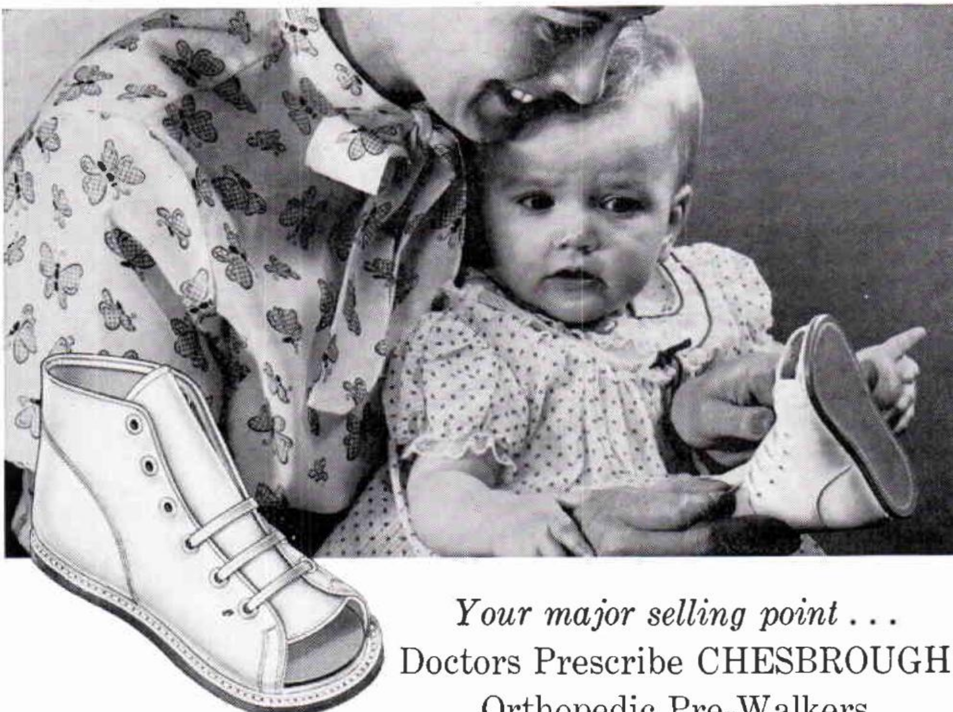
Kendrick is advertising for THE SURGICAL DEALER every month to more than 175,000 active physicians in
MODERN MEDICINE

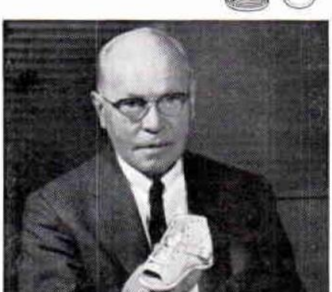


Your major selling point . . .
Doctors Prescribe CHESBROUGH Orthopedic Pre-Walkers

No. 1400 OPEN TOE
Straight-line symmetrical last, firm heel, no back seam. Adaptable to Denis Browne Splints.

No. 1300 CLOSED TOE
Lace-to-toe design permits snug, gentle fit. Perfectly smooth inside.

No. 1700 CLUBFOOT, OPEN TOE
Special outflare last, sturdy instep strap to stabilize heel.



Louis C. Weld, President of G. W. Chesbrough Co. . . . "My own personal experience led to the development of the new Chesbrough Shoe."

This is the reason Chesbrough Orthopedic Shoes have had such spectacular success in three short years. Orthopedic surgeons in 49 states and many foreign countries are now prescribing them. This large referral business continues to grow and we invite you to share in it.

Any parent whose child requires orthopedic correction will tell you the expense is great, as frequent purchase of new shoes is required.

This problem was brought home to Chesbrough's president, Louis C. Weld, a few years ago, when a child in his own family needed such a shoe. Recognizing the need for orthopedic shoes at an economical price, Chesbrough put their 63 years of shoemaking experience to work and Chesbrough Corrective Pre-Walker Shoes were born.

Here is a shoe of highest-quality workmanship and fine leathers, made to sell at a moderate price.

All shoes in unlined white elk, sizes 000 to 4, narrow and wide. Available in full pairs, split pairs or single shoes (no extra charge for half pairs).

MAIL COUPON FOR SAMPLES

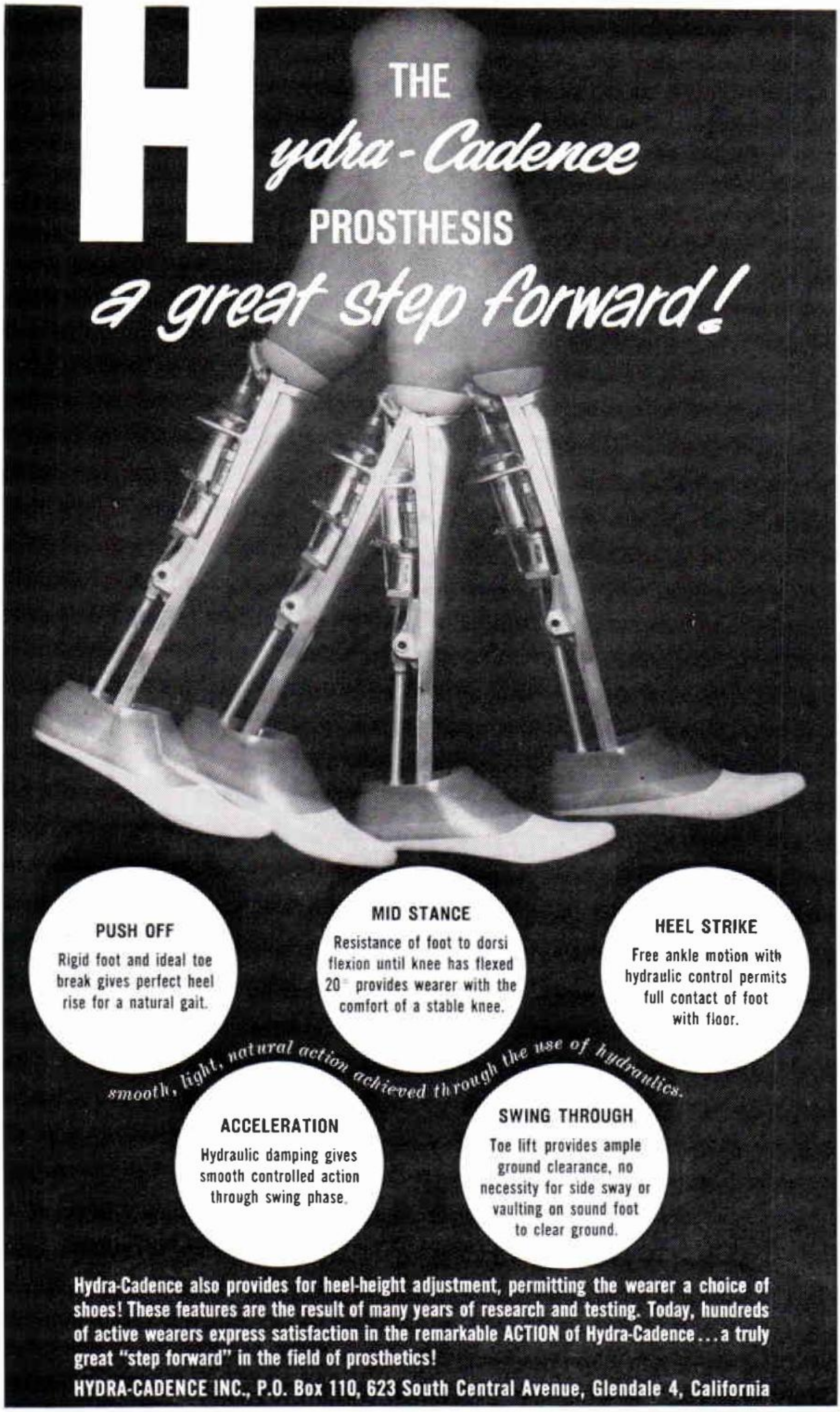
G. W. CHESBROUGH CO.

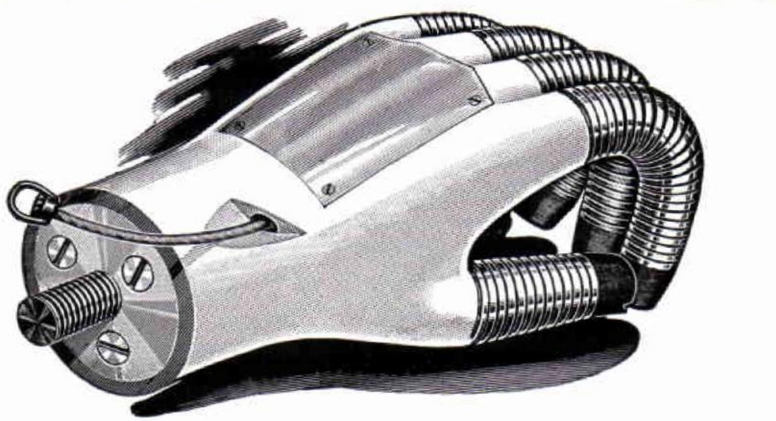
797W. Smith Street, Rochester 6, N. Y.

NAME ____________________

ADDRESS ____________________

CITY ____________________ STATE ____________________


THE
Hydra-Cadence
PROSTHESIS
a great step forward!
PUSH OFF
Rigid foot and ideal toe break gives perfect heel rise for a natural gait.
MID STANCE
Resistance of foot to dorsi flexion until knee has flexed 20° provides wearer with the comfort of a stable knee.
HEEL STRIKE
Free ankle motion with hydraulic control permits full contact of foot with floor.
smooth, light, natural action achieved through the use of hydraulics.
ACCELERATION
Hydraulic damping gives smooth controlled action through swing phase.
SWING THROUGH
Toe lift provides ample ground clearance, no necessity for side sway or vaulting on sound foot to clear ground.
Hydra-Cadence also provides for heel-height adjustment, permitting the wearer a choice of shoes! These features are the result of many years of research and testing. Today, hundreds of active wearers express satisfaction in the remarkable ACTION of Hydra-Cadence ... a truly great "step forward" in the field of prosthetics!
HYDRA-CADENCE INC., P.O. Box 110, 623 South Central Avenue, Glendale 4, California



ADVERTISING DATA FOR AOPA PUBLICATIONS

Orthopedic and Prosthetic Appliance Journal

A Quarterly Publication
Which Includes in Its Mailing List Many
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As Well as Members of the Limb and Brace Profession
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THE AMERICAN ORTHOTICS AND PROSTHETICS ASSOCIATION

(Formerly the Orthopedic Appliance and Limb Mfrs. Assn.)

919 18th Street, Washington 6, D. C.—EXecutive 3-0385

SURVEY OF SERVICES AVAILABLE TO THE ORTHOPEDICALLY DISABLED—RD 430

Conducted by the American Orthotics and Prosthetics Association under a grant from the U. S. Office of Vocational Rehabilitation.

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