MARCH, 1966

ORTHOPEDIC & PROSTHETIC APPLIANCE JOURNAL

The Journal of the Limb and Brace Profession

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Directors of the Association

See Story on Page 57

publisher: American Orthotics and Prosthetics Association

OFFICIAL NOTICE

The 1966 National Assembly of the American Orthotics and Prosthetics Association will be held October 16-20, 1966

PALM SPRINGS, CALIFORNIA

Reconvened Session

OCTOBER 21-28

HONOLULU, HAWAII

(AOPA Technical Mission)

FOR PROGRAM DETAILS AND REGISTRATION INFORMATION

write The American Orthotics and Prosthetics Association
919 - 18th Street, N.W., Washington, D. C. 20006

The Assembly is open to all who are interested in the rehabilitation of the orthopedically disabled

Orthopedic and Prosthetic

Appliance Journal

(Title registered U. S. Patent Office)

VOLUME 20 MARCH, 1966 NUMBER 1

Second class postage paid at Washington, D. C., U.S.A.

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The *Orthopedic and Prosthetic Appliance Journal* is issued in March, June, September and December. Subscription price payable in advance is five dollars a year in the Western Hemisphere, 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. All correspondence should be addressed to: Editor: *Orthopedic and Prosthetic Appliance Journal*, 919 18th St,. N.W,. Washington, D. C. 20006. Telephone, Area Code 202, 296-4160.

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

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INDEX TO ADVERTISEMENTS
MARCH, 1966

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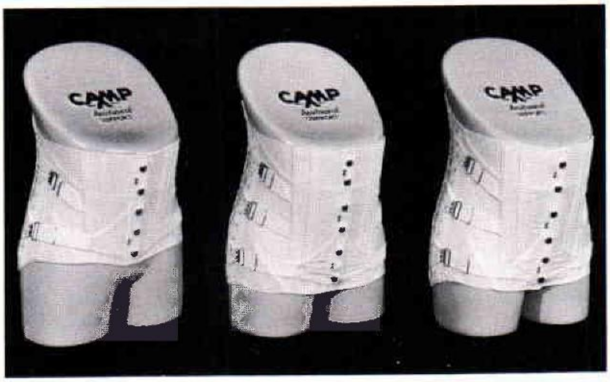

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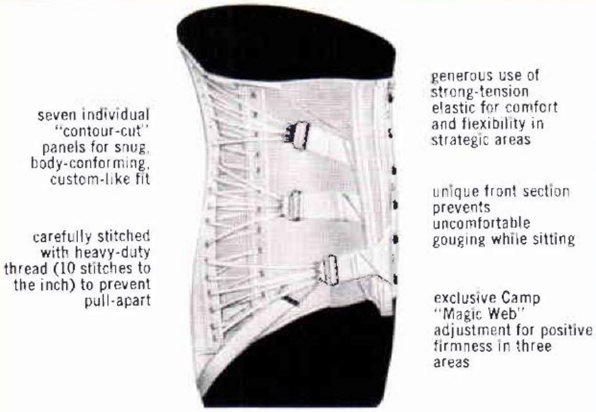

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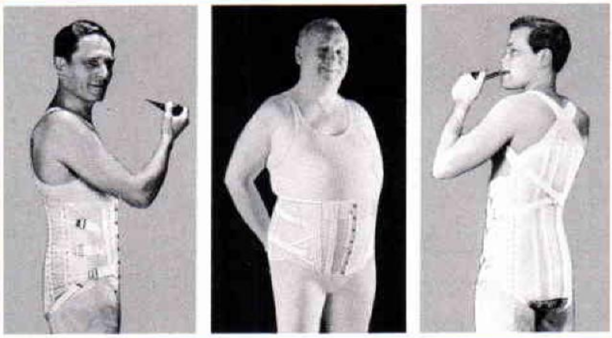

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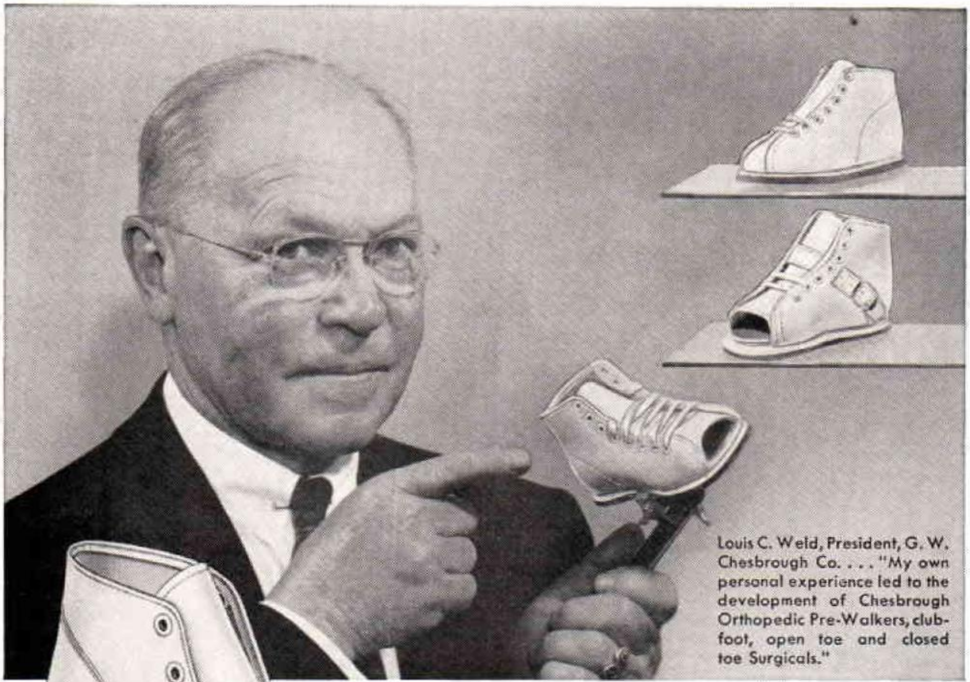

Louis C. Weld, President, G. W. Chesbrough Co. . . . "My own personal experience led to the development of Chesbrough Orthopedic Pre-Walkers, clubfoot, open toe and closed toe Surgicals."

"Chesbrough Pre-Walkers mean NEW business for you"

"Here are orthopedic shoes parents can afford. Orthopedic surgeons in 50 states and many foreign countries are now prescribing them. Spectacular sales figures prove it. This important referral business can be yours.

"When a child in my own family needed a corrective shoe, I discovered what a strain it can mean to a family budget, because 1) corrective footwear is expensive and 2) frequent purchase of new corrective shoes is required. Then and there I decided there was a real need for a moderately priced corrective shoe—a shoe parents could afford. That's why and when Chesbrough Orthopedic Pre-Walkers were born.

"Our 68 years of shoe-making experience resulted in corrective Pre-Walkers of scientific design, expert workmanship, fine leathers combined with orthopedically correct lasts to provide necessary correction at an economical 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).

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

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

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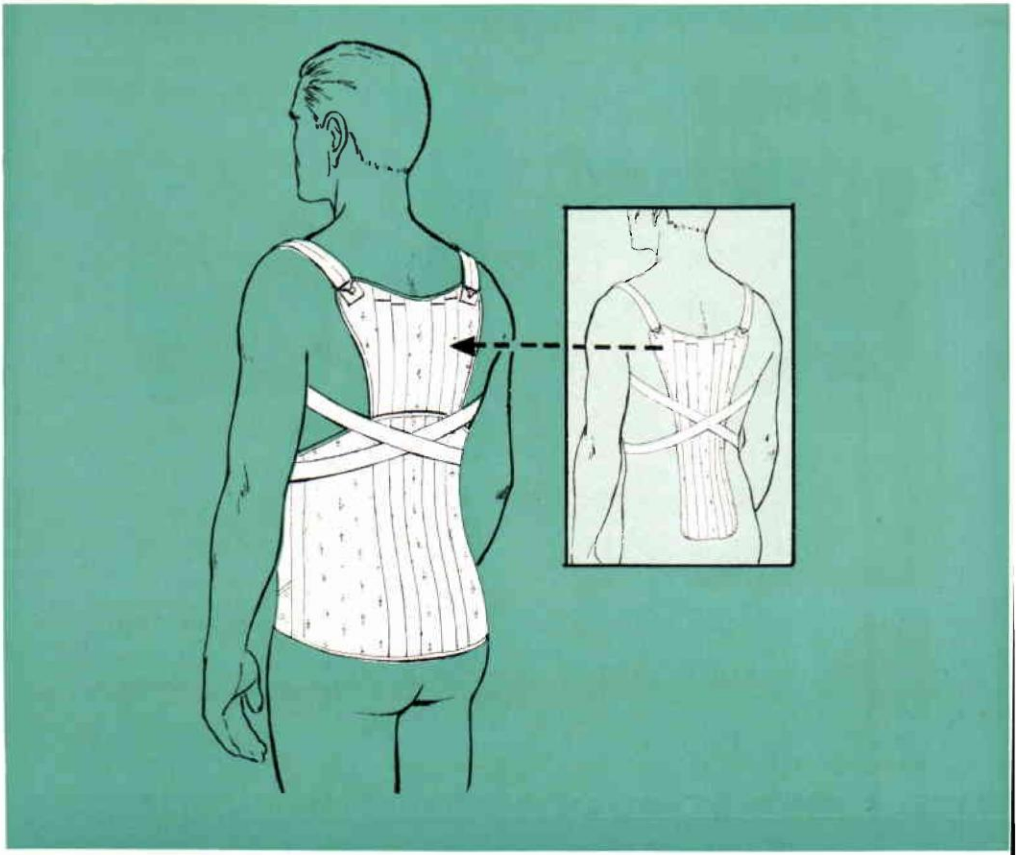
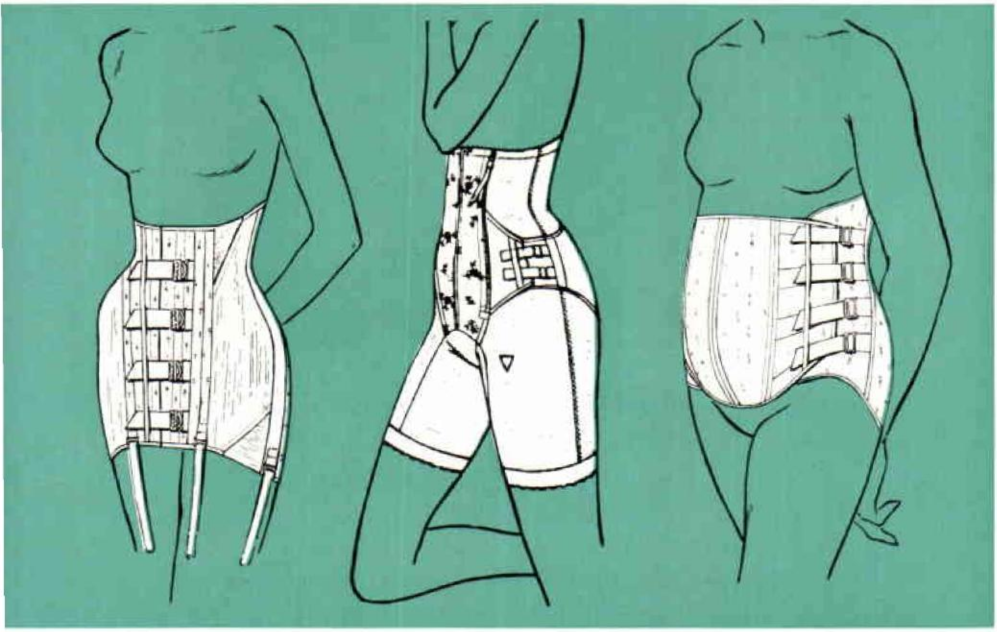
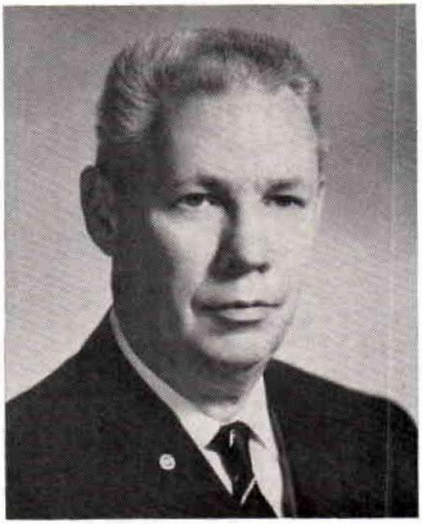




The National Orthotics and Prosthetics Assembly, 1966

AN INVITATION TO READERS OF THE JOURNAL

By PROGRAM CHAIRMAN LEROY NOBLE, C.O.



The National Orthotics and Prosthetics Assembly in 1966 will convene first at the Riviera Holiday Inn in Palm Springs, California, October 16. Following four days of technical papers and functions, it will adjourn to reconvene in Honolulu, for a discussion of rehabilitation problems with physicians and rehabilitation counsellors and a session on management problems in orthotics and prosthetics.

The Assembly is open to all who are interested in the rehabilitation of the orthopedically handicapped and I welcome this opportunity, therefore, to tell the readers of the *Journal* something about the plans which are being made for the 1966 sessions.

The Assembly is sponsored by the American Orthotics and Prosthetics Association and the annual business meeting of the Association is held in conjunction with the Assembly sessions. The Assembly, however, is attended by many physicians, therapists, government officials, and counsellors. Indeed, its registration represents a broad group of persons concerned with the provision of orthopedic and prosthetic appliance care.

A special invitation to attend is extended by AOPA President Fred J. Eschen, to orthopaedic surgeons, physiatrists, and other physicians interested in this field. Several related educational and research groups will hold their meetings in conjunction with the Assembly, including the University Council on Prosthetic-Orthotic education (UCOPE). Region IX of AOPA will be the host for this Assembly session and its members, representing Southern California and the State of Arizona, are welcoming the opportunity to meet their colleagues from the East. Not since 1951 has the Assembly been held in California and there have been great and important developments since then.

Medicare, with all of its tremendous implications for this field, will be prominently featured in the program. By then there will have been some significant experience with the administering of this program. Details of this and other presentations will be given in the preliminary program. Copies of this and the hotel registration forms may be obtained by writing to: The American Orthotics and Prosthetics Association, 919 18th Street, N.W., Washington, D. C. 20006.

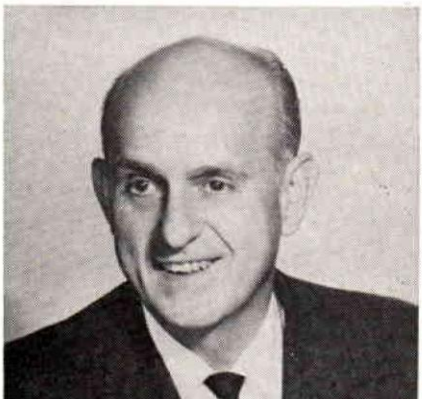
A brief outline of the arrangements is given here. however, for the convenience of the readers who must plan their official and professional travel in advance: *Preliminary Session.* There will be an opportunity on Friday, October 14, for visitors from other states and countries to visit several AOPA member facilities in Southern California. Tours are being planned at Rancho Los Amigos, Cerritos College, and the University of California Prosthetic-Orthotic Training Program. The Child Amputee Prosthetic Project of the University under the direction of Dr. Milo Brooks will also be visited. There will be an opportunity for visitors' families to enpoy Disneyland and other attractions.

Early arrivals at Palm Springs, California will have an opportunity to register for the AOPA Golf Tournament and to compete for the Kingsley Trophy.

The Formal Opening of the Assembly under the gavel of AOPA President Fred J. Eschen will be held Sunday morning, October 16. The technical supply and educational exhibits being arranged by Exhibits Co-Chairmen Kenneth Dodd and Cletus Iler will open that morning and will be available for inspection through October 19. Dr. Robert G. Thompson of Chicago, Illinois will address the Annual Meeting of the American Board for Certification in Orthotics and Prosthetics on Monday, October 17. Dr. Thompson is a member of the faculty of the Northwestern University Medical School Prosthetic-Orthotic Education program. He is one of the three members of the American Board for Certification serving by nomination of the American Academy of Orthopaedic Surgeons.

The Hawaiian Sessions. For the sessions in Honolulu and on the Islands of Maui, Kaanapali and Kauai, the following Committee on Arrangements has been appointed: Co-Chairmen, George N. Newton, C.P.O. of Honolulu and J. Morgan Greene, of Glendale, California; James A. Hennessy of Los Angeles, and David Tope of Glendale, California.

They will plan a technical program with the assistance as consultant of Dr. Ivor Larsen of Honolulu. Physicians, Rehabilitation counsellors and Veterans Administration Personnel of Hawaii have been invited to these sessions.



KENNETH DODD

CLETUS ILER

Clinical Application of the Plantaflexed Talus Shoe

PRELIMINARY REPORT

By TOM OUTLAND, M.D.; G. R. McKEEVER, M.D.; ALFONS GLAUBITZ, C.P.O.

State Hospital for Crippled Children, Elizabethtown, Pennsylvania

Pronated feet are probably the most common deformities faced by the the orthopedic surgeon managing growing children. The mild ones, fortunately, respond within a few years to a firm shoe with wedges and pads. Many would probably respond spontaneously. However, the severe pronation deformities are all too often unchanged in spite of several years

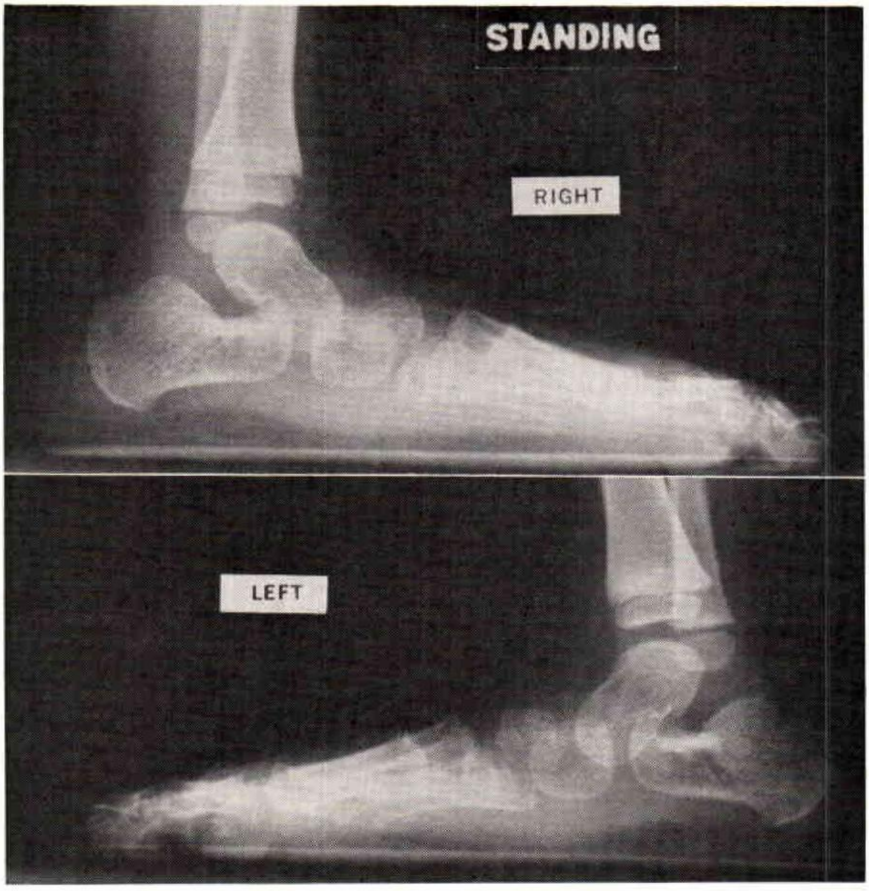


FIGURE 1—This 3-year-old boy demonstrates a bilateral flatfoot deformity. On weight-bearing, note the plantarflexed position of the talus in relation to the tarsal configuration allowing dorsiflexion of the forefoot and relative equinus of the calcaneus.

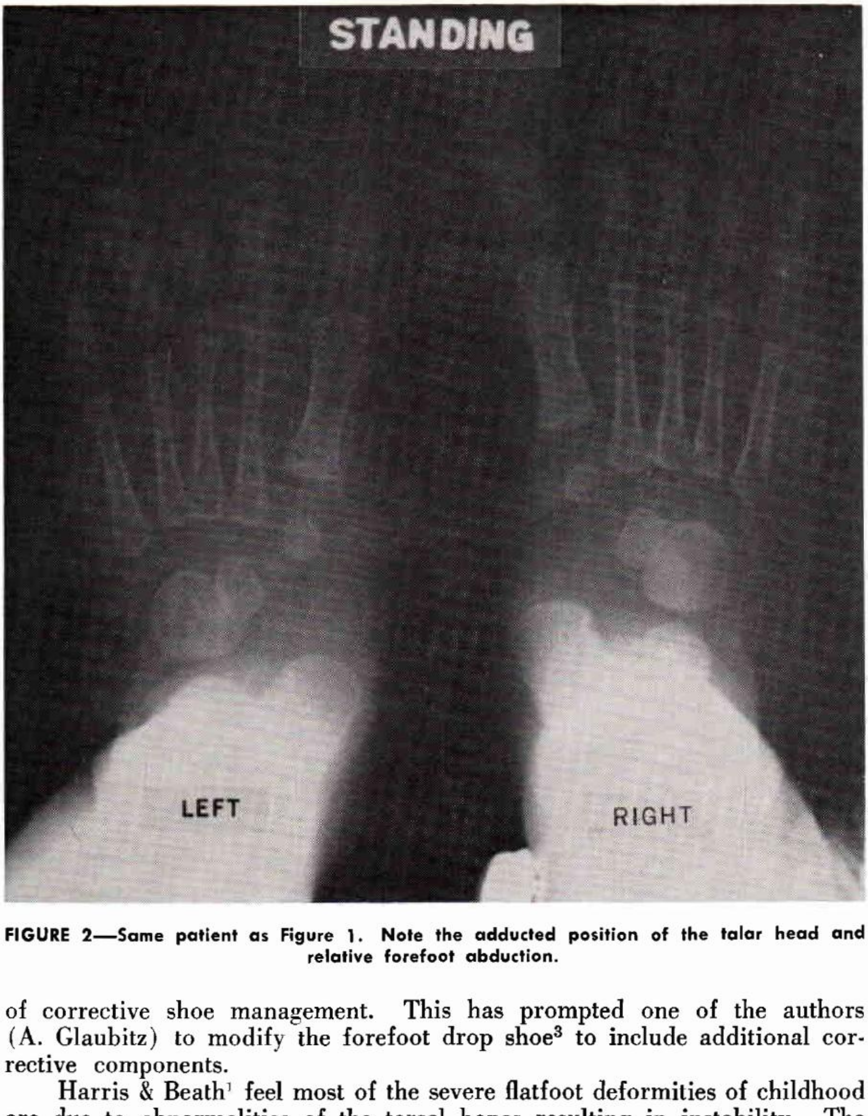


FIGURE 2—Same patient as Figure 1. Note the adducted position of the talar head and relative forefoot abduction.

of corrective shoe management. This has prompted one of the authors (A. Glaubitz) to modify the forefoot drop shoe[3] to include additional corrective components.

Harris & Beath[1] feel most of the severe flatfoot deformities of childhood are due to abnormalities of the tarsal bones resulting in instability. The primary finding was inadequate support of the talus by the calcaneus. With weight-bearing, the head of the talus assumes a plantarflexed (Fig. 1) and slight varus position (Fig. 2). The forefoot assumes a position of valgus and dorsiflexion in relation to the talus when flat on the ground. This results in mild equinus of the calcaneus. If this condition is uncorrected the heel cord becomes shortened, further increasing the deformity.

The plantarflexed talus shoe (Fig. 3) is designed to correct and maintain this type of foot until sufficient internal stability is present or until the child has obtained sufficient age to consider corrective surgery.

The plantarflexed talus shoe is a shoe with three corrective components. (1) A reverse calcaneal heel to bring the hindfoot out of equinus; (2) forefoot drop to bring the forefoot down to meet the hindfoot and (3) slight forefoot adduction to bring the forefoot under the talar head. These modifications of the "neutral last" result in the establishment of a well-molded longitudinal arch to support the talar head.

The amount of forefoot equinus designed in a shoe will depend on the height of the anterior portion of the reverse calcaneal heel. A suggested practice is to dorsiflex the hindfoot firmly with one hand, then plantarflex the forefoot with the other hand. The height of the reverse calcaneal heel can then be determined. The heel should reach well under the talonavicular joint. The height of the posterior aspect of the heel is about one-half the height of the anterior aspect of the heel. To maintain the proper relationship between the forefoot equinus and the reverse calcaneal heel, a long steel shank is essential. The amount of correction which one may employ

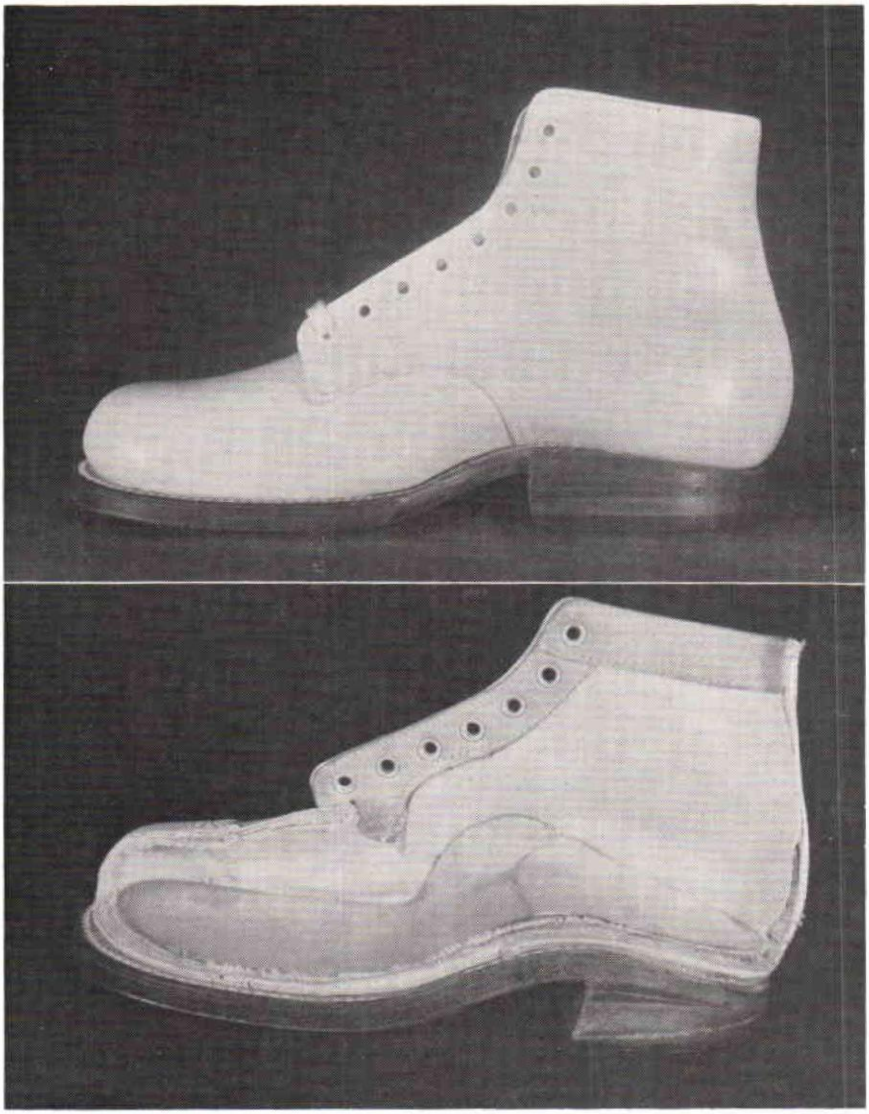


FIGURE 3—Medial view of plantarflexed talus shoe inside and outside. Note midtarsal angulation produced by reverse calcaneal heel and forefoot equinus.

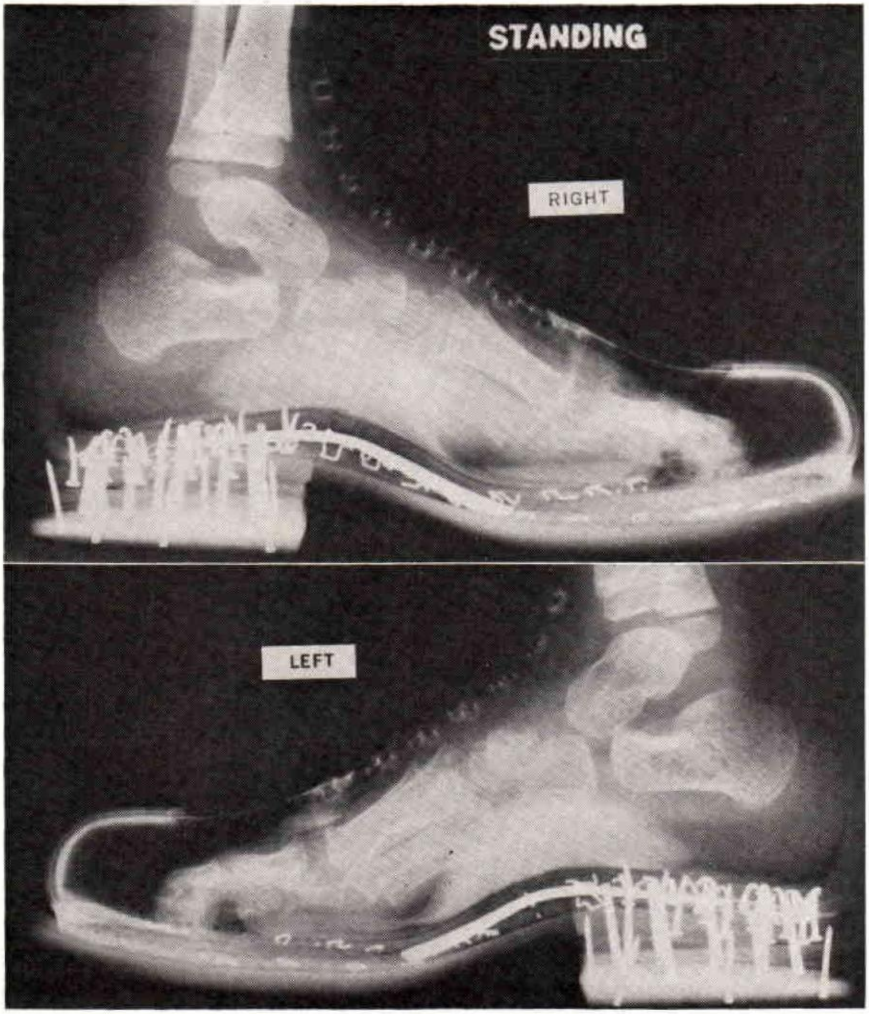


FIGURE 4—Shows same patient as Figure 1 & 2. Note improvement in the position of the talus with weight-bearing in the plantarflexed talus shoe.

depends on the severity of the flatfoot. In a mobile flatfoot in which the tight heel cord can be clinically stretched without great effort, significant correction may be employed initially. In the more rigid case, a nominal amount of forefoot equinus with the accordingly lower reverse calcaneal heel should be used. As the patient's condition improves, increase in the height of the reverse calcaneal heel and greater forefoot equinus should be considered.

We have used this shoe at the State Hospital for Crippled Children in Elizabethtown, Pennsylvania, over the past year with satisfying results. Figure four shows the same patient as Figure one. Improvement in the relationship of the talus to the tarsal bones is evident.

We feel the plantarflexed talus shoe will be a definite adjunct in the treatment of the mobile flatfoot. We do not feel it to be of any benefit in the treatment of a rigid flatfoot or a true congenital vertical talus.[2, 4].

SUMMARY AND CONCLUSIONS

The plantarflexed talus shoe is designed to dorsiflex the hindfoot and plantarflex and adduct the forefoot at the talo-navicular joint. Although no final conclusion can be drawn from this preliminary report, we feel the basic principles involved are sound and we have been satisfied with our early results. It is our hope that others will be interested enough to give this shoe a fair trial in their practices.

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3. Outland, T., Flynn, J. C. & Glaubitz, A. R.: The Forefoot Drop Shoe and its Clinical Application; *Orthopedic and Prosthetic Appliance Journal*, March, 1958, pages 21-26.
4. Outland, T., Sherk, H. H.: Congenital Vertical Talus; *Clinical Orthopedics*, 16: 214, 1960.

VRA to Work with Disabled Public Offenders

A new nationwide program to rehabilitate disabled public offenders to self-supporting jobs has been announced by Miss Mary E. Switzer, Commissioner of Vocational Rehabilitation in the U. S. Department of Health, Education, and Welfare.

This is the first attempt on a national scale to blend vocational rehabilitation services with Federal prison, probation, and parole programs designed to rehabilitate persons convicted of crime.

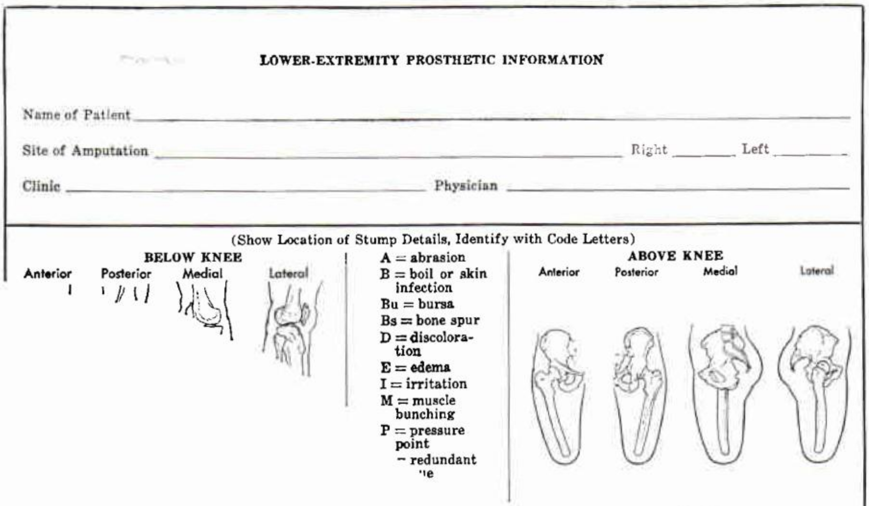
The program will be a cooperative effort of the Vocational Rehabilitation Administration, and three Federal correctional agencies—U. S. Bureau of Prisons, U. S. Probation Service, and U. S. Board of Parole—along with their counterpart organizations in the States. The VRA administers the Federal-State vocational rehabilitation program to prepare disabled persons for suitable employment. This agency also conducts a research and demonstration grant program to find new and better ways of rehabilitating physically or mentally handicapped people.

The program for public offenders, which began this month and will be financed by VRA research and demonstration grants, will consist of eight demonstrations in selected cities throughout the United States. These projects will involve intensive counseling, as well as medical, psychological, training and job placement services.

"For the probationer, parolee, or released prisoner, one of the first requisites for avoiding further crime is a job," Miss Switzer said. "Too often the community fails to give tangible assistance that will reinforce the offender's resolve to 'go straight.' In these projects, the time-tested methods and services of vocational rehabilitation will be used to meet the offender's need for help in resuming responsible, productive lives in his community."

The program will be administered through a "master" project in Seattle, Washington. There will be seven "satellite" projects in Atlanta, Georgia; Denver, Colorado; Springfield, Illinois; San Antonio, Texas; Raleigh, North Carolina; Chicago and Pittsburgh. In each instance, the State vocational rehabilitation agency will receive funds from the Vocational Rehabilitation Administration to conduct the program in conjunction with local Federal probation offices and Federal correctional institutions.

Facility Forms Available for Members


LOWER-EXTREMITY PROSTHETIC INFORMATION

Name of Patient ____________

Site of Amputation ____________ Right ______ Left ______

Clinic ____________ Physician ____________

(Show Location of Stump Details, Identify with Code Letters)

BELOW KNEE

Anterior Posterior Medial Lateral

A = abrasion
B = boil or skin infection
Bu = bursa
Bs = bone spur
D = discoloration
E = edema
I = irritation
M = muscle bunching
P = pressure point
– redundant ...e

ABOVE KNEE

Anterior Posterior Medial Lateral

...ength: ______ inches

...HARACTERISTICS

Average	Hard

Efficient shop operations will be made easier for members of the American Orthotics and Prosthetics Association through the use of four new forms now available through Association headquarters.

These forms were developed by the AOPA Conference of Prosthetists, in cooperation with the Committee on Prosthetic-Orthotic Education of the National Research Council, which underwrote the costs. Carlton Fillauer, of Chattanooga, Tennessee, Chairman of the Conference, reports that after extensive testing in member shops throughout the country, it was decided to also make the forms available for sale. A sample set of the four forms is available at 15¢.

A brief description of each of the four forms follows:

Form A—Medical History

Necessary information on each patient is recorded here, and includes such items as medical complications, amputation history, and source of patient.

Form B—L/E Prosthetic Information

Here space is provided for recording details of the prescription. Line drawings of both the above and below-knee stump provide space to record additional information.

Form C—U/E Prosthetic Information

These forms are similar to those for L/E Prosthetic information, and include line drawings of the above and below-elbow stump. Forms A, B, and C are on card stock, strong enough to stand up under shop usage.

Form D—Progress Record

These are on offset paper and can be used in a typewriter. The patient's name, type of prosthesis, and stump sock size are recorded here. There is ample additional space to record facility visits, services performed, and charges made.

The Syme Prosthesis

By J.M. McFARLEN, C.P.
Dallas, Texas

Several techniques have been used to fabricate the socket for a Syme prosthesis. To date, all use some type of wall opening sufficiently large to receive the bulbous-end stump. These methods result in problems of maintaining structural strength, straps, or laces, and comfort.

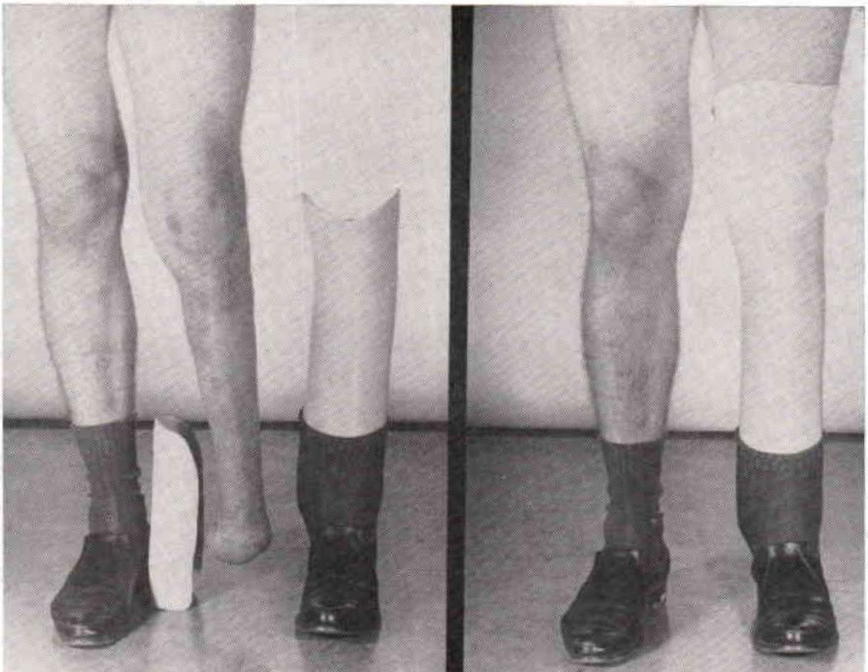
In our shop we have been using an insert to effect a cylindrical stump with a slightly bulbous end so that donning and suspension are obtained without opening the wall.

I offer here two extremely bulbous end stump cases.

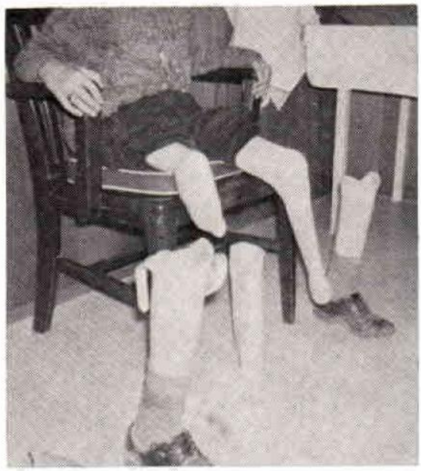
CASE #1

Trauma case amputation in 1952 at age 26, weight 200 lbs., 5′ 11″. Wore lace leather socket, steel frame ankle joint, and wood foot until 1963. Needless to say, excessive repairs were necessary to maintain these prostheses with replacement every three years.

The above prosthesis was fabricated in May of 1963. It is being used at this time. The only repair in the 2½ years was in May of 1965 when we re-soled the S.A.C.H. foot.



CASE NO. #1

CASE #2

Eleven year old boy, Spina Bifida, tumor removed at age 4, right below knee amputation at age 7, left Syme at age 9. The prosthesis used up to the time we furnished the above prosthesis was a medial opening plastic socket under 2 years old. Several repairs had been made to maintain the structure at the base opening. The bulbous area was thick and heavy and still weak.

The prosthesis pictured above will be two years old in February 1966. The right P.T.B. was replaced last March. The only repair to the Syme prosthesis was to restore the toe of the foot which had been trimmed by the boy to go into a shoe which was too small for the foot. I believe his father provided the necessary punishment for the deed.

We suggest making the insert in the following manner:

1. Modify the cast as you usually do.

2. Measure the girth of bulbous end and locate the level on the shaft of the cast where the bulbous end will pass. This is the proximal level of the insert.

3. Fill the shaft between this point and the ball with the insert enough to leave the end slightly bulbous—about 3/16" to 3/8" more depending on the tissue's condition and ability to pass through a smaller size. Study the contour and determine the size and area for the insert so that with the insert on the cast the appearance is cylindrical.

4. Lay a piece of good orthopedic horsehide on the cast and over the area of the insert smooth side to the cast, securing it in place by hand stitching in a place where it will be cut away.

5. Using T-161 or similar glue, lay on the first 1/8" neoprene crepe layer. This piece should be the full size of the insert. Add additional layers one at a time until sufficient material is applied to fill out as desired.

6. Trim off the excess crepe and sand smooth, leaving room for an exterior cover of horsehide. The inside and outside cover of horsehide should extend about 3/16" beyond the crepe and be skived and glued so that the edge of the insert is very thin.

8. Waterproof the leather with cellulose acetate, "Filkote," or something similar.

8. Stabalize insert on the stump model with cast sock and/or stump sock, building up the size according to fitting requirements. Our experience has led us to use two 3-ply socks, fitting one next to the stump and one to hold the insert in position on the stump. Now apply the P.V.A. bag.

9. Fabricate the plastic socket according to individual requirements. Beef up the distal area of the socket with some glass cloth where the foot attaches.

10. Attach foot in the manner your are accustomed to using.

If cases like these can utilize this type of fitting, then it should be considered for all Syme amputations.

Association Develops Plans for Medicare Programs

The eleven Regional Meetings of the American Orthotics and Prosthetics Association, to be held in the Spring and Summer of 1966, will feature a program on Medicare and the Geriatric Patient.

Chairman D. A. McKeever, of the Association's Intra-Agency Committee, brought together a planning panel for the programs at Miami in December, 1965. While there, the participants also attended the Geriatric Amputee Seminar conducted by the University of Miami School of Medicine.

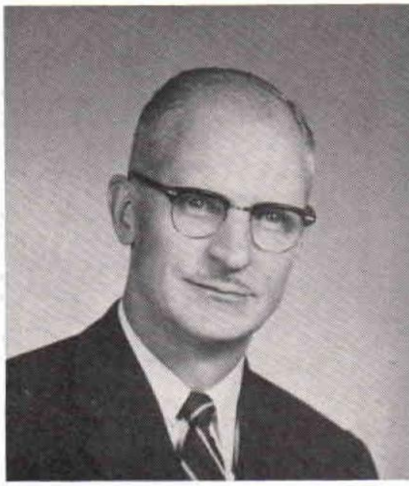
The program was developed in consultation with an outstanding group of orthopaedic surgeons, whose participation was made possible by the Committee on Prosthetic-Orthotic Education of the National Research Council.

The panel has recommended that a half-day at each Regional Meeting be devoted to a program planned around the following four areas:

1. Providing Orthotic and Prosthetic Service under Medicare.
2. Criteria for Patient Selection.
3. Appliances for the Geriatric Patient.
4. Fitting of Geriatric Patients.

S. H. CAMP & CO. ELECTS NEW OFFICERS

S. H. Camp & Co. President
CHARLES E. YESALIS



FORREST I. YEAKEY

Charles E. Yesalis was elected President of S. H. Camp & Company at the firm's annual meeting in February. The Camp Company, manufacturers of surgical supports and braces in Jackson, Michigan, is a Supply Member of the American Orthotics and Prosthetics Association.

Mr. Yesalis started as a Field Representative in a midwest territory for the Camp Company in 1947, and later was in charge of the Chicago office of Camp in the Merchandise Mart.

Previous to joining the Camp organization he had been department manager for the Fair, in Chicago, and had spent four years in the Army Medical Administrative Corps with the rank of Captain.

Mr. Yesalis was promoted to Sales Manager in February 1951. He was elected a Director in 1955, and Vice President in charge of sales in 1957. He was elected Executive Vice President early last year.

Forrest I. Yeakey, immediate Past President, was elected Chairman of the Board and Chief Executive Officer. Officers re-elected were Leslie T. Danby, Vice President and Treasurer; and Richard B. Firestone, Secretary.

Mr. Yesalis was Program Chairman for the AOPA Technical Mission to Europe in 1963. In this capacity he planned visits to European hospitals and facilities for 40 members of the Association. A report on the mission was later presented for the entire membership at the 1963 Assembly in New Orleans.

Birth Defect Bracing

By ROBERT E. FANNIN, C.O.
Columbus, Ohio

EDITOR'S NOTE: The following article was presented at the National Assembly of the American Orthotics and Prosthetics Association in Colorado Springs, Colorado, September 2, 1965.

In birth defect bracing, as in many other types of bracing such as polio, cerebral palsy, trauma, etc., the same problems plus a few new twists arise. The attempt here is not to give you a word to be followed explicitly, but to try to pass on a few problems that we have solved and a few still to be solved.

The problems are as mentioned in the article written by Dr. Robert Larrick in the December 1966 *Orthopedic and Prosthetic Appliance Journal,* pp. 294-297, peculiar and many. We are dealing with the combination of motor, trophic, sensory and mechanical aspects as well as a normal proportionate body, a normal mentality, and normal upper extremities. The first four factors gave us problems such as scoliosis, club feet, and hip dislocation. Rigidity and contractions are frequent and still give us some problems mainly because of the sensory problem of no feeling.

Let us take some of the problems, starting with the feet and working up the body framework.

In Figure 1 we have a typical club foot condition. This patient, however, is very flail with no rigidity at all. Figure 2 has rigidity in the left foot and plantar flexion tightness in the right foot. The patient in Figure 3 is quite flail in the right foot but has a dorsiflexion tightness in the left. To control the foot one must control the heel. The best way we have accomplished this is with over-instep strapping with heel and tongue padding. The shoe we have found best for this is the open-toe lace-to-toe shoe. However, most of our patients are from three months old to one year old when measured. In older children there may be a better shoe. The open-toe shoe also is good because it can be bought in a straight, pronator and regular lasts. The over-instep strap helps to lock the heel down in the shoe in as correct a position as possible. The padding merely helps to relieve any pressure sores that may develop.

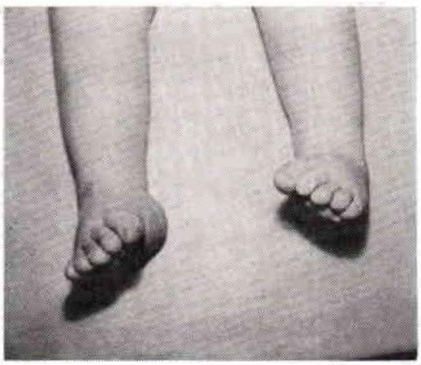


FIG. 1

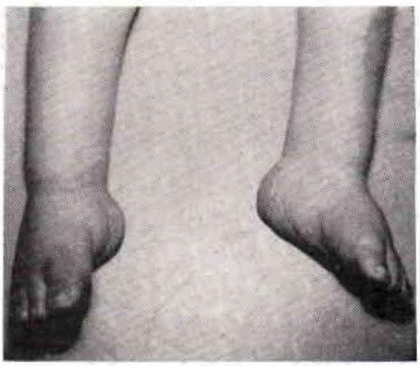


FIG. 2

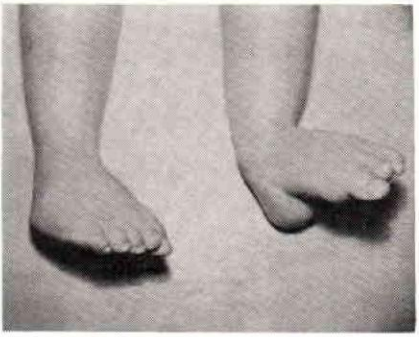


FIG. 3

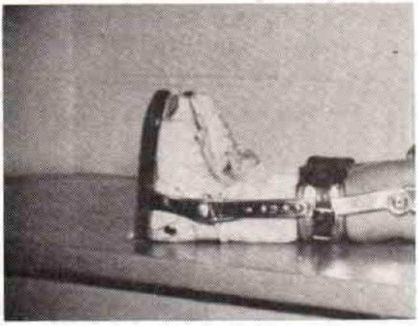


FIG. 4

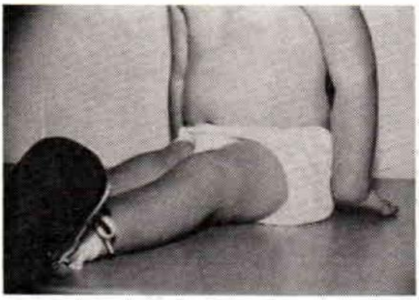


FIG. 5

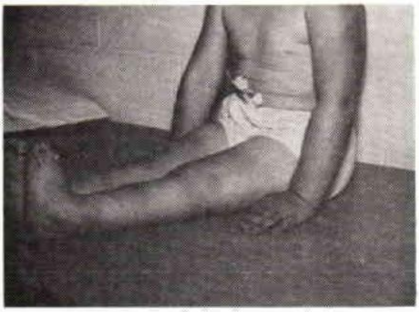


FIG. 6

The shoe attachments are always a problem. We have tried solid stirrups, split stirrups, and round caliper. The only thing we have noticed is that if no ankle motion is wanted, and the patient is very, very small, a solid stirrup works well. However, if you see that this patient is going to be ambulatory quickly, a round caliper with anterior and posterior stops is more feasible because of shoe wear and replacement. If only plantar flexion or dorsi-flexion stops are needed and the patient is growing to good size, a solid stirrup or split stirrup places the true ankle motion where it should be and the patient seems to walk better. (One word of advice: Keep shoe attachments as light in weight as possible.)

In covering a stirrup or socket we have found that a full sole of neoprene or leather, depending on which one the patient walks better with, is better than trying to put on a heel and make the shoe tread flat. (See Figure 4.)

Any control straps needed can be used, but we find if the heel is controlled and the braces are aligned correctly, very few control straps, T-straps, etc., are needed.

As we brace on up the leg we run into all sorts of problems with the knees.

In Figure 5 we have a patient with free working knee joints but very flail legs. In Figure 6 is a patient with very straight knees sitting, but practically no flexion at all. At the same time, however, this same patient has extreme recurvatum and genu-valgum weakness as seen in Figure 7. The patient in Figure 8 has fairly good flexion but contractures keep the knees from extending. This patient is flail with practically no muscle power at all.

With correct alignment and fitting of braces plus some control straps at the knees, these deformities can be controlled or corrected.

If the patient is small and very young (three months to 1 year) keep braces light and very small in proportion. No knee joints are necessary sometimes in the first set of braces, because all we are trying to do is get the patient in an upright standing position. This inflates their desire to walk and also increases growth and circulation factors. It also makes all body functions start working properly such as respiration, bowels, kidneys, etc.

This brings us to the hip region in our bracing. Of the cases we have seen almost all have needed hip locks to stand upright. This is mainly because although most of them have some hip flexors, none has little or any trace of hip extensors. This seems to be characteristic in the meningomyelocele patients. In Figures 9, 10, and 11 are shown three patients with damages at approximately the same level of the spinal cord. In Figure 9 the patient has very little hip flexors and no extensors. In Figure 10 a little more hip flexor strength but still no extensors. In Figure 11 a very strong set of hip flexors and knee extensors, but no hip extensors or knee flexors. The difference in these three patients' hips is just one of the many challenges there are in birth defect bracing.

The missing hip extensors in these patients were an easy problem for us because of a design in hip and buttocks padding we have used for about 15 years. Figures 12, 13, and 14 show three ways we use the pelvic buttocks sling. The sling works only if it is slung away from the pelvic and buttocks bands. All three braces in these figures are over two years old and still do not have pressure on the pelvic or buttocks bands. The sling pad gives a glove action on a gibbus or scar. By glove action we mean the pad moves with the patient, as a glove moves on one's hands.

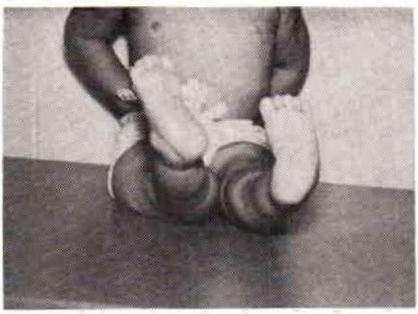


FIG. 7

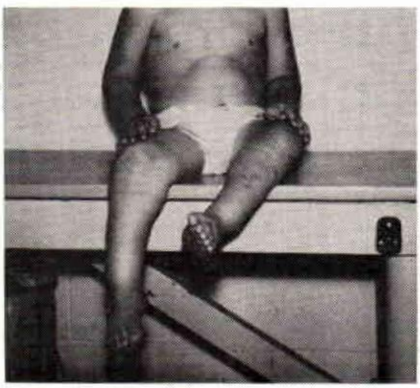


FIG. 8

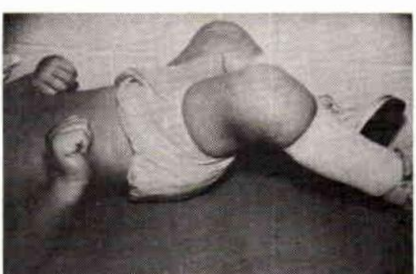


FIG. 9

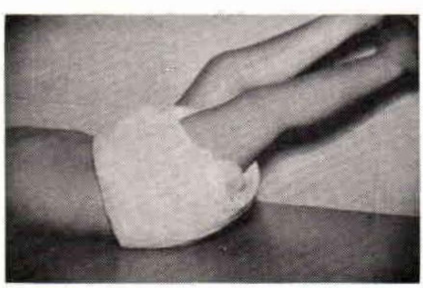


FIG. 10

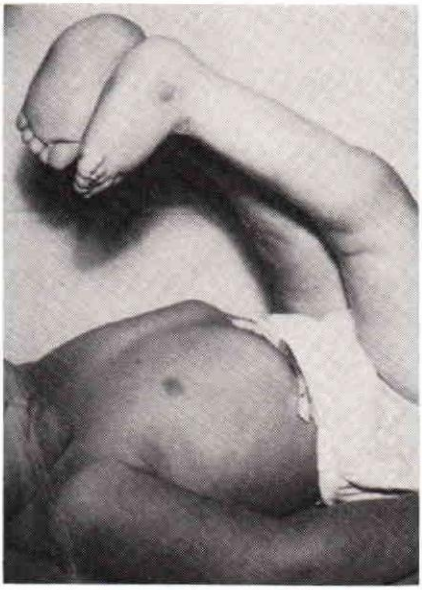


FIG. 11

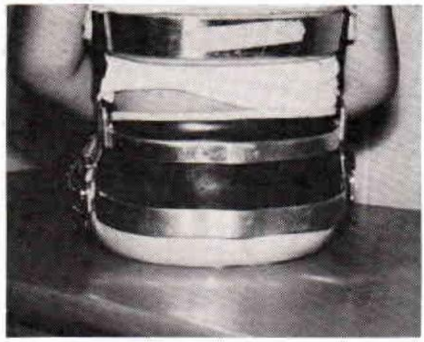


FIG. 12

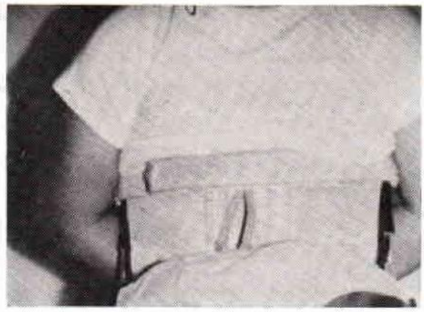


FIG. 12A

Figure 12 shows both pelvic and buttocks bands used with sling. This patient has some adductor tightness and also walks with a swing through gait which needs some extra strength, so we used both bands and pad. In Figure 13, the patient is a small girl with no tightness so we used a pelvic band only. We reinforced the pelvic buttocks pad in Figure 13 because the patient sat in a very soft chair and always leaned far back and caused the pad to wrinkle. Figure 14 patient is one with good thoracic strength, good hip flexion and good walking gait so we used only pelvic band and regular pelvic buttocks pad.

The big reason for this pad, in case most of you have not guessed, is to hold the hips in extension with a large area of pressure on as soft an area as possible; the gluteus. The best and only way we know of making a person stand erect is to tuck in the gluteus and force the patient to extend his hips. To help this even more we have also allowed a little hyperextension "slop" in hip locks so that the patient can hyperextend but cannot flex at hips. This allows the weight of the body to come into a more equal weight bearing line.

Figures 15 and 16 are closer views of the anterior posterior makings of the pelvic buttocks sling. With this sling we have cut pressure sores on the spine area almost 100% and our patients very rarely have any advancing tightness in hip flexor. They walk much better and develop good walking gaits.

From the hips we move up to the thoracic area. In a great number of Spina Bifida patients the thoracic area muscles are knocked out and we see

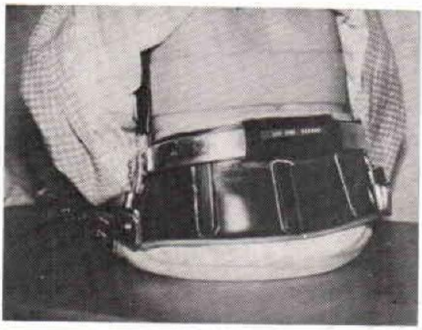


FIG. 13

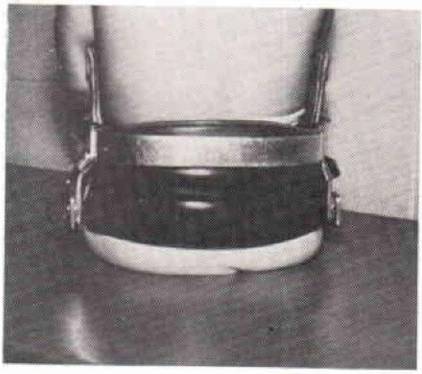


FIG. 14

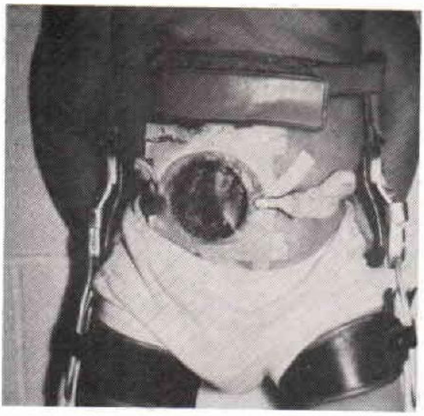


FIG. 14A

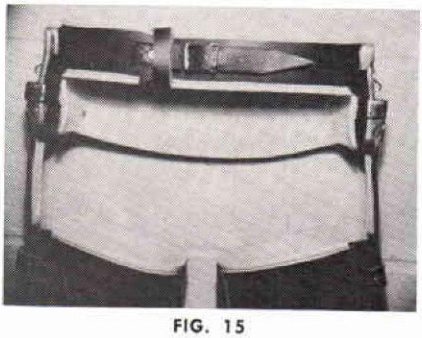


FIG. 15

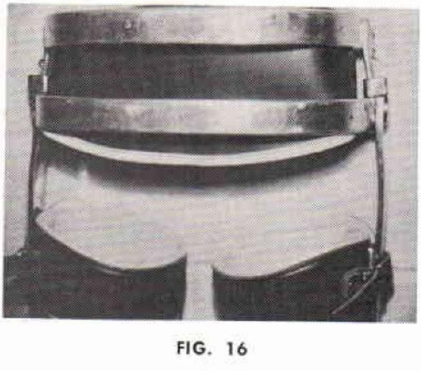


FIG. 16

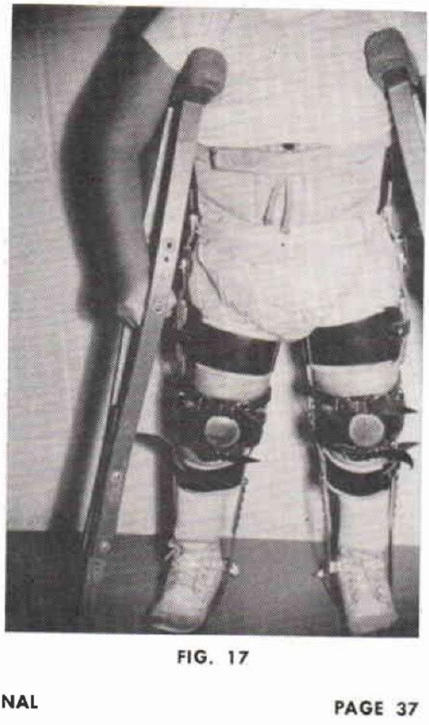


FIG. 17

scoliosis and collapsing of the trunk. We then have to add a thoracic extension to the braces. In extreme weakness we add lateral extensions and a thoracic dorsal band plus an elastic abdominal front as in Figures 12 and 12-A. In Figure 13 we added lateral uprights with an elastic abdominal front but no thoracic band. We also added a 2″ elastic high lumbar sling to help the patient from flexing at waist. The patient needed something just to touch this area to keep her straight. In Figures 14 and 14-A we added lateral uprights and a velcro chest strap just to clear an Ileostomy stoma.

Most of these children are going to walk with crutches, so be very careful when adding the thoracic extension that you allow enough room between top of band or uprights to the axillary area for crutches as in Figure 17. If they use lofstrand forearm crutches you have no worry; but most are too small and not strong enough for this type of crutch.

We feel we have done a fair job in solving some of the problems of birth defect bracing but we also feel we have just scratched the surface. Most of these patients are under 5 years of age. What are the problems in the future years of these patients? The statistics show 250,000 to 300,000 birth defect children are born each year. 150,000 to 200,000 are potential brace patients. With all the new surgery techniques and hospital care the life expectancy is much higher for these children. A much longer life-span is also expected and this means more bracing problems.

What can we do to improve their future in braces? The next five to ten years will be up to us in the field of Orthotics to get some answers and to solve many problems. The earlier we can get these answers the better their future will be.

There are listed in the 1966 Certified Facilities Roster 302 Orthopaedic Brace shops in the United States and Canada. If the 200,000 birth defect bracing patients were divided equally each facility would have approximately 65 to 70 per year now and a possibility of a greater number in the future.

Could your facility do a good job of bracing these patients?

CERTIFICATION EXAMINATION DATES ANNOUNCED

The American Board for Certification in Orthotics and Prosthetics, Inc., has announced that the 1966 Board Examinations will be held as follows:

August 30 to September 1, 1966

at

Elks Aidmore Hospital
2040 Ridgewood Drive, N.E.
Atlanta, Georgia

September 6 to September 8, 1966

at

Navy Prosthetic Research Center
8750 Mountain Boulevard
Oakland, California

The deadline for submission of applications is June 1, 1966.

Knee Disarticulation *

A NEW TECHNIQUE AND A NEW KNEE-JOINT MECHANISM**

By ROBERT MAZET, JR., M.D.†, and CHARLES A. HENNESSY, C.P.O.‡
Los Angeles, California

From the Orthopaedic Service, Wadsworth Hospital, Veterans Administration Center, the University of California Medical Center, and the Orthopaedic Hospital, Los Angeles

It is the purpose of this presentation to review published experience with disarticulation through the knee, to describe a new operative technique designed to produce a more serviceable stump, and to introduce a new type of prosthesis for this stump, including an innovation in the knee mechanism.

The primary requirements for a satisfactory amputation stump in the lower extremity are:

1. The stump must be covered by healthy, well nourished, full-thickness skin, that is free of painful scars and possesses good sensation;
2. Weight-bearing must be distributed over as large an area as possible, preferably an area that normally supports the body weight;
3. The stump should be as long as feasible;
4. There must be good muscle control;
5. There should be no bone prominences or severed nerve endings which might be traumatized by the prosthesis;
6. The knee joint should be preserved when possible.

Under certain conditions when it is not possible to do a below-the-knee amputation, definite benefits may sometimes be anticipated from knee disarticulation instead of amputation at a higher level.

Most surgeons in this country, because of the antipathy of limb makers to end-bearing stumps engendered by the fitting problems involved, showed little interest in end-bearing stumps until confronted by the large number of amputees incident to World War II. The resulting experience with the Syme amputation, and the development of a practical prosthesis for limbs amputated at this level, firmly established this amputation as a valuable surgical procedure. The advantages of knee disarticulation, however, have not been widely appreciated. Prosthetic considerations have been chiefly responsible. The bulbous stump caused by the flaring femoral condyles usually requires use of the cumbersome, unsightly, and unsanitary leather lace-up thigh socket and external knee joints. Existing standard joints lack the necessary strength to withstand the torque to which they may be subjected by a vigorous, husky man, and provide no friction.

If the stump is not particularly bulbous, prosthetists prefer to use the type of knee joints used with the standard above-the-knee socket. This type provides constant friction, but prolongs the socket about three inches, making the artificial knee protude in the sitting position.

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* Reprinted by permission of the authors and editors from *The Journal of Bone and Joint Surgery*, January 1966, Vol. 48-A, pp. 126-139.

** Read at the Annual Meeting of the Western Orthopedic Association, Seattle, Washington, September 25, 1963.

† Veterans Administration Center, Wiltshire and Sawtelle Boulevards, Los Angeles, California 90025.

‡ School of Medicine, University of California, Los Angeles, California.

Many standard textbooks ignore the knee as a level of amputation [1, 6, 7, 16, 20, 25, 26, 29]. Several mention, but do not recommend, this operation [5, 18, 21]. DePalma and Verrall discouraged amputation through the knee. Colonna stated that a knee-disarticulation stump is difficult to fit with a a prosthesis but that the procedure should not be condemned. Peterson remarked that disarticulation at the knee gives a good end-bearing stump. Kelham stressed the relative speed and absence of shock of the knee-disarticulation operation. He reported some success among patients with peripheral vascular disease. Slocum enumerated the advantages and disadvantages of knee disarticulation, quoting at length from Rogers. Gillis re-emphasized that, compared with an above-the-knee stump, knee disarticulation, particularly in older people, gives better control of the prosthesis and better balance. Slocum and Kirk decried the unsightliness of the usual bulbous stump, believing the thin skin over it subject to breakdown. Nathan Smith made the first report of knee disarticulation in the American literature in 1825. Velpeau described fourteen cases in 1830. Batch, Spittler, and McFaddin, in 1954, referred to two additional reports of knee disarticulation from this country, one by Stephen Smith in 1870, the other by Otis Huntington in 1883. Together these articles reported on 189 such disarticulations performed during our Civil War, and Batch and associates added twenty-eight cases of their own without follow-up data. They emphasized the better balance and gait after knee disarticulation compared with above-the-knee amputation.

The most enthusiastic contemporary protagonist of knee disarticulation is Rogers, who noted that it provided the largest horizontal end-bearing surface area available in the lower extremity; the bone, soft tissues, and skin at the end of the stump are normally adapted to weight-bearing; the terminal integuments of the stump are subjected to pressure but not to tension; muscle control of the stump is achieved by preserving the length and attachment of every muscle motivating the thigh; excellent leverage can be exerted on a prosthesis because the stump is long and its end is firm and relatively insensitive; muscle atrophy is minimized by preserving the function of most of the muscles left in the stump and by the early use of a permanent prosthesis; if the popliteal artery is ligated below its superior geniculate branches, the richest system of arterial anastomoses available in the extremity is preserved; the greater part of the terminal flap comes from in front of the joint space and therefore already has a blood supply independent of its underlying tissues; and preservation of the lower femoral epiphysis, accountable for 90 per cent of the growth of the femur, allows normal development of the stump following amputation in childhood. Rogers also stated that disarticulation should not be done in patients with peripheral vascular disease.

Quite recently Dederich and Mercer[19], commenting on physiological considerations in amputation stumps, restated the desirability of good muscle control of the stump, advocating suture of severed muscles over bone ends.

Two undesirable features are present in the conventional knee-disarticulation prosthesis: its unsightliness and lack of satisfactory swing-phase control provided by the standard external knee joints used for below-the-knee prostheses. In addition, these joints sometimes break under the torque to which they are subjected in the knee-disarticulation prosthesis. Finally, insertion of a bulbous stump into the leather bucket is a rather awkward maneuver, and lacing up the long front of the cumbersome socket is time-consuming.

In view of these considerations it was decided to make a less bulbous and more cosmetically acceptable stump, which would permit replacement of the unsightly leather bucket with a more pleasing and more sanitary plastic type. To accomplish this, the standard knee disarticulation was modified and an improved prosthesis for the resulting stump was fabricated.

OPERATIVE TECHNIQUE

The customary fish-mouth skin incision is made with a longer anterior flap that extends four and one-half inches below the level of the knee joint. The posterior flap is one and one-half inches in length. The skin flaps must be long enough to close without tension (Fig. 1). The skin and deep fascia are incised, dissected off the capsular structures of the knee, and reflected upward as one layer, well proximal to the femoral condyle. The patellar tendon is divided mid-way between patella and tibial tubercle. The knee is flexed and its capsule and various ligaments are severed. Then with the knee further flexed to 90 degrees, the popliteal vessels and nerves are tied and divided. No effort is made to preserve the inferior geniculate arteries. The hamstrings are detached from their insertions, and the patella is dissected from its tendon and discarded.

After removal of the leg, the medial one-half of the medial femoral condyle, the lateral one-third of the lateral condyle, and the protruding posterior surfaces of both condyles are removed with a wide osteotome. The corners are rounded with a rasp, preserving a fairly broad weight-bearing area on each condyle. The patellar tendon and hamstrings are sutured to one another in the intercondylar notch under slight tension. Hemostasis is se-

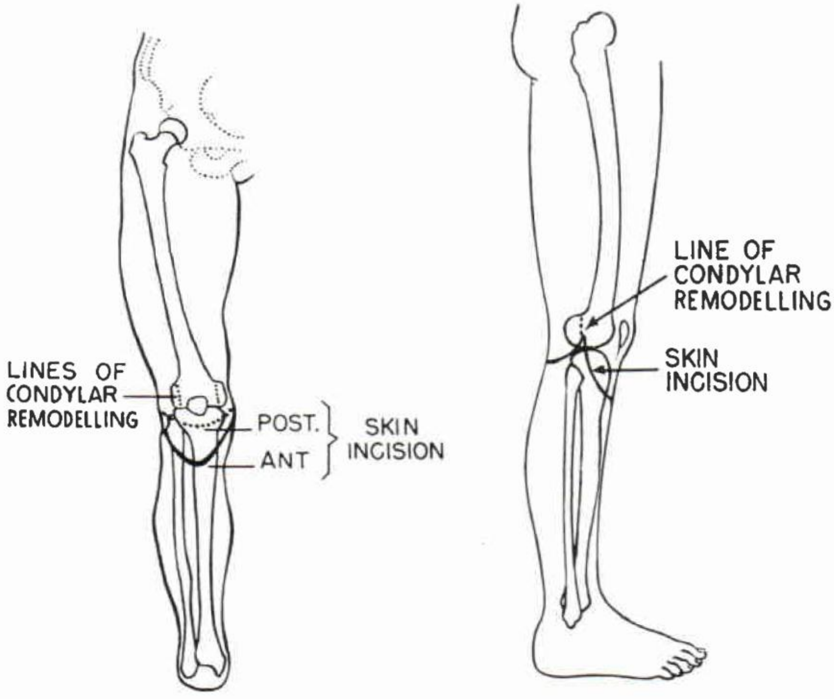

FIG. 1

Skin incisions and condylar modeling for knee disarticulation.

cured. The deep fascia and then the skin are closed separately in the usual manner. Drains are inserted in each end of the wound, and a compression dressing is applied. The resulting stump is truncated, with adequate weight-bearing surface on the femoral condyles.

Condylar trimming in children whose distal femoral epiphyses are not yet closed has not been done. In young children, growth of the condyles in length and width is slowed following knee disarticulation, and a conical stump develops without trimming of condyles.

THE NEW PROSTHESIS

The prosthesis fabricated for this truncated stump differs in several details from the standard knee-disarticulation device.

The bulbousness of the conventional prosthesis for a knee-disarticulation stump is avoided, since the truncated stump permits use of a socket with a more pleasing contour.

With the conventional knee-disarticulation stump with full width of the condyles, it may be difficult to maintain evenly distributed weight-bearing over the broad surface of both condyles. If this even distribution is not achieved, breakdown of skin over the condyle bearing the most weight may occur. The problem is intensified if there is any flexion or abduction of the stump. If either or both of these contractures are present, the necessary socket alignment may cause uneven swing-through, stump rotation, and irritation of the stump end. The non-bulbous stump without flaring condyles allows more latitude in adjusting the alignment and permits needed stump adduction.

When there is a hip flexion contracture, the stump and socket must be set in flexion to accommodate this. If this adjustment is made with the conventional socket, the bulbous end of the bucket projects forward at the knee joint and is extremely unsightly. The necessary flexion is less noticeable with a non-bulbous socket.

In the new prosthesis, the foot appears to be outset owing to adduction of the stump to obtain lateral stability. The knee is located a little medial to the weight-bearing plumb line from ischium to heel. The foot is directly under the ischial tuberosity, in its proper place, permitting a narrower base (Fig. 4) in stance and gait.

The new socket is made of laminated plastic over Kemblo rubber and lined with thin horse hide that withstands perspiration well. The socket weighs a little less than the leather lace-up type and is easily cleaned. The non-bulbous stump can be inserted and withdrawn with ease. The life of the material in the plastic socket is appreciably longer than that of leather.

The need for external, friction knee joints has been recognized for some time. Several years ago the Amputee Research Group at the University of California, Berkeley, developed a practical constant friction outside knee joint of sufficient strength for use on a knee-disarticulation prosthesis. This joint provides better control of the prosthesis than the above-the-knee joint and produces a smoother gait by lessening excess heel rise and reducing terminal impact. We used these Berkeley hinges most successfully in Cases 1 and 4. Unfortunately, these joints are not commercially available and we could secure only two pairs.

Inability to procure additional Berkeley external joints necessitated reversion to the above-the-knee mechanism with the excessively long socket. One of us (C.A.H.), with Mortensen, evolved an application of the Hydra Nu-Matic variable swing-phase control mechanism for use with standard external knee joints. This control has been used on three amputees (Cases

4, 8, and 14). It permits use of a socket only three fourths of an inch longer than the normal thigh and reduces heel rise and terminal impact. This device has proved eminently satisfactory in the three cases in which it was used. Details of this mechanism are shown in the Appendix. End-bearing and control of the prosthesis are essentially the same in both the conventional and the new sockets.

The friction knee joint gives better control of the prosthesis, provides better proprioceptive sensation, obviates pendulum motion of the skin, and lasts longer. With the new prosthesis, the patient has a more natural gait and expends less energy in walking.

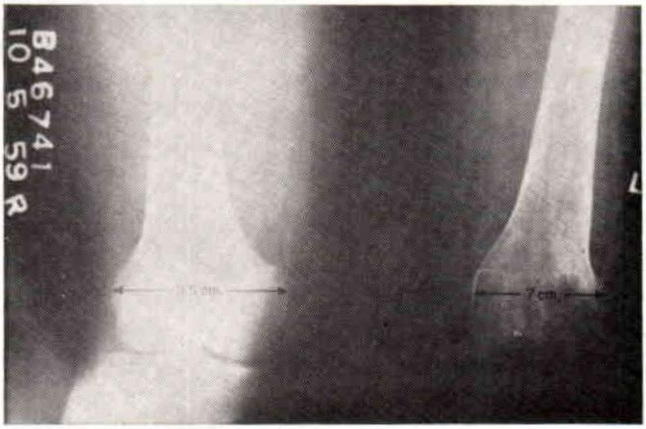

FIG. 2

Case 1. Ten months after left knee disarticulation; the condyles of the left femur have been trimmed to obviate bulbousness of stump.

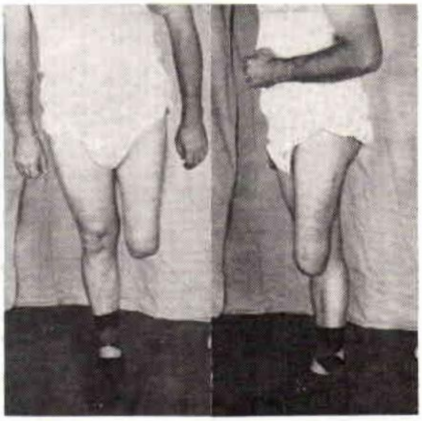

FIG. 3

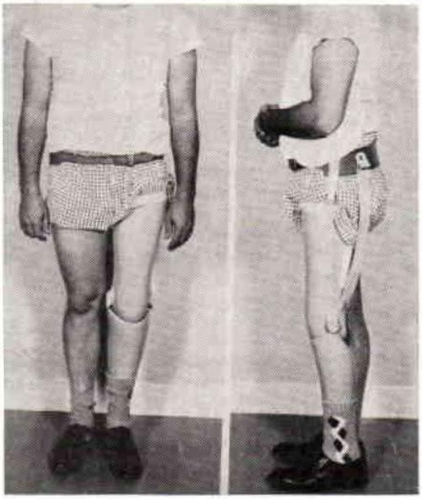

FIG. 4

FIG. 3—Case 1. Five years after disarticulation. Note absence of bulbousness.

FIG. 4—Case 1. Five years after disarticulation, with knee-bearing plastic prosthesis. Note appearance, absence of long thigh lacer, and the external knee joints.

TABLE I

Patient, Age at Amputation *(Years)*, Sex	Cause of amputation	Type of Amputation	Age at Last Visit *(Years)*	Difference in Thigh Lengths *(Inches)*	Type of Prosthesis			Occupation and Activities	Complications and Comments
					Socket	Knee Joint	Suspension		
Case 1, C. P., 35, M	Chronic osteomyelitis, left tibia	Condyles trimmed	43	0	Modified suction	External Berkeley; later Hydra Nu-Matic	Pelvic belt	Commercial artist; much on feet	Returned to work five mos. after amputation; six yrs. later the knee joints were worn out and external Hydra Nu-Matic joints substituted; doing well after eight years
Case 2, R. S., 46, M	Osteogenic sarcoma, left tibia	Condyles trimmed	47½	0	Modified suction	Standard below-the-knee	Pelvic belt	Laborer; did not return to work	Skin flaps too short and necrosis required plastic surgery; walked on peg leg seven mos. after operation and articulated leg one yr. after operation; died of pulmonary metastases nineteen mos. after operation
Case 3, E. J. A., 37, M	Chronic osteomyelitis, left tibia	Condyles trimmed	41	0	Modified suction	Standard below-the-knee	Pelvic belt	Athletic trainer; worked at automobile assembly past year	Full weight-bearing five mos. after operation; on feet eight hrs. daily; no stump trouble four yrs. after operation
Case 4, E. I., 41, M	Acute osteomyelitis, right tibia	Condyles trimmed	44	0	Modified suction	External Berkeley; later Hydra Nu-Matic	Suction	Painting contractor; drives truck, rides bicycle, climbs ladders three yrs. after operation	Osteomyelitis of medial condyle developed after standard knee disarticulation; removal of patella and trimming of condyles produced hardy stump
Case 5, R. K., 28, M	Berger's disease	Condyles trimmed	46	½	Thigh lacer; later modified suction	Standard above-the-knee	Suction	Portrait painter; stream fishing as a hobby	Stump end not bulbous but prosthetic knee joint protrudes

Case 6, A. R. D., 26, M	Gangrene following tear of popliteal artery	Standard	45	0	Leather lacer	Standard below-the-knee	Lace-up socket	X-ray technician; on feet all day; gardens in spare time	Patella left in place; very bulbous stump; good walker
Case 7, B. L. A., 35, M	Chronic osteomyelitis of tibia	Standard	55	0	Leather lacer	Standard below-the-knee	Soft belt	Television announcer; no heavy work; on feet two-thirds of the time; gardens as a hobby	
Case 8, P. J. H., 14, F	Osteogenic sarcoma of tibia	Condyles trimmed	18½	0	Modified suction	Standard below-the-knee with Hydra Nu-Matic	Suction	Schoolgirl; works as hospital volunteer, dances	Has conical stump
Case 9, J. W. K., 2, M	Multiple congenital deformities	Standard	13	Bilateral	Modified suction	Standard above-the-knee	Soft belt	Extremely active in scouting	Femora thin, not bulbous, seem long for his age
Case 10, R. C., 3, F	Paraxial tibial hemimelia	Standard	20	2½	Suction	Standard above-the-knee	Suction	Married; does housework	Has well truncated stump
Case 11, R. L. K., 7 days, M	Malignant tumor of tibia	Standard	13	½	Suction	Standard above-the-knee	Suction	Very active; plays baseball and skates	Femur is smaller than its opposite; prosthetic knee protrudes
Case 12, D. D. D., 2, F	Congenital absence of leg and foot	Standard	15	½	Modified suction	Standard above-the-knee	Soft belt	Schoolgirl; dances	Femur is smaller than its opposite; prosthetic knee protrudes
Case 13, K. C., 6, F	Paraxial fibular hemimelia	Standard	21	1	Total contact	Standard above-the-knee	Suction	College student; active on newspaper	Femur shorter and thinner than its opposite, not bulbous
Case 14, J. deM., 52, M	Automobile accident; osteomyelitis, right tibia	Condyles trimmed	54	0	Total contact	Standard below-the-knee with Hydra Nu-Matic	Suction	Owns building maintenance business	Much on feet, working full time two yrs. after operation

CLINICAL MATERIAL

We reviewed all the cases of knee disarticulation that we could find. Fourteen patients who had been walking on knee-disarticulation prostheses for from one to twenty years were collected and carefully studied (Table I). Three had their disarticulations at the Los Angeles Veterans Hospital (Cases 1, 2, and 3), three were private patients (Cases 4, 8, and 14), three were seen at the Los Angeles Regional Office, having lost their extremities in World War II (Cases 5, 6, and 7), and five were patients at the Los Angeles Orthopaedic Hospital who had been amputees for eight to twenty years (Cases 9, 10, 11, 12, and 13). Each patient was examined by one of us (R. M., Jr.) and many were seen by both of us. Eight were adults at the time they became amputees; six were children. Three had become adults since loss of their extremity. In the adults amputation was necessitated by trauma in all but one with Berger's diesease and one with osteosarcoma. Four of the children had disarticulation because of congenital deformities; two, because of malignant tumors. Stump difficulty occurred in only one of the seven patients treated by the method described. In Case 2, the skin flaps were made short and plastic surgery was required to cover the skin defect. Despite this complication, a good weight-bearing stump was achieved and the patient was able to begin walking on his knee seven months after operation. He continued to walk on it until shortly before he died of pulmonary metastases from his osteogenic sarcoma nineteen months after amputation. In Case 4, a standard knee disarticulation performed elsewhere was followed by stump breakdown. Revision with trimming of the condyles produced an excellent stump.

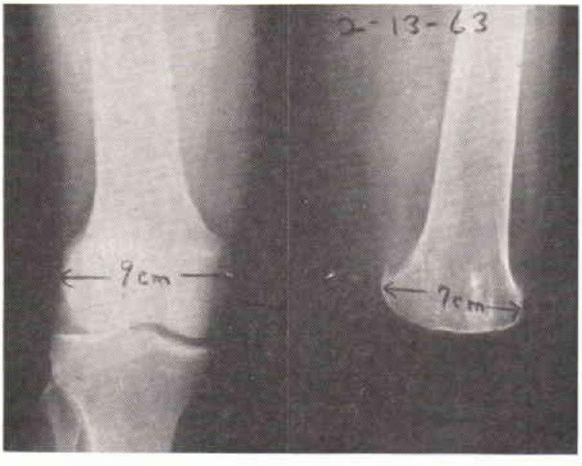

FIG. 5

Case 5. Modeling of condyles eighteen years after disarticulation of the knee and an unknown amount of trimming. The femur is one-half of an inch shorter.

In the six children, whose ages ranged from seven days to fourteen years at the time of amputation, conventional knee disarticulations were performed in all except Case 8, a girl, fourteen years old, whose femoral condyles were trimmed according to the method previously described. In all children the femur on the side of disarticulation continued to grow, but at a slower rate than on the normal side; but in the one child with bilateral amputation

(Case 9), the femora appeared to be longer than normal when the boy was thirteen years old, ten and a half years after bilateral knee disarticulation because of multiple congenital anomalies. In the three children who had completed their growth at follow-up (Cases 10, 12, and 13) the difference in femoral length ranged from one-half to two and a half inches, the average

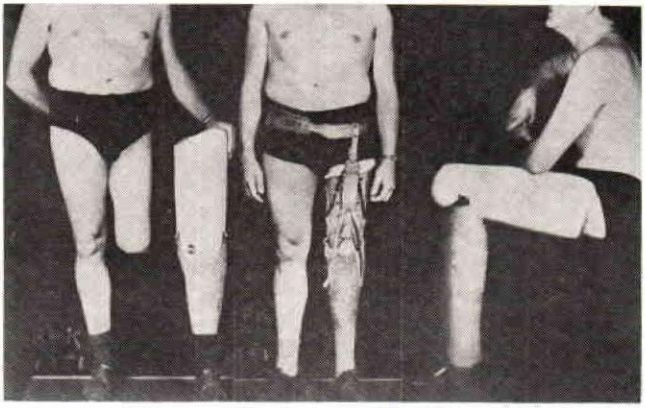

FIG. 6

Case 5. Left, the stump is nicely truncated; center, the original leather lace-up socket with external below-the-knee prosthetic joint; right, the present socket with an above-the-knee prosthetic joint and elongated socket.

being 1.67 inches. In two children, growth was not complete at the time of this study. One was Case 9, the bilateral amputee. The other was Case 11, a boy whose disarticulation was performed at the age of seven days. His femoral shortening at the age of thirteen years was one-half inch. In Case 10, that of a girl whose disarticulation was performed at three years, femoral shortening was two and one-half inches at the age of twenty years. In Case 8, that of a girl who had trimming of the femoral condyles when disarticulation was performed at fourteen years of age, the distal femoral epiphyseal plates were closed when operation was performed.

As the children with conventional knee disarticulation grew, growth in width of the femur on the side of disarticulation, especially at the distal end, was less than that on the normal side. As a result, none of the children's stumps were bulbous at follow-up (Fig. 10).

In six of the fourteen cases, the condyles were trimmed according to the technique recommended (Cases 1, 2, 3, 4, 8, and 14). In Case 5, a less radical trimming had been done elsewhere. In the remaining cases the condyles were not disturbed. In Case 6, the patella was left *in situ*, producing a very bulbous stump.

Not included in this series are five patients, fifty to sixty-one years old, who had knee disarticulations and trimming of the condyles for peripheral vascular arteriosclerotic disease. The anterior skin flap necrosed in all five. These were patients with advanced generalized arteriosclerosis. In each, the popliteal pulse was palapable but not strong. Two of them had gangrene of a toe. None had papable pedal pulses. We agree with Rogers that generalized arteriosclerosis interdicts knee disarticulation.

CASE REPORTS

CASE 1. C. P., a commercial artist, thirty-five years old, sustained an open fracture of the upper third of the left tibia from a mortar shell when he was twenty-one years old. Chronic infection necessitated many operations, and a cold, anesthetic foot with an equinovarus deformity developed. Knee motion was from full extension to 45 degrees of flexion. The knee and upper part of the leg ached constantly; pain was excruciating during acute exacerbations of his osteomyelitis. At the time of admission a draining sinus led to a cavity, two by two by three centimeters, in the upper end of the tibia.

On December 22, 1958, when the patient was thirty-five years old, left knee disarticulation was performed by the technique described (Fig. 2). Wound healing, stump shrinkage, and conditioning proceeded uneventfully (Fig. 3). The patient received a prosthesis with moulded plastic socket and the Berkeley knee joint four months after operation. He learned to walk easily and rapidly and returned to work five months after operation.

During the ensuing eight years after disarticulation he wore the prosthesis all day every day, doing considerable walking. There had been no irritation or discomfort, although a few minor adjustments of the prosthesis had been necessary. Fifteen months after amputation, because of a little shrinkage of distal end of the stump, he changed from a three-ply to a five-ply sock. The original Berkeley friction joints were used for six years (Fig. 4). They were then replaced by external below-the-knee joints with Hydra Nu-Matic control.

CASE 5. R. P. K., a portrait painter, forty-six years old, had a left knee disarticulation performed eighteen years previously for Berger's disease. Since then he had worn an end-bearing prosthesis using a belt and thigh lacer for eight years and recently a suction socket. He was active and did considerable walking and gardening as a hobby. He had had no trouble with his stump.

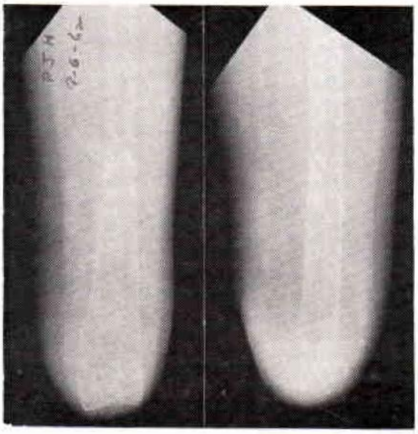

FIG. 7

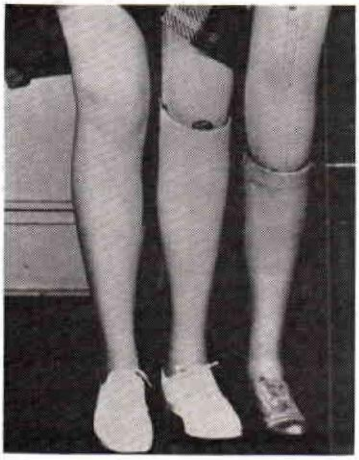

FIG. 8

FIG. 7—Case 8. The narrowed femoral condyles and the conical stump, 6 months after operation.

FIG. 8—Case 8. Patient in the new suction-socket device with Hydra Nu-Matic knee mechanism. The socket is essentially the same length as her normal thigh. Shown also is her first prosthesis with the standard above-the-knee mechanism. Note long socket.

The stump was shaped like a truncated cone, without bulbousness. The circumference of the stump end was twelve inches; that of the opposite thigh at the level of the condyles was sixteen inches. The femur on the stump side was one-half inch shorter than the opposite femur.

A roentgenogram made on February 13, 1963, showed that the condyles had been trimmed to decrease the width of the distal end of the femur and to shorten it slightly (Fig. 5). Why the condyles were trimmed in this man is not known, but it appears that his surgeon anticipated our conviction that this procedure would produce a better stump long before the idea occurred to us.

The patient now wears a conventional above-the-knee type of knee joint with an elongated socket (Fig. 6). Absence of bulbousness permits use of suction for suspension.

CASE 8. P. J. H., a fourteen-year-old girl, was admitted to the hospital on February 8, 1962, with an osteogenic sarcoma of the left tibia, proved by biopsy. On February 16, the extremity was perfused with phenylalanine mustard. On March 23, when knee disarticulation with trimming of the

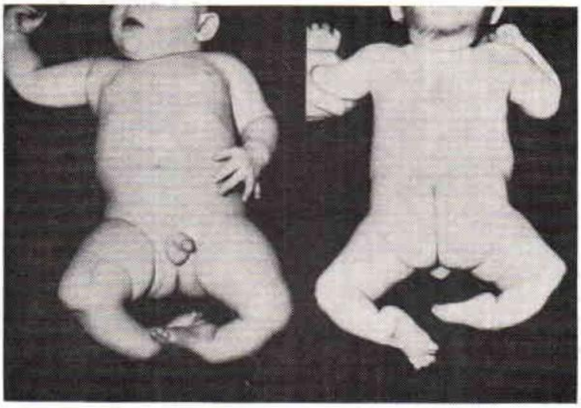

FIG. 9

Case 9. Shortly after birth. Note malformations of both lower extremities.

FIG. 10

Case 9. At age ten, the stumps are conical. The lower epiphyses are preserved, but the condylar flare is less pronounced than normally.

condyles was done, the distal femoral epiphyseal plate was closed. She received a total-contact, suction-socket, end-bearing prosthesis with a standard, constant-friction knee joint. The socket was three inches longer than the normal thigh. Three months after disarticulation she resumed her regular school activities. She also worked regularly as a volunteer hospital aid on a children's ward. Her conical stump (Fig. 7) slipped in and out of the socket readily. The circumference of the stump end was eleven inches compared to a circumference of fourteen inches on the opposite side.

A year after amputation she received a new prosthesis provided with a Mortensen Hydra Nu-Matic swing-phase control mechanism. The standard outside knee joint with this new device permitted fabrication of a socket only three-fourths of an inch longer than the normal thigh, a difference ordinarily not noticeable (Fig. 7).

Four and a half years after amputation she was very active. She had no stump trouble, and there was no evidence of recurrence or metastases of the tumor.

CASE 9. J. W. K., a boy, was first seen when he was two years and eight months old. He was born with bilateral dislocation of the hips and

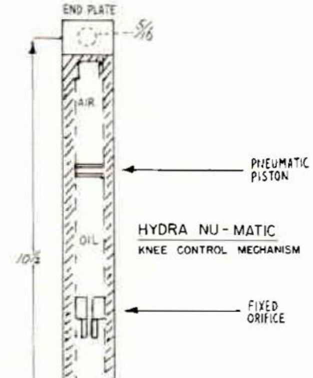

CHART I

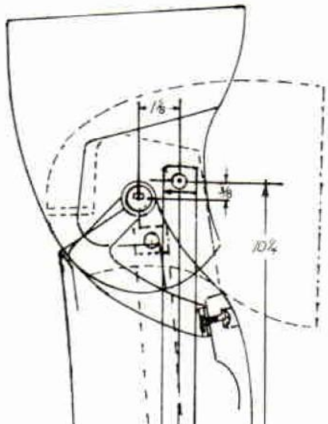

CHART II

CHART I—The Hydra Nu-Matic knee control mechanism.

CHART II—Placement of device in the prosthesis. The upper end-plate is fixed to the socket one and one-eighth inches posterior to and three-eighths of an inch above the knee axis. Knee flexion forces the cylinder down over the hydraulic piston, forcing the oil through a fixed opening. This in turn compresses the air in the upper cylinder which exercises a braking action at both extremes of swing phase.

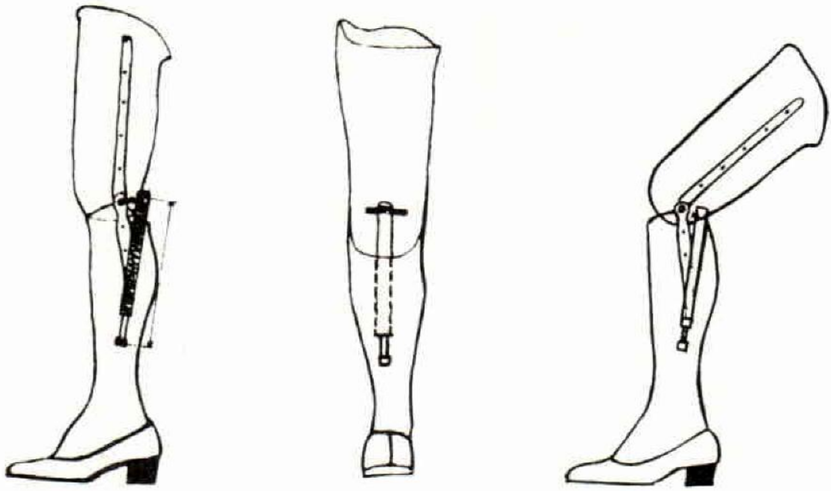

CHART III

Left, a schematic drawing of placement of device, lateral view, knee extended; center, posterior view; right, knee flexion forces cylinder down over piston.

knees, absence of the tibiae, and club feet with supernumerary digits (Fig. 9). These defects were treated in Akron, Ohio, by multiple plaster casts and heel-cord lengthenings. A long spur was removed from the right femur when he was two months old. When he was two years old, bilateral knee disarticulation was performed, with removal of the patellae and preservation of the lower femoral epiphyses. Prostheses were provided seven months after operation and he was seen by us soon thereafter.

Gait training was instituted and he quickly learned to use the devices well. When he was three and one-half years old, an osteochondroma was removed from the left femur.

At thirteen years of age, this boy was an active prosthesis-user and had worn out several sets of prostheses. He was keeping up with other Boy Scouts on overnight hikes, playing baseball, and the like. He had excellent end-bearing conical stumps and was wearing plastic sockets with a soft pelvic belt, single-bolt knees, two-way ankles, and wood and rubber feet. Roentgenograms made when he was ten (Fig. 10) showed preservation of the distal femoral condyles and epiphyseal plates. However, the condylar flare seen in normally developed femora was considerably reduced.

DISCUSSION

Success after knee disarticulation depends largely on the viability of the skin flaps. Their blood supply must come from above, since there is no muscle bed beneath the flaps to nurture them. A satisfactory outcome can be anticipated only in extremities with vessels that are neither atheromatous nor scarred from trauma or infection. Rogers, in his discussion of the presentation of Batch, Spittler, and McFaddin, stated that he did not disarticulate the knees of patients with diabetes or arteriosclerosis, even though circulation appeared adequate.

SUMMARY

Knee disarticulation provides an amputation stump that is stable, tough, and long lasting, and assures excellent muscle control of the prosthesis. The procedure is not indicated in the presence of peripheral vascular disease.

Fourteen cases are presented in which weight-bearing on the femoral condyles for from one to twenty years had not resulted in stump breakdown.

An operative technique designed to obviate the bulbousness of the lower end of the femur that is characteristic of the usual knee disarticulation is described. Six cases in which this technique was used are reported (in Case 5, partial trimming was done elsewhere).

Two types of external knee joints, the Berkeley and the Hydra Nu-Matic, incorporating friction and a swing-phase control mechanism, are described.

APPENDIX

The Hydra Nu-Matic knee-control unit* is composed of a three-chambered cylinder, a pneumatic piston, and a hydraulic piston with oil in the lower two chambers and air in the upper chamber (Chart I).

The unit's length is ten and one-half inches; its outside diameter, seven-eights of an inch. The upper end of the cylinder is fixed to the socket a little above and behind the axis of the knee joints (Chart II). The lower end (the end of the hydraulic piston) is secured within the shin. Knee flexion moves the superior end of the device downward and forward. As a result, the cylinder slides over the hydraulic piston (Chart III) and oil is forced from the lower chamber through the fixed orifice in the cylinder into the middle chamber. This in turn elevates the pneumatic piston, compressing air in the upper chamber. The compressed air then acts as a kicker to trigger extension of the knee as the foot swings forward after push-off. This automatic knee extension eliminates excessive heel rise. As the knee extends and the hydraulic piston is pulled down, the oil flows back through the fixed orifice, restraining knee extension with decreasing force, and the pressure differential in the middle and lower chambers is decreased by the flow of oil through the fixed orifice as heel strike is approached. Terminal impact at heel strike is thereby softened. The linkage of the unit is such that when the wearer is seated the unit is inactive, and the feet are flat on the floor. As the standing position is resumed, the compressed air is ready and available to aid in extension of the leg.

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IN MEMORIAM: MRS. SARAH MELLON SCAIFE

A TRIBUTE, by George R. Kowatic

President, Pennsylvania Orthopedic and Prosthetic Society

The death of Mrs. Sarah Mellon Scaife on December 28, 1965, was an irreparable loss, not only to the community where her charities were numerous, but to the Pennsylvania Orthopedic and Prosthetic Society.

Those of us in the profession will remember her bountiful appropriation through the Sarah Mellon Scaife Foundation a quarter of a century ago to the Mellon Institute to establish research into orthotics and prosthetics. Although that research was abandoned in 1960, its impetus was not in vain, and many other research programs were inaugurated as a result of it.

Mrs. Scaife's endowment was more than monetary: It gave our profession greater dignity and stature and we now have won greater respect from the medical profession.

We of the Pennsylvania Orthopedic and Prosthetic Society mourn her death because of her great love for people and her humanitarian cause.

She was Pittsburgh's Great Lady.

Translation and Abstract Service

This issue of the *Orthopedic and Prosthetic Appliance Journal* is the third to bring to readers translations of foreign orthopedic and prosthetic articles. Reader reaction has been most favorable to this translation service.

Chairman William A. Tosberg, of the Abstract and Translation Committee, and the *Journal* editors, would like to take this opportunity to express their appreciation to the Association members who have devoted their time and energies to preparing these articles: Laurence Porten, C.P.O. (whose second translation appears below), Siegfried Jesswein, C.P.O., and Siegfried Paul, C.P.O.

Readers as well as the editors are much in the debt of the members listed above. Chairman Tosberg has expressed this appreciation for all of the translators in writing about the December *Journal* in particular:

"I also think that Mr. Siegfried W. Paul should be congratulated on the excellent translation of the article by Mr. Habermann. Translation of such material is very difficult and Mr. Paul must have spent many hours in the wording of this article. I have seen articles of mine translated into another language, and some of them I just could not recognize because they were translated by the book and not by people who knew the material. This one, however, actually translates not only the language but also the contents of Mr. Habermann's very informative paper."

Providing Double Below Knee Amputees With Fin-Prostheses *

By HEINRICH WALB

[Translated by LAURENCE PORTEN, C.P.O., O.M.M., F.S.O.P.]

To avoid any mistake, it is pointed out that this type of fin-prosthesis is not a technical novelty. It has been described in a book by Hans Lorenzen, *Sport and Play*. However, the idea had been discarded because "on land there is no need for it," and in the water, a single amputee can still swim satisfactorily without any gadget. If this holds true for single B/K amputees, then it is almost a logical assumption that hands should be kept off Bilateral B/K amputees in providing them such prostheses.

However, the wish and intuition of an obstinate and stubborn double amputee induced us to experiment with fin prostheses, and the result was so gratifying that we feel compelled to report it.

The surprise effect was that the double amputee not only could swim unrestricted by his handicap, but, as the illustrations clearly show, also could

* Translated and reprinted with the permission of the author and the publishers from *Orthopaedie-Technik*, Wiesbaden, Germany, Heft 7: July 1965, pp. 199-201.

stand and walk on the fin prostheses. When only half submerged in the water, the buoyancy of the prostheses created a very favorable situation.

The good results in the swimming pool were surpassed when the amputee used the prostheses on the sandy beach and in the water of the Italian Adriatic Coast. In half deep water he experienced an excellent stance and feeling of safety, and in the deeper and more agitated water he developed a high sense of security which was not inferior to that of a healthy person.

The fins also provided him with protection against sand, shells or stones, which his stumps could not have done. The short trip from the cabin or beach chair to the water is accomplished with the help of water-tight knee gliders, as seen in Figure 1. Although the steps in the swimming pool were anything but ideal for the amputee, he had no difficulty whatsoever getting into the water.

FIGURE 1—The amputee with the attached fin-prostheses and the previously mentioned knee-gliders.

FIGURE 2—Water contact after descending steps.

FIGURE 3—Demonstrates the stability and good balance obtained by slightly touching the pool rail with one hand.

FIGURE 4—The prostheses submerged in water with clearly visible knee parts.

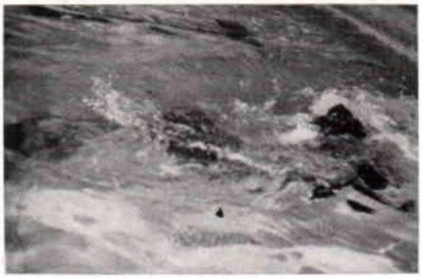


FIGURE 5—The quick and forceful start from the pool steps.

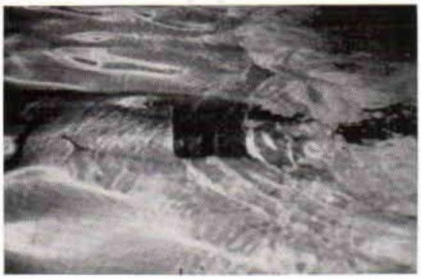


FIGURE 6—Gives a good impression of the safe and elegant swim style of the bilateral amputee.

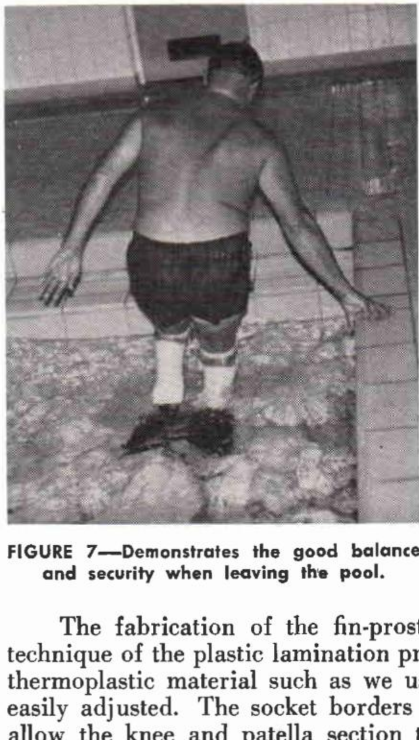


FIGURE 7—Demonstrates the good balance and security when leaving the pool.

FIGURE 8—Both prostheses shown in action from the back, when leaving the pool.

The fabrication of the fin-prosthesis is no problem if one knows the technique of the plastic lamination process. The stump sockets are made from thermoplastic material such as we use in the U.S.A. Pressure spots can be easily adjusted. The socket borders on the condyles are made very high to allow the knee and patella section to be free, and to ease the water flow. Furthermore, this helps the dorsal blockage and avoids overstretching.

To secure the prostheses to the legs, the Otto Bock Knee Bandage, which is similar to our PTB knee strap, is fastened by means of studs. The fins are the regular type used by skin divers. The heel parts are cut in the middle and the fins pulled tight to the socket ends. The shorter the distance between fins and stump-ends, the more easily they will work. If the lengths of the stumps differ, an equal length of the prostheses and fins should be maintained to effect balance in standing and walking.

The tips of the fins point slightly to the outside—like the normal foot position—and upwards.

After the temporary line-up, a trial swim should be arranged. The patient can still decide on the final line-up.

To finish the prostheses, the hollow space between fins and sockets should be filled with pedilon foam, and finally the fins are fastened by means of rivets or screws.

The author suggests using 2 layers of perlon stockinet, 1 layer of fibre glass and, as overall cover, 2 layers of Helanca stockinet. To secure a perfect union, about ½ to ¾ inches of the fins should be moulded into the final plastic cover, and a small hole should be drilled to be used as an air and water expiration outlet.

In summary, it can be stated that the amputee with the fin-prostheses can swim faster than a normal average swimmer, and in semi-deep water walks better than he would with artificial limbs on land. The leg muscles are better trained and the thigh muscles especially have a chance to relax from the strangulation of the limbs. No disadvantages have been found from soaking and floating the stumps, even after a few hours of walking and swimming in the water. However, the advantage of giving double amputees a chance to swim and enjoy water sport again is well worth the expenditure since it will raise his spirits, health and well-being.

Note by the translater: If German material is not available—except through the Otto Bock Firm in Minneapolis—then it is suggested to use all the necessary materials which are known in U.S.A. for laminating purposes.

1966 REGIONAL MEETINGS AND DIRECTORS OF THE ASSOCIATION

The eleven men whose pictures appear on the cover of this issue of the *Journal* are the Regional Directors of the American Orthotics and Prosthetics Association who direct the Association's affairs and plan the yearly meetings in each area of the country.

Two of these meetings have already been held. Director **William A. McElduff of Region IV** presided at the February meeting in Orlando, Florida; and Director **Charles Kymes, C.P., of Region VIII** directed the March meeting at Dallas.

Regional Directors and meeting dates and sites for the other nine regions follow:

Region I, Director John Glancy, C.O., of Boston. Meets April 21-22, at the Charter House, Cambridge, Massachusetts.

Region II, Director Benedict Pecorella, C.P.O., of Buffalo, New York. Meets May 13 at the Americana Hotel, New York City.

Region III, Director Rudi Bindi, C.O., Baltimore, Md. Meets April 23-24, at the Lycoming Hotel, Williamsport, Pa.

Region V, Director Cletus E. Iler of Saginaw, Michigan. Meets June 3-5, at the Pontchartrain Hotel in Detroit, Michigan.

Region VI, Director John A. DeBender, C.O., Chicago, Illinois. Meets June 24-26, at O'Hare Inn, DesPlaines, Illinois.

Region VII, Director Everett F. Haines, C.P., Des Moines, Iowa. Meets April 15-16, at Johnny & Kay's Motor Inn, Des Moines, Iowa.

Region IX, Director Leroy E. Noble, C.O., Whittier, California. Meets May 13-15, at the Newporter Inn, Newport Beach, California.

Region X, Director Earl Cummings, C.P., Sacramento, California. Meets May 21-22, at the Sacramento Inn, Sacramento.

Region XI, Director William L. Bartels, C.O., Portland, Oregon. Meets June 16-19, at Seattle, Washington.

Survey of the Diabetic Amputee*

By A. L. WILSON, M.B., Ch.B., D.P.H.,

Senior Medical Officer, Scottish Home and Health Department

This survey includes all lower limb amputees who attended the five artificial limbe centres during 1964 and were fitted with a prosthesis for the first time. All patients suffered from diabetes and had their limb amputated on account of diabetic gangrene or chronic ulceration which did not respond to treatment.

The amputees referred to in Tables 1 and 2 were alive at the time of the surgery, a minimum of nine months and a maximum of 22 months after amputation.

TABLE 1

VASCULAR DISEASE WITH LOWER LIMB AMPUTATED

	Vascular Disease Only (A)		Vascular Disease with Diabetes (B)		All Cases		% Total	
Male	95	(12)	27	(2)	176	(14)	69.3	(100)
Female	40	(2)	29	(1)	87	(3)	79.3	(100)
	135	(14)	56	(3)	263	(17)	72.6	(100)

The figures in parentheses represent the number of double leg amputees included in each total.

TABLE 2

AGE GROUP AT DATE OF AMPUTATION

Vascular Disease Only

	30-39	40-49	50-59	60-69	70-79	80-89	All Age Groups
(A)							
Male	2	6	13 (2)	32 (3)	31 (7)	11	95 (12)
Female	2	2	1	9	16 (2)	10	40 (2)
	4	8	14 (2)	41 (3)	47 (9)	21	135 (14)

Vascular Disease with Diabetes

	30-39	40-49	50-59	60-69	70-79	80-89	All Age Groups
(B)							
Male	—	2	2	17 (2)	5	1	27 (2)
Female	—	—	4 (1)	12	10	3	29 (1)
	—	2	6 (1)	29 (2)	15	4	56 (3)

The figures in parentheses represent the numbers of double leg amputees included in each total.

* Reprinted by permission of the author and editors from *Scottish Health Bulletin*, Vol. XXIII, No. 4, September 1965, pp. 79-80.

Table 1 shows number of patients who had lower limb or limbs amputated for vascular disease and those with vascular disease associated with diabetes. 69.3% of all male amputees and 79.3% of all female amputees were the result of vascular disease with or without diabetes and 22.1% males and 42% females of those with vascular diesease suffered from diabetes.

Table 2 shows sex and age distribution of amputees with vascular disease and vascular disease associated with diabetes; Tables A and B show the majority are 60 years or over. In the case of the vascular group, the greatest number are in the 70-79 age group (34.8%), whereas in the diabetic group more than half are in the 60-69 age group (51.8%).

Deceased

Three males and four females died within one year following amputation, making a total of 63 primary amputees for 1964. One of the three males who died was a bilateral amputee. 11.1% primary diabetic amputees died within one year.

Site of Amputation

Table 3 shows the site of amputation by sexes. Only in the case of one male and two females was the myoplastic surgical technique performed. Five males and four females included in Table 3 had to have re-amputation. Details of re-amputation are given in Table 4.

TABLE 3

SITE OF AMPUTATION

	Male	Female	Total	%
A/K	11	10	21	37.5
T/K	3	3	6	10.6
B/K	13	15	28	50.0
Symes	—	1	1	1.9
	27	29	56	100.0

TABLE 4

RE-AMPUTATIONS

Male		Female	
T/K	to A/K	B/K	to A/K
B/K	to A/K	Symes	to B/K
Symes	to B/K	Pirogoff	to B/K
Chopart	to B/K	Toes	to B/K
Toes	to B/K		

Delayed Healing

Excluding the nine patients who required reamputation, six males and five females suffered from delayed healing of the stump. Most of these patients presented a problem at the prosthetic fitting stage due to flexion contracture. The patients who had delayed healing were seen at the artificial limb clinics between two and six months following amputation, whereas the 36 patients who had no complications after amputation were fitted with a temporary pylon within one month of amputation.

Other Disabilities

Defective vision was present in seven cases to a marked degree and one patient was totally blind. Two patients had intermittent claudication of the remaining limb, and a further two patients had had lumbar sympathectomy with fair results.

Degree of Diabetes

Seventeen (30.3%) patients were controlled by diet, 19 (33.9%) were controlled by oral hypoglycaemics and 20 (35.8%) were controlled by insulin. The severity of diabetes had no relationship to the site of amputation.

Type of Artificial Limb

The 36 patients who had no complications after amputation and where the stump healed quickly were supplied with a pylon and, with one exception, are now wearing standard artificial limbs.

The 11 patients with delayed healing were fitted with pylons, nine went on to be supplied with standard limbs, one has been submitted permanently to hospital and one is confined to a wheel-chair.

The nine patients who required re-amputation were fitted with pylons, six went on to be fitted with standard limbs, the remaining three no longer wear a prosthesis.

Walking Ability

Fifty patients achieved some degree of independent mobility through the use of a prosthesis, 12 could be classed as good walkers, the remainder required one or two sticks to get about, and the distance varied from being confined to the house to a short distance from their home. Males made better use of their prosthesis than females.

Summary

Sixty-three primary diabetic amputees are included in this survey. Seven (11.1%) died within one year of amputation.

22.1% male amputees and 42% female amputees with vascular disease suffered from diabetes. The majority were 60 years and over.

Five males and four females required re-amputation and 11 patients had delayed healing of the stump. The level of amputation is difficult to decide particularly in the elderly. Whitefield[1] considers the level of amputation should as far as possible be selected to allow the patient to make use of the most suitable available prosthesis. Defective vision was the main additional disability.

The diabetes in 17 patients is controlled by diet, in 19 patients by oral hypoglycaemics and in the remaining 20 by daily insulin.

The walking ability of patients included in this survey compares favourably with the report by Cameron Lennard-Jones, Robinson.[2] This may be due to fitting the patient as early as possible with a temporary pylon to enable the patient to be ambulant as soon as possible after operation.

As in the survey by Wilson,[3] males were more efficient with their prosthesis than females.

REFERENCES

(1) Whitefield, George, (1964) *Hlth. Bull. (Edin.)*, Vol. 22, p. 4.

(2) Cameron, Lennard-Jones, Robinson, (1964), *Lancet*, Vol. 2, p. 605.

(3) Wilson, A. L., (1964) *Hlth. Bull. (Edin.)*, Vol. 22, p. 4.

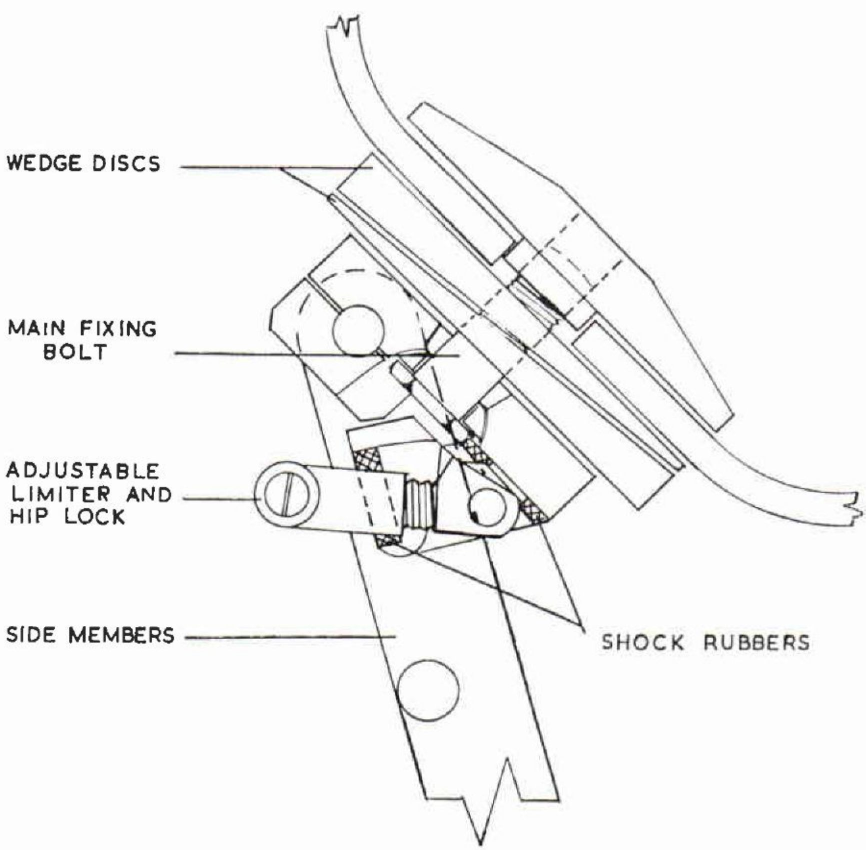
NEW HIP UNIT FOR THE CANADIAN HIP DISARTICULATION PROSTHESIS*

By GEORGE MURDOCH, M.B., F.R.C.S.Ed.,

Dundee, Scotland

This mechanism is designed to simplify the manufacture and fitting during trial of the prosthesis used for hip disarticulation and hindquarter amputations.

A split wedge-disc is interposed between socket and the artificial joint itself. This allows alteration of the spatial relationship between socket and



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joint. It permits a full 10° adjustment on either side of neutral about the vertical and lateral axes and unlimited movement about the longitudinal axis.

During fitting trial the socket is attached to the unit by a single ½″ bolt and after satisfactory alignment is achieved, a further four ¼″ high tensile screws lock the socket and hip joint unit together.

In accordance with British practice the design includes a hip limiter (stride length adjustment) with a range of from 8° to 20°. Slightly modified the same unit can be used as a hip lock when required.

The device is designed for use with glass reinforced plastic sockets. The antero-lateral corner of the socket is built-up and shaped to accept the unit. The interior form of the socket is reconstituted with a foamed silicone rubber. This hip unit can also be used with a blocked leather socket but a steel tuber plate would be required as the leather would not be strong enough locally to sustain the loads imposed upon it.

This device was designed and constructed in the Prosthetic Research Department of Robert Kellie & Sons, Artificial Limb Manufacturers, Dundee, who have a patent pending. A limited trial of this unit is being carried out.

* * * *

A NEW WEDGE-DISC ALIGNMENT UNIT

By GEORGE MURDOCH, M.B., F.R.C.S.Ed., Dundee

This unit, which embodies the now familiar wedge-disc angular displacement principle, incorporates several distinctive features which will prove valuable to the prosthetist.

An external locking ring is used to facilitate adjustment while the prosthesis is being worn.

The locking ring allows simpler attachment to sockets and eliminates the need for a socket container. Furthermore it is readily fitted to any type of foot or ankle mechanism.

There is axial stability of the unit when unlocked as the design includes a ball with a peg located in a slot thus permitting tilt but no rotation.

Instability, i.e., "wobble," is avoided when the unit is unlocked. This is achieved by use of a rigid vertical bolt and an arrangement whereby the wedges slide, one on the other, to compensate the variation in geometry due to tilt. This also ensures that there is no tendency to shift from a given angle to a lesser angle.

A later model of the unit described and illustrated here incorporates a tab washer placed between the locking ring and the adjacent wedge-disc. This modification ensures no loss of setting during tightening.

The unit can easily be fitted with a slide to enable antero-posterior or medio-lateral displacement independent of tilt, the whole unit still being locked with a single locking ring.

The actual bolt and locking unit, ⅜″ diameter B.S.F., is made of high tensile steel. The remainder of the unit may be fabricated in dural or even plastic material with suitable mechanical properties.

The unit is capable of incorporation within the definitive prosthesis once the correct alignment is achieved at the completion of rehabilitation. This can best be accomplished by the use of an epoxy resin.

This device was designed and constructed in the Prosthetic Research Department of Robert Kellie & Sons, Artificial Limb Manufacturers, Dundee, who have a patent pending. An evaluation trial of fifty patients is being carried out.

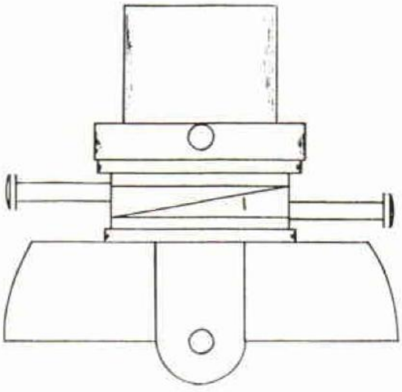

FIG. 1

Sketch of Split Wedge Alignment Unit Assembled

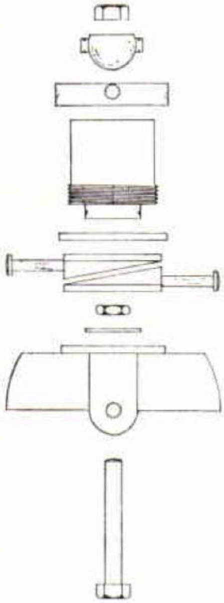

FIG. 2

Unit in exploded form showing from above down: locking nut, ball, locking ring, threaded body with ball seating washer, pair of wedge-discs, clamp nut and washer, ankle base, steel bolt.

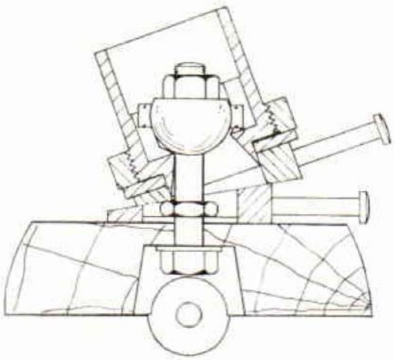

FIG. 3

Sectioned drawing of the unit illustrating tilt

Late Sequelae of Amputation*

THE HEALTH OF FINNISH AMPUTATED WAR VETERANS

By KAUKO A. SOLONEN, H. J. RINNE, M. VIIKERI and E. KARVINEN

Helsinki, Finland

PART II

(Part I of this article appeared in the December 1965 *Orthopedic and Prosthetic Appliance Journal*)

Findings in the Back and Spine

Back pain constitutes the commonest complaint among amputees. Table 16 gives the history of back symptoms causing temporary unfitness for work or repeated marked disturbance which has occurred for a minimum period of half a year.

TABLE 16

CHIEF SITE OF BACK PAIN

Group	Cervical spine %	Thoracic spine %	Lumbar spine %
AE	8	2	48
BE	8	4	33
AK	—	—	65
BK	1	1	73
C	1	2	35

It was found that in lower limb amputees pain in the lumbar spine was highly significantly commoner than in the control group and in upper limb amputees. In upper limb amputees pain in the cervical spine was commoner than in the other groups.

Postural scoliosis often occurs in order that the balance be maintained when the centre of gravity has been displaced as a result of the loss of an upper or lower limb. Table 17 lists the cases of scoliosis occurring in the present series calculated as a percentage of the number of cases of each group.

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* Reprinted by permission of the editor and authors from *Annales Chirurgiae et Gynaecologiae Fenniae*, Vol. 54, Supplement 138, 1965, is from the Kaskisaari Rehabilitation Centre and the Institute for Occupational Health in Helsinki, Finland.

TABLE 17

SCOLIOSIS (AS A PERCENTAGE OF THE NUMBER OF PERSONS OF EACH GROUP)

(Site of greatest scoliotic curvature)

Group	Thoracic spine		Lumbar spine	
	Clinical	Radiological	Clinical	Radiological
AE	92	46	19	21
BE	67	42	17	17
AK	20	28	50	28
BK	24	29	32	22
C	1	22	5	16

The clinical observations were made while the patient was standing, the lower limb amputees with prosthesis and shoes on, the upper limb amputees generally without their prosthesis. As a rule, the scoliosis seemed to become corrected when the patient was lying down. However, radiograms showed that there were also numerous cases of scoliosis in the control group, even when the person examined was in the recumbent position. Radiologically demonstrable deviations of 5 mm were regarded as scoliosis. The thoracic scoliosis in the upper arm amputees was always directed towards the side of the stump. In one-eighth of the forearm amputees with thoracic scoliosis it was directed towards the healthy side. In one-fifth of the cases of lumbar scoliosis in amputees with an amputated thigh, the scoliosis was directed towards the intact side and, correspondingly, almost one-quarter of the cases of lumbar scoliosis diagnosed in the lower leg amputees were convex towards the intact side. In thigh amputees the direction of the scoliosis seemed clearly to depend on a poor, mostly short and tender, stump or on a poor prosthesis and this also seemed to be the reason in many of the cases of lower leg amputation.

It can be concluded that clinically established thoracic scoliosis is statistically highly significantly commoner in upper limb amputees than in the control group.

Clinically, the difference is also highly significant between upper and lower limb amputees, clear enough to allow the statement that clinically demonstrable thoracic scoliosis is typical of upper limb amputees. Likewise radiologically thoracic scoliosis is significantly commoner in upper limb amputees than in other groups ($P < 0.05$). With regard to the incidence of thoracic scoliosis the lower limb amputees hardly differ radiologically from the control group, while the upper limb amputees clearly do so.

The frequency of clinical lumbar scoliosis is significantly higher in lower limb than in upper limb amputees.

Radiologically there is no significant difference in this respect between upper and lower limb amputees, although, reckoned in per cent, lumbar scoliosis is commonest in thigh amputees, and in all groups of amputees commoner than in the control group. Borgmann observed lumbar scoliosis radiologically in about 45 per cent of thigh amputees and Arens in about 80 per cent of lower limb amputees.

It should be mentioned for the sake of comparison that Moreton and others (1958) in a pre-employment radiological examination demonstrated scoliosis of the lumbar spine in 1.3 per cent of 13,000 (non-amputated) men whose average was 26 years. Here a deviation of 10 mm was considered a scoliotic curvature. In Crow and Brogdon's (1959) series of 936 air force cadets aged 17 to 27 years, scoliosis occurred in 0.5 per cent. It should be noted that in this series a deviation of over one inch was considered scoliosis.

Other changes in the curvature of the spine were changes in the degree of thoracic and lumbar curvature. A deviation from the normal is difficult to establish and to classify reliably. An increase of the normal thoracic curvature was clinically estimated to be present in 13 per cent and radiologically in 5 per cent of the lower limb amputees, and clinically in 19 per cent and radiologically in 12 per cent of the upper limb amputees, clinically in 37 per cent and radiologically in none of the patients with two stumps, and clinically in 7 per cent and radiologically in 1 per cent of the controls. A reduced thoracic curvature was present clinically in 12 per cent and radiologically in 2 per cent of the lower limb amputees, clinically in 21 per cent and radiologically in 4 per cent of the upper limb amputees, clinically in 12 per cent and radiologically in 0 per cent of patients with two stumps, and clinically in 1 per cent and radiologically in 2 per cent of the controls.

The lordosis of the lumbar spine was considered to be increased in lower limb amputees clinically in 8 and radiologically in 11 per cent of cases, in upper limb amputees clinically in 1 and radiologically in 27 per cent of cases, in amputees with two stumps clinically in 0 and radiologically in 3 per cent of cases, in the control group clinically in 2 and radiologically in 3 per cent of cases. The lumbar lordosis was flattened in lower limb amputees clinically in 18 and radiologically in 2 per cent of cases, in upper limb amputees clinically in 21 and radiologically in 0 per cent of cases, in amputees with two stumps clinically in 25 and radiologically in 0 per cent of cases and in the control group clinically in 8 and radiologically also in 8 per cent of cases. Radiography of the spine was carried out with the subject to be examined in a recumbent position.

It will be observed that changes in the shape and carriage of the spine are commoner in amputees than in uninjured persons. This phenomenon does not, however, seem to follow any rules that could be clearly correlated, with, for instance, the type of amputation, the stump, the use of a prosthesis or the occupation. Evidently the change in posture necessary for the maintenance of balance, the quality of the prosthesis and the exceptional movement that is necessary force the trunk, when upright, into a changed position which depends on many factors, different in each individual case, and this changed position may be manifested as an abnormal curvature of the spine.

The results of radiological examination of the spine are also given in tables 18—20.

TABLE 18

RADIOLOGICAL FINDINGS IN THE CERVICAL SPINE

Group	Flattening of a disc %	Osteochondrosis %	Spondylarthrosis %
AE	15	10	27
BE	21	21	17
D	6	—	—
C	21	4	18

TABLE 19

RADIOGRAPHIC FINDINGS IN THE THORACIC SPINE

Group	Spondylosis deformans %	Spondyl-arthrosis %	Scheuermann's kyphosis %
AE	21	15	17
BE	50	4	—
AK	31	20	8
BK	32	13	20
D	42	—	24
C	25	16	9

TABLE 20

RADIOGRAPHIC FINDINGS IN THE LUMBAR AND SACRAL REGIONS OF THE SPINE

Radiographic finding	Upper arm amputees %	Forearm amputees %	Thigh amputees %	Lower leg amputees %	Double amputees %	Control group %
Osteochondrosis	—	12	9	10	—	5
Spondylosis deformans	27	50	31	34	35	14
Flattening of the intervertebral disc	—	4	9	12	6	8
Scheuermann's kyphosis	6	—	2	4	6	8
Spondylarthrosis	12	—	9	13	12	9
Sacrum horisontale	2	—	—	1	6	1
Spondylolisthesis	8	—	2	—	—	—
Arthrosis of the sacro-iliac joint	—	—	5	3	—	2

There do not seem to be any significant differences in the frequency of flattening of an intervertebral disc or the other abovementioned changes between the control group and the upper limb amputees. In all groups a flattened disc is commonest in the two lowest intervertebral spaces of the cervical spine. In the remaining cases the condition occurred in the spaces C3 to C5 or in several simultaneously.

Osteochondrosis of the cervical spine was commoner in amputees than in the control group. There was no difference between the groups in regard to localization. The percentage of spondylarthrosis was higher for amputees than for the controls.

It will be seen from the table that spondylosis deformans was commonest in the group of forearm amputees. The difference as compared with all other groups, however, was not statistically significant There are no significant differences between the frequency values for spondylarthrosis.

In the literature, the following incidences of Scheuermann's kyphosis have been reported: Söderberg and Andrén (1955) 23—33.5 per cent, Crow and Brogdon 20.7 and Rübe and Hemmer (1962) 20.18 per cent. In some groups of our series the frequency of Scheuermann's kyphosis is of the same magnitude.

The radiographic findings given in table 20 were absent in 10 upper arm amputees, 6 forearm amputees, 16 thigh amputees, 26 lower leg amputees, 3 amputees with two stumps and 20 subjects of the control group.

Spondylosis deformans was clearly commoner in amputees than in the control group. In the groups of upper and lower limb amputees the percentage of cases is about equal. Spondylosis deformans occurred in about 52 per cent of the thigh amputees investigated by Borgmann.

Fritz and Aufdermaur (1950) describe a case in which clear spondylosis deformans and scoliosis developed in a thigh amputee within a few years. These authors believe that a prosthesis of the wrong length may cause scoliosis and spondylosis deformans on the side of the concavity of the lumbar spine.

Statistically significant differences between the different groups are not demonstrable in osteochondrosis of the lumbar spine, flattening of the disc, Scheuermann's kyphosis and spondylarthrosis.

When these results are compared with the results obtained in investigations on non-amputated persons it should be mentioned that in Allen and Lindem's (1950) series of 3000 men degenerative changes in the lumbar spine were present in 13 per cent of cases, while changes indicative of disc degeneration occurred in 1.13 per cent of cases only. Chrom (1945) found osteochondrosis in patients with back pain in about 15 per cent of cases and in less than 2 per cent in healthy persons. Tammia (1940) demonstrated osteochondrosis in about 6 per cent of cases, Hanraets (1959) found spondylarthrosis in 60 per cent of persons over 50 years old and in 50 per cent under 40 years old. In Runge's (1954) radiological investigation, which comprised over 4000 workers in heavy industry, some pathological finding was made in the lumbar spine in 25 per cent of cases.

In amputees, lack of symmetry in the tonus of the back muscles is often observed (Solonen and Aho, Lindemann and others 1963). Table 21 gives the deviation from the normal observed at clinical examination of the muscles of the back in the present material.

TABLE 21

ASYMMETRIC TONUS OF THE ERECTOR MUSCLES OF THE TRUNK

Group	Increased muscular tonus	
	On the intact side %	On the side of the amputated limb %
AE	—	92
BE	—	92
AK	23	63
BK	22	54
C	5	

Muscular tonus, motility of the back and level of shoulders were determined while the patient was standing upright (lower limb amputees with prosthesis and shoes, upper limb amputees with prosthesis) as relaxed and symmetrically as possible. Even though a result obtained by palpation might seem unreliable, the variation in muscular tonus was often considerable and even clearly visible.

Estimation of the movements of the back solely by eye is inexact. The following observations were made (table 22).

TABLE 22

LIMITATION OF MOVEMENTS OF THE BACK (FORWARD BENDING, LATERAL BENDING AND/OR ROTATION IN BOTH DIRECTIONS)

Group	Limitation of movement (in per cent of group)
AE	46
BE	33
AK	23
BK	31
D	41
C	28

From this we can only conclude that in amputees with two stumps and in upper arm amputees the motility of the lumbar spine may more often be limited than in the other groups.

Clear changes in the motility of the cervical spine were not observed even in upper limb amputees. In the present series there were hardly any diseases traceable to irritation of or pressure on nerve roots or bundles of the region of the cervical spine.

Drop shoulder is often observed in amputees. Observations in this respect in the present series are given in table 23.

TABLE 23

ASYMMETRIC HEIGHT OF SHOULDERS
(in per cent of the no. of persons in each group)

Group	Higher on the amputated side	Higher on the non-amputated side	
AE	90	4	
BE	71	8	
AK	23	15	
BK	17	15	
		Right	left
C	.	17	10

It should be mentioned that in the control group the asymmetry observed was insignificant and, as a rule, less marked than in amputees. In upper limb amputees the shoulder on the amputated side is often pushed forward (Solonen and Aho). In the present series this occurred in about 70 per cent of upper arm amputees and in about 30 per cent of forearm amputees. We did not determine the degree of this hunching. It was demonstrable when the patient's shoulders were observed from above, with the patient standing on the floor and the examiner on a platform. This phenomenon has been described by Loeschke in kyphotics (1914).

Findings in the Lower Limbs

The following observations were made on the motility of the hip joints in thigh amputees: In the amputated limb there was marked limitation of motility in about 39 per cent and flexion contracture of at least 10 degrees in about 15 per cent of cases. In the hip joint of the intact lower limb limited motility was observed in one case only. In the control group there was limited motility of the hip joint in only one case. In leg amputees there was full motility of the hip joint on the amputated side in all cases, while flexion was limited in two cases in the intact limb. The radiographic findings in the hip joint are given in table 24.

TABLE 24

RADIOGRAPHIC FINDINGS IN THE HIP JOINT

Group	Arthrosis coxae		Protrusio acetabuli	
	Amputated side %	Non-amputated side %	Amputated side %	Non-amputated side %
AK	31	38	2	2
BK	15	17	1	2
	right	left	.	—
C	13	15		

In the above table the arthrosis deformans has been stated to occur on that side on which the arthrotic changes were more clearly demonstrable. In about half the cases arthrosis was also observable more or less clearly on the other side.

There is no significant difference in the incidence of arthrosis between the group of leg amputees and the control group. In the hip joints of the intact limb in thigh amputees there is a slightly higher incidence of arthrosis than in the hip joint on the amputated side, but in both there is significantly more arthrosis than in the hip joint of persons of the control group.

Protrusion of the acetabulum was rare in both groups of lower limb amputees. This radiographic finding was not made in the control group.

No significant limitation of the motility of the knee could be observed in the groups of thigh and lower leg amputees or in the control group. Chondromalacia of the patella was a common finding (cf. Kallio 1947), as shown by table 25.

TABLE 25

CHONDROMALACIA PATELLAE

Group	Intact lower limb %	Amputated lower limb %
AK	75	.
BK	62	57
C	53	.
	(right and left)	

The diagnosis was based on the common clinical symptoms of this disorder. Chondromalacia of the patella is commoner in the group of lower limb amputees than in the control group while there is no clear difference between thigh and lower leg amputees.

The radiographic findings in the knee joint are given in table 26.

TABLE 26

RADIOGRAPHIC FINDINGS IN THE KNEE JOINT

Group	Arthrosis genus		Arthrosis genus bilateral %
	Amputated limb %	Intact limb %	
AK	.	25	.
BK	22	27	17
	right	left	
C	21	21	23

There is no statistically significant difference between the different groups.

In the whole series of lower leg amputees there was but one in whom marked arthrotic changes in the knee were observed. All the other cases of arthrosis in both the control group and the amputees were slight. Heine (1927) found at autopsy that arthrosis was considerably commoner in the intact knee of thigh amputees than in non-amputated persons.

The motility in the talocrural joint of the intact leg was clearly reduced only in one case of thigh amputation, in three lower leg amputees and in one subject of the control group. There was clinical reason to suspect arthrosis of the intact ankle joint of three lower leg amputees and one thigh amputee.

The radiographic findings are seen in table 27.

TABLE 27

RADIOGRAPHIC FINDINGS IN THE ANKLE JOINT

Group	Talocrural arthrosis %
AK	15
BK	10
D	6
C	2

According to table 27, there was significantly more talocrural arthrosis in leg and thigh amputees than in the control group ($P < 0.05$).

Flat-foot

The frequency of flat-foot in lower limb amputees and the control group is given in table 28.

Flat-foot was highly significantly commoner ($P < 0.001$) in lower limb amputees than in the control group. The deformity was, as a rule, slight. This group also includes feet broadened in their distal portion owing to

TABLE 28

PES PLANUS, PES PLANOVALGUS

Group	Pes planus or planovalgus %
AK	83
BK	94
C	53

weakness of the intrinsic muscles; this condition is often called pes transversoplanus. The flat-feet were in most cases subjectively symptom-free. The radiographic findings are given in table 29.

TABLE 29

RADIOGRAPHIC FINDINGS IN THE FOOT

Group	Calcaneal spur %	Arthrosis of the 1st metatarsophalangeal joint %	Arthrosis of the joints of the foot %	Changes indicating postfractural condition %
AK	3	8	8	3
BK	—	5	6	2
C	—	17	1	—

There was slightly more arthrosis of the joints of the foot in the group of lower limb amputees than in the control group. The arthrotic changes were commonest in the talonavicular joint.

Arthrosis of the 1st metatarsophalangeal joint was slightly commoner in the control group.

Circulatory Disturbances

Varicose veins occurred in the intact limb in 2 per cent of the leg amputees, 5 per cent of the thigh amputees and 9 per cent of the control group. Arteriosclerosis obliterans of the lower limbs was observed in 1 per cent of the lower leg amputees and 4 per cent of the forearm amputees.

Circulatory disturbances of the upper limbs were not demonstrable in the clinical investigation.

Miscellaneous

Such sequelae of amputation as atrophy of the stump and of the muscles directly concerned in its motility, and changes in the skin of the stump and in the subcutaneous tissue will not be considered here, except insofar as they have influenced the classification of the stump as good, satisfactory or poor. The occurrence of such changes after amputation is regular and unavoidable. This also applies to radiographically demonstrable but, as a rule, clinically insignificant osteophytosis of the stump which occurred in all groups of amputees, varying from 19 per cent (lower leg amputees) to 46 per cent (thigh and forearm amputees).

Phantom Limb Pain

The phantom limb problem has not been dealt with in detail in the present work since the same series has recently been used to investigate this phenomenon (Solonen 1962). Table 30 gives the information obtained in the present investigation:

TABLE 30

SIGNIFICANCE OF PHANTOM LIMB PAIN

Group	Great inconvenience %	Slight inconvenience %	No inconvenience or phantom %
AE	42	33	25
BE	4	63	33
AK	60	20	20
BK	26	31	43
D	35	18	47

Great inconvenience means persistent pain which disturbs work and sleep, slight inconvenience means rare occurrence of phantom pain which does not significantly reduce working capacity.

PHYSIOLOGICAL EXAMINATION

Exercise is of the utmost importance from the point of view of physical condition. Since amputation of a lower limb in particular renders movement more difficult, it is to be expected that the exercise obtained by a lower limb amputee will differ from that of a normal person not only in quantity but also in the degree of effort required. The result may be a change in the physical condition of the amputee. We therefore deemed it advisable to examine the physical condition of the amputee by physiological methods.

Determination of condition was based on ergometric tests.

The circulation in the intact limb and the stump was moreover investigated by registration of the pulse of the limb arteries.

Method

The ergometric test was carried out with a frictional bicycle ergometer (Karpovich 1950). The test was carried out either by pedalling or by winding with the hand. The load was either 10 or 15 kgm/s and the test was carried out for five minutes. An electrocardiogram was recorded (Leads V4, V6 and V4R), before work, during work and 1, 2, and 5 minutes after work while the person examined was still sitting in the saddle of the bicycle. The maximal oxygen uptake was estimated according to Åstrand (1962) on the basis of the ECG pulse rates obtained.

Physical fitness classification was modified from Åstrand's classification by adding a fitness group 6 to accommodate those subjects who could not perform the test. Thus, the fitness classification was as follows:

Class 1 good
Class 2 rather good
Class 3 medium
Class 4 rather poor
Class 5 poor
Class 6 could not perform for the time required

Oscillograms were made both of the intact and the amputated leg with a Cameron heartometer. On the basis of the oscillation amplitude the oscillograms were divided into normal and weak.

Results

The results of ergometry are given in table 31.

The estimated average maximum oxygen uptake is not much lower than in the control series. The estimated average fitness classification for both amputees and controls, including all those who interrupted their test, lies as a rule within the medium range (class 3). A lower average fitness class was only observed in the test which thigh amputees carried out using lower limbs only when the small size of the remaining muscle groups reduce the result and the result cannot here be considered illustrative of the physical fitness of the thigh amputees. When estimated from the result of upper limb performance, the condition of thigh amputees was quite comparable to that of control subjects. That the figures obtained when measuring the condition with upper limbs are lower than those obtained with the lower limbs depends on the fact that the grading is severer for efforts achieved with upper limbs than it is for lower limbs. The average fitness class of persons with two stumps was lower than the figure for the control group. This is perhaps due to poorer adaptation in these cases to cardiovascular stress than in normal persons, as demonstrated by Ruosteenoja and Karvonen (1956) in paraplegics and in double thigh amputees.

The number of interrupted performances was greater in the group of amputees than in the control group. The factors causing interruption in each individual case might merit closer examination.

The oscillographic findings are given in table 32.

It can be seen that the oscillograms of the intact legs are on the whole as normal as those of the control group. The oscillograms obtained from the amputated limbs, however, are throughout weaker.

DISCUSSION AND CONCLUSIONS

A surprisingly large number of the war amputees of the present series, 62 per cent, were engaged in heavy or medium heavy work and over three-quarters were obliged to move about a great deal in their work.

Internal disorders in the history of the amputees were no more frequent than in the control group, neither did they show any trend deviating from the usual.

The use of the prosthesis was most regular in the lower limb amputees and least so in the upper arm amputees. 8 percent of the latter and 4 per cent of the forearm amputees had never used a prosthesis.

Fatigue pain in the intact lower limb was commoner than in upper limb amputees or in the control group. The difference was statistically significant and pain was commonest in the area of the knee and ankle.

Fatigue pain in the area of the ankle was significantly commoner in thigh than in lower leg amputees. Only a few lower limb amputees complained of fatigue pain in the stump.

In upper limb amputees fatigue pain in the intact arm was common. In the control group, however, there was no history of any such disturbance. Fatigue pain in the upper limb stump, particularly in persons who made great use of their stump, was also common in forearm amputees.

Pain in the cervical spine was commoner in upper limb amputees than in the other groups. Symptoms from the lumbar spine, however, were com-

TABLE 31

RESULTS OF ERGOMETRIC TESTS

Group	Maximum oxygen uptake 1/min	Test carried out with lower limbs: Ml oxygen per kg x min. average [1]	Test carried out with lower limbs: Mean fitness classification [2]	Subjects who interrupted the test %	Tests carried out with upper limbs: Maximum oxygen uptake 1/min	Tests carried out with upper limbs: Ml oxygen per kg x min. average [1]	Mean fitness classification [2]	Subjects who interrupted the test %
AE		38.7	3.4	9				
BE		39.2	3.4	13				
AK	2.7	34.3	4.2	13	2.9	35.7	3.9	14
BK		35.8	3.9	10		33.1	4.1	14
D		35.6	4.4	20				
C	3.0	40.1	3.2	3	2.8	38.6	3.9	22

[1] The estimated weight of the missing limb was added to the body weight.

[2] Condition classes according to Åstrand except that those who interrupted the test were referred to a group of their own. The best class is 1, the "medium" is 3.

TABLE 32

OSCILLOGRAPHIC FINDINGS

Group	Intact limb: Normal %	Intact limb: Subnormal %	Weak %	Not measured %	Amputated limb: Normal %	Amputated limb: Subnormal %	Weak %	Not measured %
AE	76	10	5	10	0	4	61	35
BE	89	0	11	0	0	15	85	0
AK	89	0	11	0	2	0	67	31
BK	96	0	4	0	55 [1]—13	11 [1]—13	33 [1]—52	2 [1]—23
D								
C	91	0	6	3				

[1] Thigh; the second figure = lower leg.

moner in lower limb amputees and highly significantly commoner than in non-amputated persons.

Phantom limb pain caused great inconvenience in the groups of thigh and upper arm amputees and was of less consequence to forearm and lower leg amputees.

The investigation revealed that the general condition of the amputees was very good and of the same level as that of the non-amputated persons of the control group.

The results of examinations carried out by an internist were more or less the same in the control group and the different groups of amputees. A tendency to overweight was commonest in lower limb amputees. (We intend to pursue this result more thoroughly in a subsequent investigation in which attention will also be paid to constitutional differences).

In the different groups the stumps were satisfactory or good in $\frac{2}{3}$ to $\frac{3}{4}$ of cases.

Scoliosis of the thoracic spine was very common in upper limb amputees and was observed at clinical examination in as many as 90 per cent of the upper arm amputees. Scoliosis of the throacic spine in upper limb amputees must be considered a characteristic deformity of this group of amputees.

Scoliosis of the lumbar spine was a common clinical and radiological finding in lower limb amputees and was much commoner in upper limb amputees than in the control group.

Other changes in the shape and posture of the spine were also frequent in all groups of amputees, *i.e.* changes in the curvature of the thoracic and lumbar spine. These changes naturally affected the shape of the whole chest, as did also the asymmetric level of the shoulders in upper limb amputees, the commonly occurring hunching of the shoulder on the amputated side and the atrophy of the muscles of the shoulder on the same side. The significance of these changes for the function of the organs of the chest could not be determined.

Besides the many afore-mentioned changes, radiographic examination also showed that the frequency of spondylosis was commoner in all groups of amputees as compared with the control group. No clear difference in the frequency of this degenerative change was observed between upper and lower limb amputees. Neither was such a difference demonstrable with regard to other degenerative changes in the lumbar spine of amputees and non-amputated persons. Radiographically demonstrable arthrosis of the sacroiliacal joint, although rare, seemed to be commonest in thigh amputees.

The frequency of osteochondrosis of the cervical spine as a radiographic finding was commoner in upper limb amputees than in the control group.

The muscles of the back that maintain the changed posture of the amputee exhibit, as a result, an asymmetric tension which is, as a rule, quite evident and clinically demonstrable in most upper and lower limb amputees.

By contrast, disturbed function of the spine is mostly insignificant and not demonstrable by clinical methods.

Objective signs of anamnestic stress symptoms in the amputees were not observable but this fact does not justify the belief that such symptoms do not exist. It would be difficult to assume that a disturbance of function, such as a changed centre of gravity, abnormal weight-bearing on and abnormal use of the intact limb would not in the amputee as in others result in deformities and degeneration, such as unphysiological compression of the affected joints, stretching of the joint capsules, ligaments and muscular insertions with ensuing distress. No doubt the symptoms observed in amputees, as in many other patients suffering from back disorders, originate in such elements of the multifold and multifunctional structure of the back which cannot be demonstrated radiographically and whose clinical symptoms are unspecific. The amputee does not, of course, complain of scoliosis, osteochondrosis, etc., but of symptoms of various organic disturbances such as pain, tenderness, tendency to fatigue, etc. There is reason to believe that with increasing structural and functional disturbances, their symptoms or subjectively demonstrable distress also increase.

In uppe: limb amputees, limited motility of the shoulder joint, together with other symptoms of so-called periarthrosis, was common in the shoulder joint of both the amputated and the intact limb. Periarthrosis was highly significantly commoner in upper limb amputees than in lower limb amputees and the control group; among the latter there was only one case referable to periarthrosis. Radiographically demonstrable degenerative changes of the shoulder joint, however, were not significantly commoner in the amputees than in persons of the control group.

In upper limb amputees limited motility was observed in the elbow joint of the intact limb and also in the amputated limb of forearm amputees. Arthrosis of the elbow joint was radiographically commonest in the intact arm of forearm amputees. Arthrosis of the wrist was radiologically demonstrable in about 4 per cent of cases in the wrist of the intact arm of upper limb amputees. This joint lesion did not occur in the control group.

As would be expected, the motility of the hip joint of the amputated limb was often reduced in thigh amputees. A radiologically demonstrable arthrosis of the hip joint was in these amputees commoner and more serious in the intact than in the amputated limb. The arthrosis was on both sides statistically significantly commoner than in the control group. In lower limb amputees these findings were not so clear. In both groups of lower limb amputees there occurred some cases of protrusio acetabuli, which was not observed in the control group.

In the motility of the knee joint no significant difference could be observed between the different groups of amputees or the control group. By means of clinical examination, however, the conclusion was drawn that chondromalacia patellae was commoner and more distinct in lower limb amputees than in non-amputated persons. In lower leg amputees chondromalacia patellae was somewhat commoner in the intact than in the amputated lower limb. The difference was not statistically significant. Significant differences in the frequency of arthrosis of the knee joint between different groups were not radiologically demonstrable.

No difference was observed in the motility of the ankle joint in the different groups. On the other hand, radiological examination revealed that arthrosis of the talocrural joint was significantly commoner in lower limb amputees than in the control group (the person being the unit).

As a clinical finding, flat-foot was highly significantly commoner in lower limb amputees than in non-amputated persons in whom, however, this insignificant deformity was observed in over 50 per cent of cases.

Radiologically demonstrable arthrosis of the joints of the foot was commoner in lower limb amputees than in non-amputated persons.

The amputees passed the physiological tests for physical condition practically as well as the persons of the control group, the only exception being the amputees with two stumps, one-fifth of whom interrupted the test.

No significant differences in the frequency of circulatory disturbances or vascular diesases between amputated and non-amputated persons could be observed. The oscillographic findings indicate that in the intact arm of the upper limb amputees and the intact leg of the lower limb amputees the arterial circulation is normal, being considerably weaker in the stump than in the intact limb. It should be observed, on the other hand, that the circulation required is less in an amputation stump than in a normal limb.

SUMMARY

The series consisted of 311 disabled war veterans from whose limb amputation an average of eighteen and a half years had elapsed and whose average age was 45 years. The series comprised 48 upper arm, 24 forearm, 65 thigh and 157 lower leg amputees and 17 disabled men with two stumps. The control group consisted of 95 non-amputated men of the same age.

Over three-fifths of the amputees were engaged in heavy or medium heavy work.

The same orthopaedist, internist, radiologist and physiologist carried out the examinations of all amputees and control subjects.

The commonest symptoms of the amputees were back pain and fatigue symptoms, which in the lower back of lower limb amputees were highly significantly commoner than in the control group. In upper limb amputees symptoms from the area of the cervical spine were commoner than in persons belonging to the control group. Fatigue symptoms in the intact leg were also significantly commoner in lower limb amputees than in upper limb amputees or non-amputated persons. Similar symptoms were also common in the intact arm of upper limb amputees and they also commonly complained of symptoms caused by stress on the stump, a complaint that was hardly ever mentioned by the group of lower limb amputees. Phantom limb pain was commonest in thigh and upper arm amputees.

The investigation showed the general physical condition of the amputees to be as good as that of the control group. Disorders of the internal organs and peripheral disturbances in the circulatory organs were no commoner in the amputees than in the control group. The maximum oxygen uptake capacity of the amputees, with the exception of those with two stumps, was fairly similar to that of the controls.

In two-thirds to three-quarters of the different groups the stumps were at least satisfactory.

Scoliosis of the thoracic spine was observed to be a characteristic deformity of the upper limb amputees. Scoliosis of the lumbar spine again was common in lower limb amputees and also commoner in upper limb amputees than in non-amputated persons.

The frequency of spondylosis deformans of the lumbar spine was higher in all groups of amputees than in the control series.

The frequency of degenerative changes in the cervical spine was higher in upper limb amputees than in the control series.

Periarthrosis of the shoulder joint was highly significantly commoner in the upper limb amputees than in the control group. Likewise, limited motility in the elbow joint was most frequent in upper limb amputees and arthrosis of the elbow joint was commonest in the intact arm of forearm amputees. Arthrosis of the wrist was radiologically demonstrated only in a few upper limb amputees.

Radiographic examination revealed that arthrosis of the hip joint was commoner in the intact lower limb of thigh amputees than in the amputated limb and in both significantly commoner than in the control group.

Chondromalacia patellae was slightly commoner and severer in lower limb amputees than in non-amputated persons.

Flat-foot was highly significantly more frequent in lower limb amputees than in the control group, while subjectively it did not seem to be of any great consequence.

As a radiological finding arthrosis of the ankle joint in the intact leg of the lower leg amputees was statistically significantly commoner than in the subjects of the control group and arthrosis of the joints of the foot was also commoner in the former.

In the incidence of other pathological findings and their severity no significant differences were observed between amputees and non-amputated persons.

Acknowledgement. — The writers wish to express their best thanks to the Disabled Ex-Servicemen's Association for the aid, both financial and organizational, received in carrying out this investigation.

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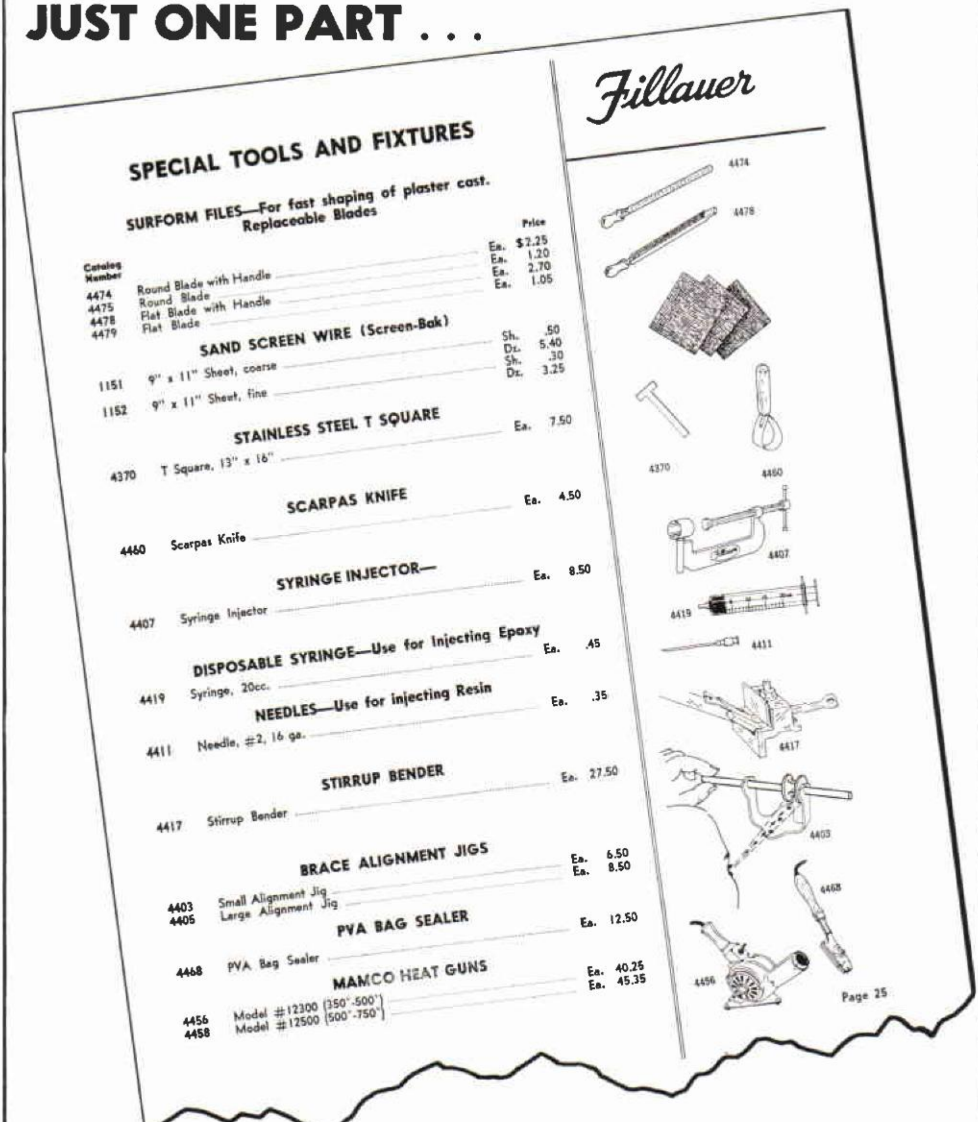

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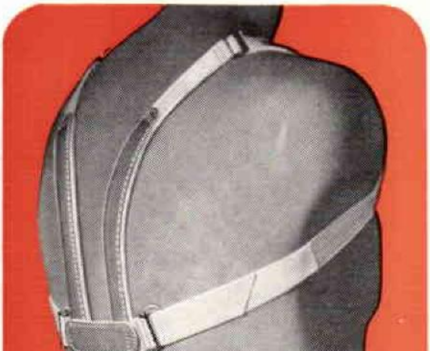
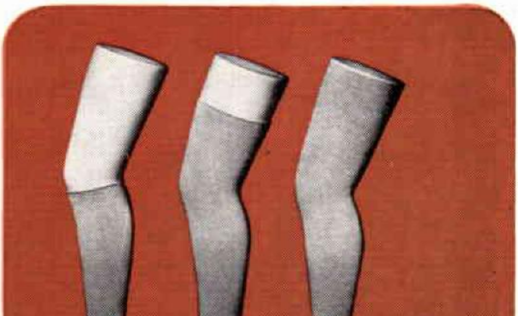
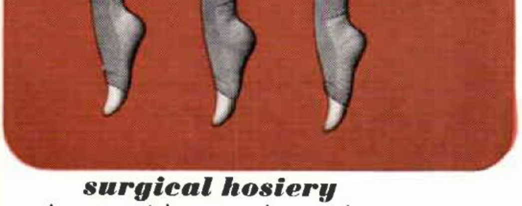
4405	Large Alignment Jig	Ea.	8.50
	PVA BAG SEALER		
4468	PVA Bag Sealer	Ea.	12.50
	MAMCO HEAT GUNS		
4456	Model #12300 (350°-500°)	Ea.	40.25
4458	Model #12500 (500°-750°)	Ea.	45.35



orthopedic appliances
of every variety



surgical hosiery
in any weight, or made-to-order



specialties
wrist splints, universal cervical collars, collars with chin support for men, women and children.

2659

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2

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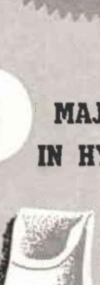
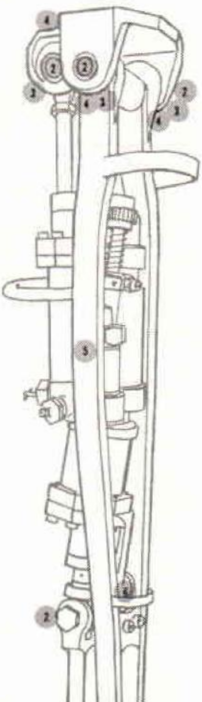
6 MAJOR CHANGES IN HYDRA-CADENCE



1 NEW FOAM RUBBER COSMETIC COVER

Specially designed - of natural foam rubber material with more flexibility, resistant to fatigue and thoroughly tested in the field.



2 BUSHINGS

Fiberite FM 3050
Tested in Hydra-Cadence over one million cycles for resistance to wear, heat, moisture absorption and dimensional stability.

3 SPRING STEEL WASHERS

Located at the knee, ankle, eyebolt and connecting rod. Eliminates noise from wear and side thrust.

4 LOCK SCREWS AND NUTS

Prevents bearings from working loose.

5 FRAME

Knee tube, ankle tube and gussets increased in size, bored and honed for closer tolerance of new FM 3050 bushings.

Frames also have been heat treated for greater tensil strength.

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Enables better alignment of the cartridge in the frame. Eliminates protrusion of the pivot points for better cosmetic appearance.

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