Prosthetic and Orthotic Devices for Nonstandard Prostheses in the Management of Limb Deficiencies

By CHARLES H. FRANTZ, M.D.
Medical Co-Director,
Area Child Amputee Center
Grand Rapids, Michigan
Lecturer in Orthopedic Surgery
Northwestern University Medical School

During the past decade great interest in the child amputee has been manifested by the development of many amputee clinics in this country that devote their efforts exclusively to the child. Paralleling this interest, industry has made an increasing number of prosthetic components available for the child amputee both by miniaturization of standard devices and by special components designed specifically for the child.

In the last ten years, two phenomena have occurred:

1) A tremendous increase in the number of *young* children wearing standard types of prostheses. (Most clinic teams have become very adept at prescription-writing and training these young children.)

2) The appearance of many young children with anomalous extremities at child amputee clinics. Usually their problems cannot be answered by the application of standard appliances or prostheses. These anomalous extremities present problems to the prosthetist and orthopedic surgeon because of gross variation in limb contour, substandard muscle power and serious underlying skeletal deficiencies.

In this evergrowing group of anomalous extremities, restoration of function usually cannot be obtained with the so-called standard prosthetic prescription. The preparation of the mold of the anomalous extremity for socket fabrication requires careful technique to obtain an accurate positive model of the limb (see figures 1-A, -B, -C).

The standard joints which are currently available may not be suitable. The difficulty of suspending prostheses on or across a substandard joint presents complex problems. Many times the team is 'hard-put' to obtain functionally significant power in the transmission system.

In many instances to obtain a comfortable socket or bucket, techniques in mixing the polyester resins must be varied to obtain the desired degree of flexibility and at the same instant maintain durability. Perforations in buckets, large or small, for abnormal contours and relief from underlying bony pressure areas may be frustrating. Energy expenditure and heat dispersion are important considerations when large areas of the body must by necessity be covered.

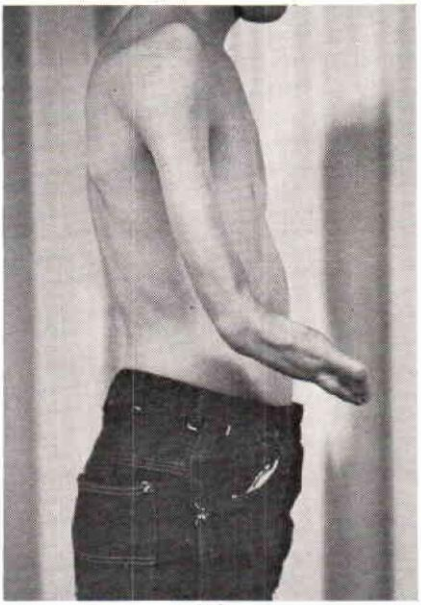
The multihandicapped child with a plurality of limb deficiencies challenges the skill of the prosthetist. He may be called upon to work in close

cooperation with the orthotist. The orthotist may be required to modify upright braces and joints in a nonstandard manner to allow for laminations in the plastic sockets. It is quite evident that these "nonstandard" situations will call for a considerable breadth and depth of knowledge.

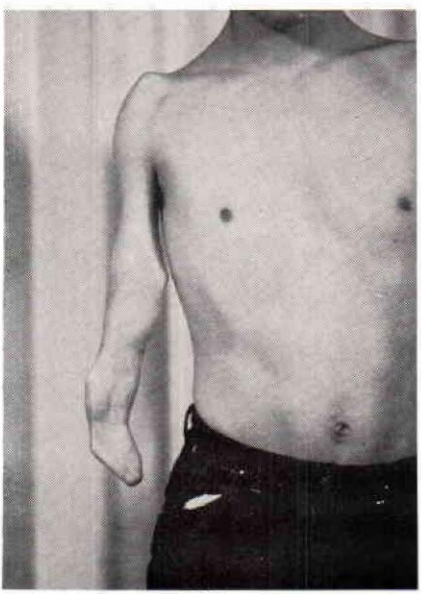
The detailed variations in body contour and lack of power and mobility of proximal joints must be appreciated by all members of the team (see figures 2-A, -B, -C, -D). With an understanding of the basic deficiencies, the necessary modifications in techniques of fabricating a socket and applying a suspension system may proceed (see 3-A, -B). The orthotist may provide crutch modifications to permit ambulation in the lower extremity amelia (see figures 4-A, -B).

Frequently the orthopedic surgeon will elect to manage an anomalous extremity during the early years with a standard type of orthopedic appliance (see figure 5-A). This appliance of course falls within the field of the orthotist. At a later stage, the knowledgeable surgeon

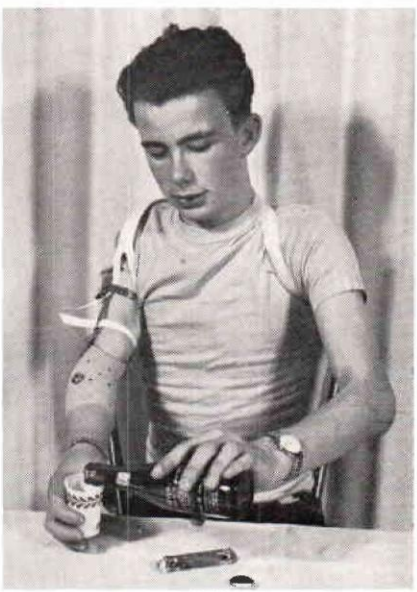
(Continued on page 278)



1-A

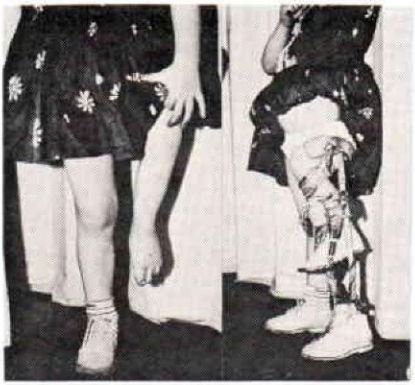


1-B

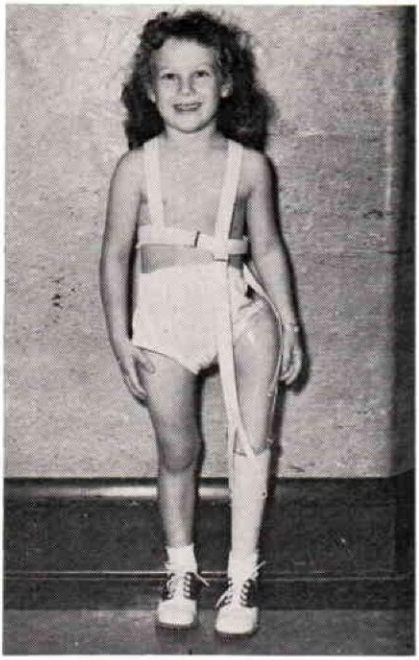


1-C

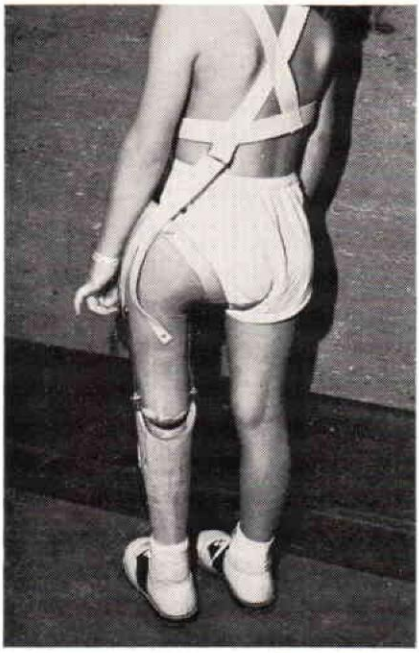
FIGURES 1-A, -B, -C: This fifteen-year-old boy with a deficient forearm is very adept without a prosthesis. He desired length and cosmetic restoration. The anatomical wrist joint has been made the elbow joint. The socket by necessity was padded and relieved to accommodate bony landmarks.



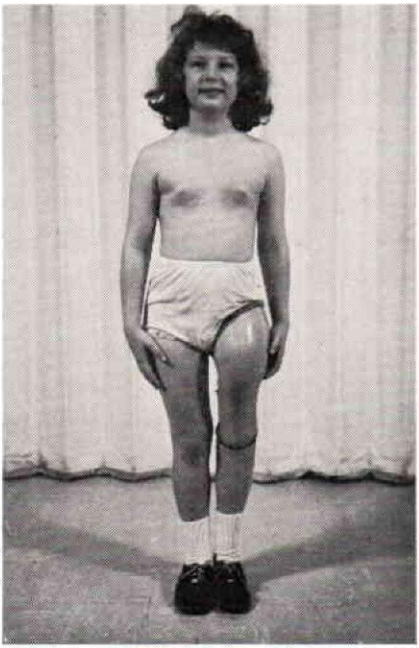
2-A



2-B



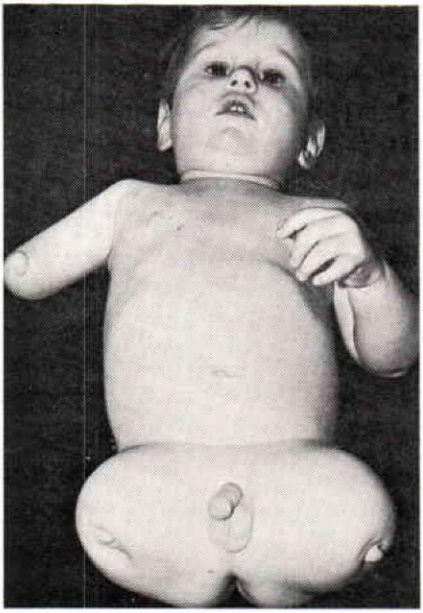
2-C



2-D

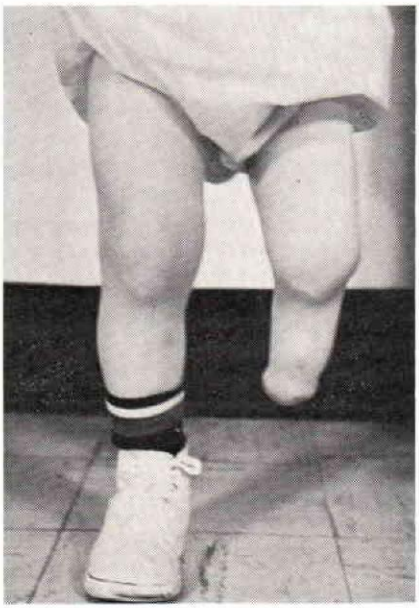
FIGURES 2-A, -B, -C, -D: This girl was born with a proximal femoral focal deficiency; she had an extremely short leg and non-existing hip joint. She managed for four years with the old type of classical ischial-bearing brace and shoe. At age four and one-half the foot was disarticulated, and an ischial-bearing above-knee prosthesis was prescribed. Note that the limb from the knee to the hip is externally rotated, and the socket is in the coronal plane and shaped much like a ship's funnel. The initial suspension was a toddler's harness. Two years later the child was able to maintain stability without harnessing.

FIGURES 3-A, -B: This child is a lower extremity proximal phocomelia (the femurs are absent). The proximal tibial plateaus rest against the pelvic wall with no sockets. These limbs are unstable and can be rotated much like the hands of a clock. The feet were disarticulated. Polyester laminates were used for sockets and for a thoracic support. Note she has hip-locks and aluminum uprights with SACH feet. She is ischial-supported with the lumbar spine stabilized with hip-locks and suspended with over-the-shoulder harness. She has an excellent swing-to gait.



FIGURES 4-A, -B: This bilateral lower amelia is fitted with a stabilizing bucket and aluminum uprights without knee joints. Note the right upper hemimelia. Here a prosthetic crutch is used (standard aluminum tube laminated into an upper arm socket with lateral suspension). (Illustrations 4A and 4B reproduced by permission of the C. V. Mosby Co. from "Management of the Child Amputee," by Charles H. Frantz, M.D., in the "Instructional Course Lectures of the American Academy of Orthopaedic Surgeons," Vol. XVII, pp. 246-295).

5-A



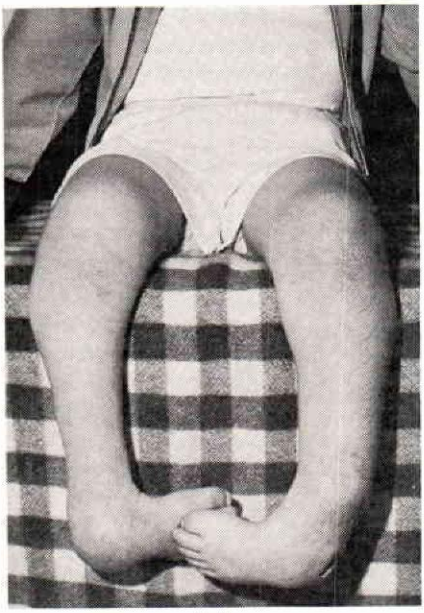
5-B

5-C

FIGURE 5-A: This toddler has a paraxial hemimelia, fibular, with an extremely short lower leg segment. The classical ischial-bearing brace is used for ambulation.

FIGURE 5-B: One year later the ankle was disarticulated to preserve the distal tibial epiphysis.

FIGURE 5-C: He is fitted with a modified standard type of below-knee prosthesis. At a later date he will be fitted with a Syme type of prosthesis.



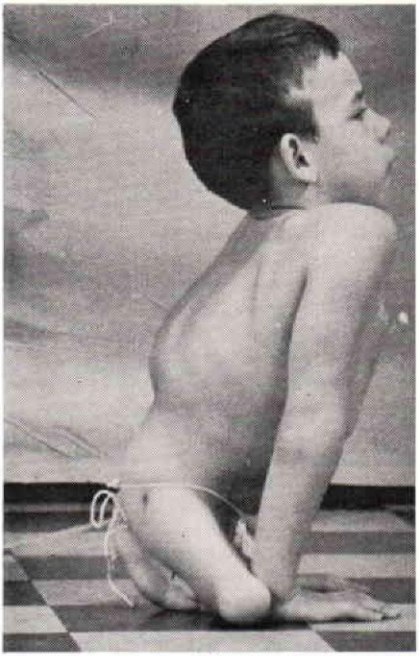
6-A

6-B

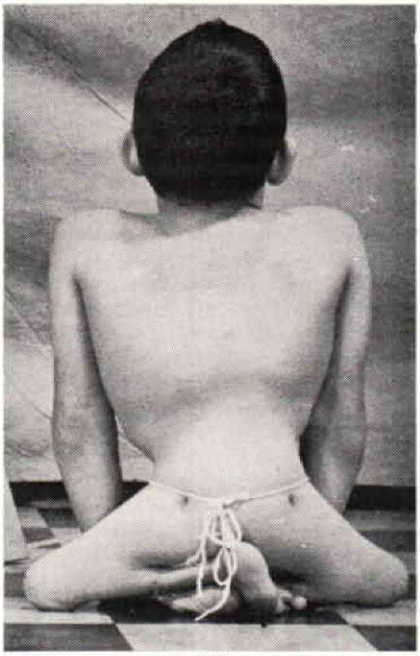
6-C

FIGURE 6-A: This seven-year-old boy is a spina bifida (L 3, 4, 5) with resistive clubfeet, lack of sensation, and ulcerations. There is no lumbar musculature to allow him to stand upright; he buckles forward.

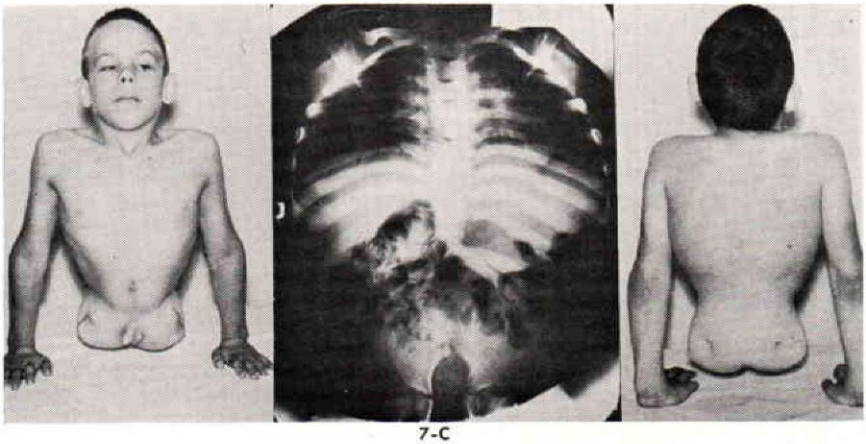
FIGURES 6-B, -C: His feet were disarticulated and he was fitted with polyester endbearing sockets which were fabricated into a modified Williams type of backbrace. He stands erect and is able to swing-to.



7-A

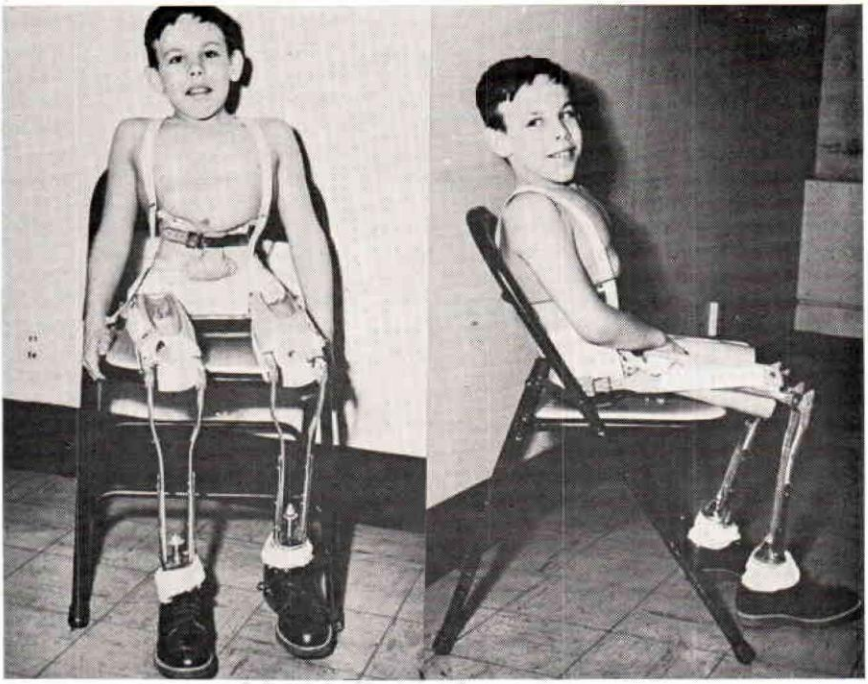


7-B



7-C

FIGURES 7-A, -B, -C, -D: This boy is the classical attitude of congenital absence of the lumbar spine and sacrum. The "Buddha" postion usually is encountered. He has incontinence of bowel and bladder. There is no musculature in the lower extremities. It is completely replaced by fatty tissue. The knees are acutely flexed with a very deep, broad, popliteal web. Sensation is present. The patient underwent bilateral subtrochanteric amputations and was fitted in a plastic laminate bucket with an opening for a urinal bag. Canadian hip joints were utilized with willow-wood thigh pieces. The below-knee segments consist of aluminum double uprights to lessen the weight. SACH feet have been prescribed. Suspension is obtained by over-the-shoulder straps. This boy attends school regularly and is able to get in and out of a chair independently. He has a wide swing-through gait. He is essentially managed as a Paraplegic. (Illustrations 7A, 7B, 7C and 7D reproduced by permission of the C. V. Mosby Co. from "Management of the Child Amputee," by Charles H. Frantz, M.D., in the "Instructional Course Lectures of the American Academy of Orthopaedic Surgeons," Vol. XVII, pp. 246-295).



(Continuation of text from page 272)

who is well acquainted by experience with the life history of the abnormal limb may amputate or disarticulate to obtain a "fitable" stump (see figures 5-B, -C). The emphasis therefore has shifted to the prosthetist who possibly may fit a standard appliance, or more likely a nonstandard socket. These changes in the management of a child with an anomalous extremity may involve either foot, knee, hip, forearm or elbow levels.

A variety of complex nonstandard appliances have been fabricated to meet the needs of many bizarre limb deficiencies when the trunk musculature is substandard. Here a Williams type of backbrace may be attached to two below-knee thigh cuffs (see figures 6-A, -B, -C). There may be the classical aluminum double upright braces fabricated into a pelvic bucket with droplocks (see Figure 3-B).

With these complex situations it is very evident that the orthopedic surgeon, prosthetist and orthotist must combine their skills and judgments to produce satisfactory and functional appliances for the multihandicapped child (see figures 7-A, -B, -C, -D).