# PROSTHESIS FOR THE CHILD—RESEARCH NOTES

By HARRY E. CAMPBELL, C.P.

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A systematic approach to the fabricating, fitting, and maintaining of prostheses for child amputees is beginning to evolve from the experience at the CAPP. Questions frequently asked of the prosthetist include: How frequently does a new prosthesis have to be made for a growing child? What components of a prosthesis have to be replaced because of malfunction or damage? How can a prosthesis be made to last longer? How do you fit the malformed child? What special devices can be provided the child amputee so he can enjoy more fully the activities engaged in by other children? These and many other questions have formed the basis for the present methods of data collection and of experimental studies.

### *Methods of Recording Data*

In order to secure information relating to the need for prosthesis and component repair or replacement, two methods of tabulation are in use:

1. Prosthesis History Card—In addition to the identifying information of each child, the following data are recorded on each card: prescription, date of prescription, date of wrap, date of final fitting, date of check-out, date of photos, and the type of terminal device, wrist unit, elbow unit, etc., where applicable. This card is set up to record this information on five prostheses with space available for other pertinent data, including modifications.

2. Adjustment Frequency Tabulation Card—A system that provides information concerning prosthetic experience by age groups, amputee types, frequency and nature of adjustments. It is from this system that predictive information can be utilized in determining the need for replacement and repair of prostheses and components by age groups and amputee types.

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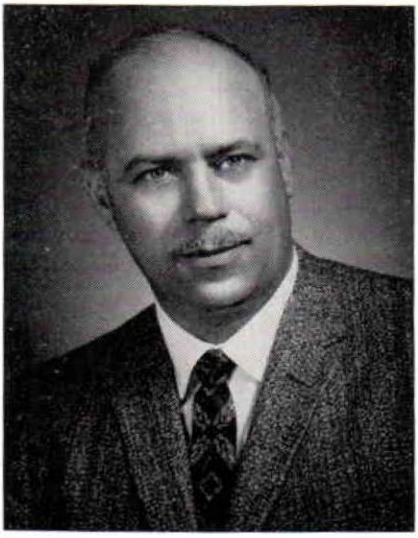


*Special Problems*

For more than a year and a half prostheses, described as standard, have been fabricated for the CAPP patients by private limb makers. This procedure has meant that the prosthetist's time and effort has been devoted to the refinement and development of methods for fitting the more complex types of amputations and malformations. The following examples in no way represent the extent of the work with these special problems, but are only illustrative of some of the approaches in meeting the needs of these children.

1. Elbow-lock Mechanisms for Phocomelias—In several of our phocomelias it has been found advantageous to use finger flexion for elbow lock control. The nature of the malformation of the musculature or the absence of some of the muscles has resulted in limited sources of power and limited ranges of motion for the operation of prosthetic devices.

A 16 year old girl with bilateral upper extremity phocomelias was initially fitted two years ago. She was fitted with modified short above elbow type prostheses because of poor shoulder function. Elbow lock control was achieved by a cable loop through which she could insert her fingers. Active finger flexion through this loop connected to standard cable control, tripped the mechanism to lock and unlock the joint, (Figure 1).

**L. A. Upper Extremity Prosthetics School. Figure 1. Showing lanyard control operated by flexion of wrist and fingers.**

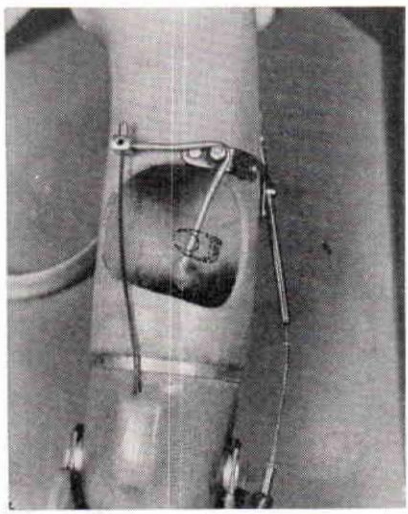


**Figure 2. Showing lever operated cable control activated by finger flexion.**

Modification of such finger control is possible to meet the demands of individual cases, (Figures 2 and 3). In Figure 2 a rod and lever mechanism activated by finger flexion was used to activate the elbow lock. With another patient wearing a child's external elbow joint, activation of the elbow is obtained by finger flexion against a single push rod mechanism instead of through cable pull, (Figure 3).

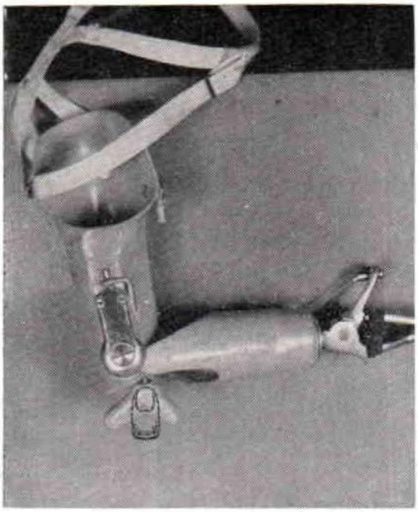


Figure 3. Showing piston type control activated by finger flexion.

2. Harness Application—The need to stabilize the prosthesis in order to provide function for an above-elbow amputee who was quite obese produced modifications of the standard type of harnessing, (Figures 4 and 5).

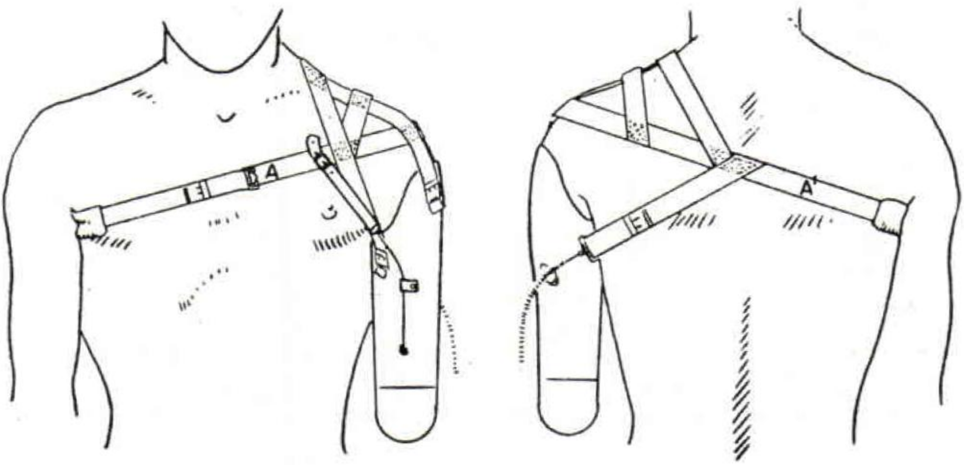


Figure 4. The socket is suspended from a webbing shoulder saddle. The chest strap A-A holds the saddle in contact with body.

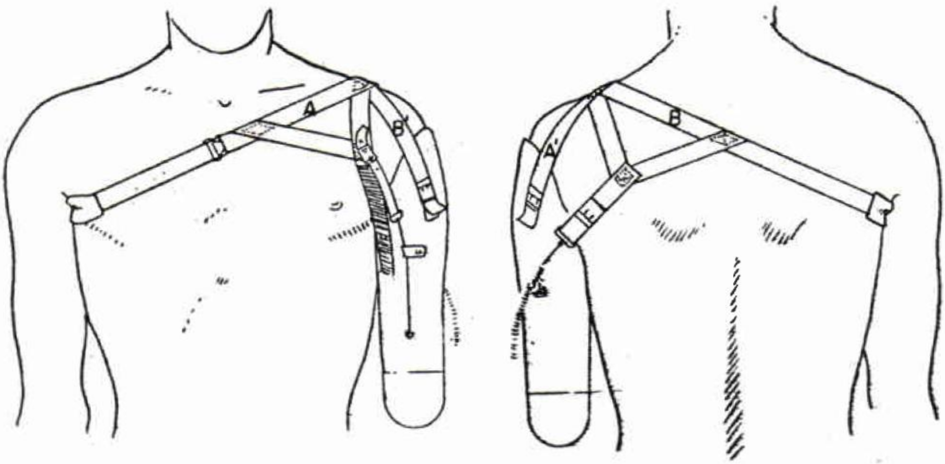


Figure 5. The socket is suspended from the chest strap A-A and B-B. There is less tendency for saddle to shift anteriorly, hence greater stability than with the standard chest strap harness.

3. Walking Mechanism for a Bilateral Lower Extremity Amelia—A six-year-old girl who is a congenital bilateral above elbow amputee and bilateral lower extremity amelia had been furnished with standard above elbow prostheses. For her lower extremities she was initially provided with a bucket type pelvic platform set on two stubby legs. By alternate pelvic rotation and without crutches, she could ambulate in the house quite well. A pair of Canadian hip disarticulation prostheses were later substituted. With the free knee she lacked stability and could not ambulate independently. The research group from the University of California at Berkeley devised a prosthesis that would provide the beginning steps in ambulation. A modification of the Canadian hip disarticulation prosthesis was used, (Figure 6).

The advantage of this type of device is that prosthetic function is initiated by spine flexion and moving the center of gravity forward, rather than rotating the pelvis. For details of biomechanics, fabrication, and fitting of this type of prosthesis, see articles by Radcliffe, C. W. (Page 29) and Foort, J. (Page 39) in Volume 4 of Artificial Limbs, Autumn 1957.

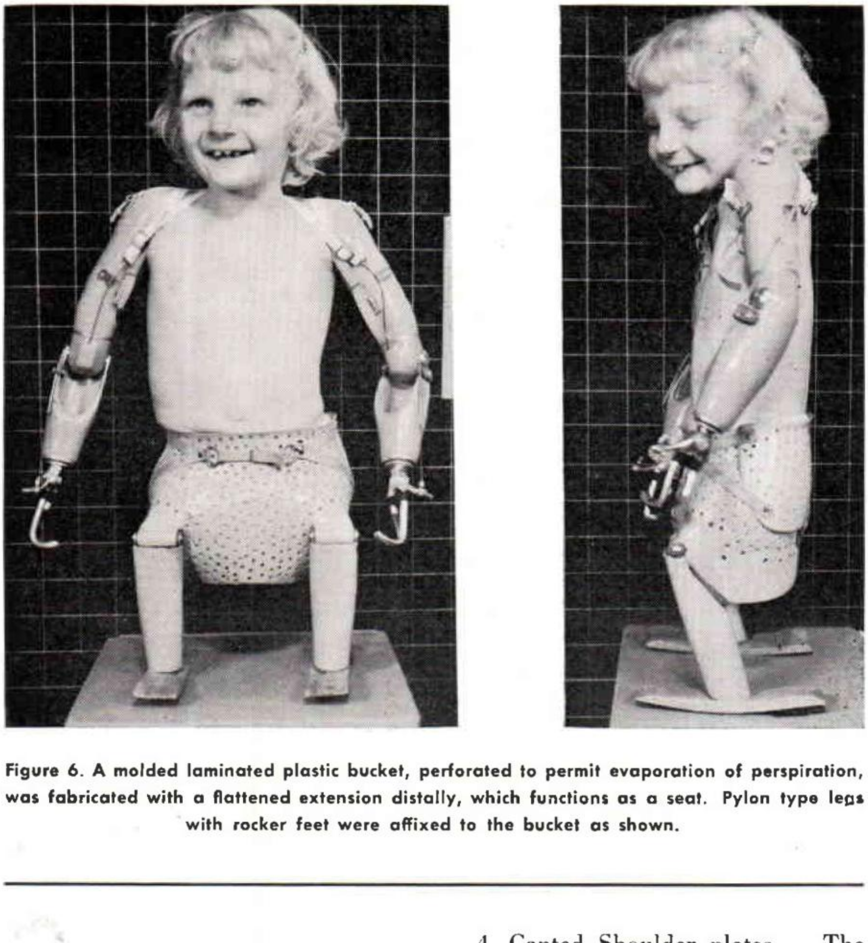


**Figure 6. A molded laminated plastic bucket, perforated to permit evaporation of perspiration, was fabricated with a flattened extension distally, which functions as a seat. Pylon type legs with rocker feet were affixed to the bucket as shown.**

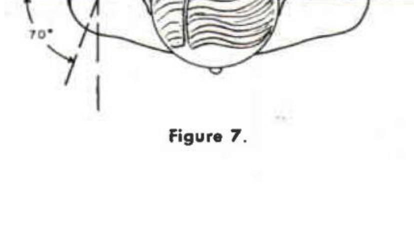



**Figure 7.**

4. Canted Shoulder plates — The conventional canted shoulder plates for a shoulder disarticulation prosthesis permit flexion at the shoulder in a sagittal plane. It has been demonstrated that abduction combined with flexion to bring the elbow forward and out places the elbow and hand in a more favorable functional position. One forequarter and several shoulder disarticulation amputees have been fitted with this type of shoulder plate, externally rotated 20 degrees from the sagittal plane (Figure 7).

*Special Devices*

The more active prosthesis users are motivated to make use of their prosthetic skill beyond the usual self-care, education, and vocational activities. They request help with the development of special devices and contribute ideas as to the ways in which they believe these devices can be developed.

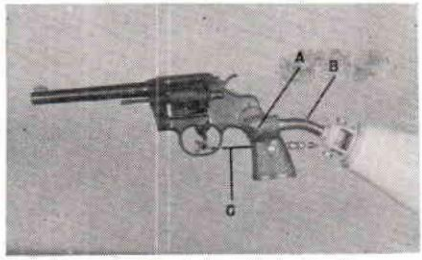
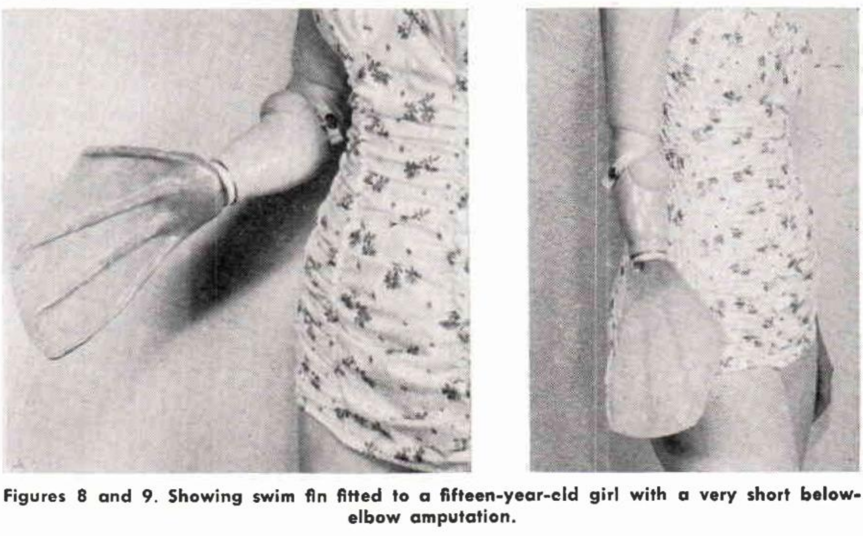


**Figure 8. Pistol Attachment Device.**

Swim fins, violin bow holders, baseball mitts are included among these special devices. Illustrated and described below are some of these special devices developed during this past year.

1. Pistol Attachment Device

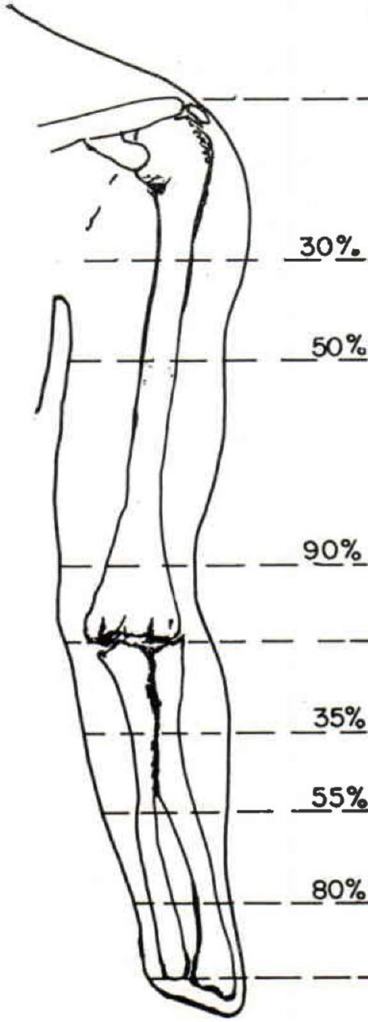
An 18 year old boy with bilateral long below elbow amputations, who had been an adept prosthesis user for 3 years, requested an instrument which would enable him to shoot a target pistol. A standard 22 Colt pistol on a 38 frame was modified in our laboratory for this patient. The grips were removed and replaced with specially constructed grips of laminated plastic with glass reinforcement, (A in Figure 8). A housing containing a threaded stainless steel insert was incorporated into the left side grip. The pistol was firmly affixed to the prosthesis by means of a ½" threaded stainless steel rod, (B in Figure 8). By a special trigger attachment an adapter was led from the cable end to trigger, (C in Figure 8). Tension on the cable fires the weapon.


**Figures 8 and 9. Showing swim fin fitted to a fifteen-year-old girl with a very short below-elbow amputation.**

2. Swim Fin

A fifteen year old girl with a very short below elbow amputation, who had been an excellent prosthetic user for three years, requested a swim fin to improve her swimming ability. This was supplied in May 1957. The device consists of a laminated plastic fin reinforced with glass cloth and nylon stockinette, (Figures 9 and 10). This was fitted to a standard VA 600 wrist unit, which was incorporated in a short below elbow socket. The socket is secured to the arm by a figure 8 strap around the lower arm.

# Available Components for Upper Extremity




| PROSTHETIC TYPE | TERMINAL DEVICE | WRIST DEVICE* |
|---|---|---|
| Shoulder Disarticulation | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Short Above Elbow | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Standard Above Elbow | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Elbow Disarticulation | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Very Short Below Elbow (split socket) | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Short Below Elbow | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Medium and Long B.E. | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction |
| Wrist Disarticulation | Infant Passive Hand or Voluntary Opening Hook - Select according to age. | Manual friction device or laminate T.D. into socket. |

*Wrist disconnect indicated when both hand and hook are prescribed.

# PROSTHESES FOR CHILDREN

| FOREARM COMPONENT | ELBOW COMPONENT | UPPER ARM COMPONENT | HARNESS TYPE* | CONTROL TYPE | NOTES |
|---|---|---|---|---|---|
| Standard forearm shell | Manual locking elbow<br>1 Loop<br>2 Nudge<br>Older children 10 → at times shoulder elevation | Shoulder cap with humeral section. Passive flexion shoulder plates canted | Basic shoulder chest strap | Shoulder dual control with opposite shoulder shrug, shoulder elevation or manual control of elbow lock | Sockets may be perforated for ventilation |
| Standard forearm shell | Active locking elbow* | Double wall semi-cap socket | A.E. figure of 8, chest strap, or Campbell | A.E. Dual | Adolescent girls with shoulder disarticulation may not tolerate chest straps |
| Standard forearm shell | Active locking elbow* | Double or single wall socket | A.E. figure of 8. A.E. chest strap | A.E. Dual | Short AEs may require high, closely fitted proximal end-care in order not to limit abduction<br>Bilateral SDs because of limited sources of power should initially be fitted unilaterally with opposite shoulder cap for SD |
| Standard forearm shell | Outside locking elbow hinge | Single wall socket | A.E. figure of 8 | A.E. Dual | |
| Split socket | Step up hinge with assistive lift where necessary | Half cuff with billet* | B.E. figure of 8 | Single. Dual when used for lift assist | After good purposeful operation of all components of prosthesis and enough power for 2nd arm has been acquired consideration should be given to fitting the second extremity |
| Double wall socket | Metal hinge single or double | Half cuff with billet* | B.E. figure of 8 | Single | |
| Single or double wall socket | Flexible hinge where possible, or single pivot, or metal double | Half cuff or triceps pad | B.E. figure of 8 | Single | B.E. sockets should be carefully molded and fit deeply |
| Single wall socket | Flexible hinge | Triceps pad | B.E. figure of 8 | Single | Two harnesses should be provided: worn over a "T" shirt |
| | *Child's size. Provision for manual operation may be necessary in very young children (under 4 years) | *Billet optional according to size of arm and fit | *One inch or half-inch webbing according to size of child | | The elbow lock may be passively operated by parents until the child has developed neuromuscular control and source of power |