Experience with the Munster-Type Below-Elbow Prosthesis, a Preliminary Report[1]

Charles H. Epps, Jr., M.D.,[2] AND
John H. Hile[3]

The Munster technique, an attempt to obviate the traditional problems associated with fitting short and very short below-elbow amputees with split sockets and step-up hinges, has been described in some detail *(1,2,3,4).* However, individual clinic experience in fitting Munster-type prostheses to patients has not been well documented. Following publication of a manual of instruction for the Munster-type below-elbow prosthesis by New York University in 1965 *(4),* the Juvenile Amputee Clinic of the District of Columbia General Hospital undertook the routine fitting of short below-elbow cases with these prostheses. The principles of construction and fitting outlined in the New York University manual were followed very closely. This article presents an analysis of patients fitted with the Munster-type prosthesis at the Juvenile Amputee Clinic.

SCOPE OF THE STUDY

Fourteen patients were fitted with a total of 24 Munster-type below-elbow prostheses between 1965 and 1967. The group comprised eight female and six male patients. The right upper extremity was involved in eight patients, the left in six. There were no bilateral cases. One ten-year-old boy had an amputation of traumatic etiology; the remaining 13 patients had congenital deficiencies. An 11-month-old infant is not included in the analysis because her family moved to another city shortly after her fitting, and no long-term follow-up data could be obtained. Stump length ranged from 1 1/4 in. to 7 in., with all but two stumps measuring less than 4 in. The distribution was as follows:

Number of Patients	*Stump Length (in.)*
1	1 1/4
1	1 1/2
1	1 7/8
2	2
1	2 1/2
2	2 3/4
1	3 1/4
2	3 3/4
1	4
1	7
Total 13	

Seven of the patients had been previously fitted by conventional means, and seven had never worn a prosthesis. It is interesting to note that only one of the previous prostheses had been of the split-socket type, the others being preflexed.

During the study period, two patients received three prostheses, six received two prostheses, and six had single fittings. In the multiple fittings, the shortest period before replacement was five months, and the longest 26 months. The average for the entire 13 patients on whom adequate follow-up information was obtained was 11.8 months. The three patients

[1] It is believed that this article will be of interest to our readers as a sequel to articles on the Munster-type below-elbow socket that appeared in the Autumn 1964 and Autumn 1965 issues of *Artificial Limbs.* This article will also appear in the July 1968 issue of the *Inter-Clinic Information Bulletin* of the Subcommittee on Child Prosthetics Problems, Committee on Prosthetics Research and Development.

[2] Chief, Juvenile Amputee Clinic, District of Columbia General Hospital, Washington, D.C. 20003; Chief, Division of Orthopaedic Surgery, Howard University College of Medicine, 520 W St., N.W., Washington, D.C. 20001.

[3] Clinic Prosthetist, Juvenile Amputee Clinic, District of Columbia General Hospital, Washington, D.C. 20003.

requiring replacement at five to six months gained weight rapidly or experienced spurts in growth.

FABRICATION AXD FITTING PROCEDURES

Taking the wrap cast is one of the most critical steps in the preparation of Munster-type prostheses. Use of a proper molding grip is essential to the success of the technique. It was found that the stump of an infant is more difficult to cast than that of an older child because of the discrepancy between the size of the infant's stump and the hands of the prosthetist. Accentuation of the groove for the patient's ulna formed by the thenar and the hypothenar eminences of the prosthetist's hand seems to be less critical in casting the infant's stump than in casting the stump of the older child or adult. The difference is probably due to the generous layer of subcutaneous fat so characteristic of infancy. No special efforts were made to relieve the olecranon during casting, but a buildup was added to the positive model of the stump. Important factors during casting are pressure at the posterior distal surface of the humerus above the epicondyle level and the two-fingered pressure on either side of the biceps tendon. On small patients, the prosthetist's middle finger is slightly bent because of the different lengths of the index and middle fingers (Fig 1). A symmetrical socket brim which provides overall fit is the goal (Fig. 2). Aside from these minor differences, the casting and all the construction procedures followed the Xew York University manual exactly.

The simplified harness system commonly referred to as the figure-nine harness, with the cable reaction point located on the proximal posterior portion of the socket, was used in the series. For the nine-month-old patient a small triceps pad with conventional figure-eight harness was used, in order to make the prosthesis more secure (Fig. 3) . It was believed that the nine-month-old patient might be able to remove the prosthesis without the additional suspension provided by the triceps pad and the anterior forked strap.

Fig. 1. Molding grip. Note slight flexion of middle finger.

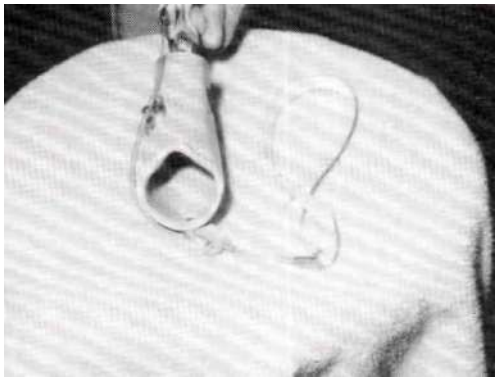

Fig. 2. End view of symmetrical socket.

EVALUATION

The value of the prosthesis was judged on two bases. First, the reactions of the patient and his parents were considered. Second, patient response and performance were compared with the checkout criteria published in the New York University manual.

All patients and parents were pleased with the Minister-type prosthesis. The simplified harness and light weight were consistently mentioned as favorable features. It was interesting to note that the seven patients who had previously worn other types definitely preferred the Munster-type. The patient who had worn the split socket was even more emphatic in his approval, as were his parents.

Standard checkout forms were used in the clinic. However, for purposes of this study,

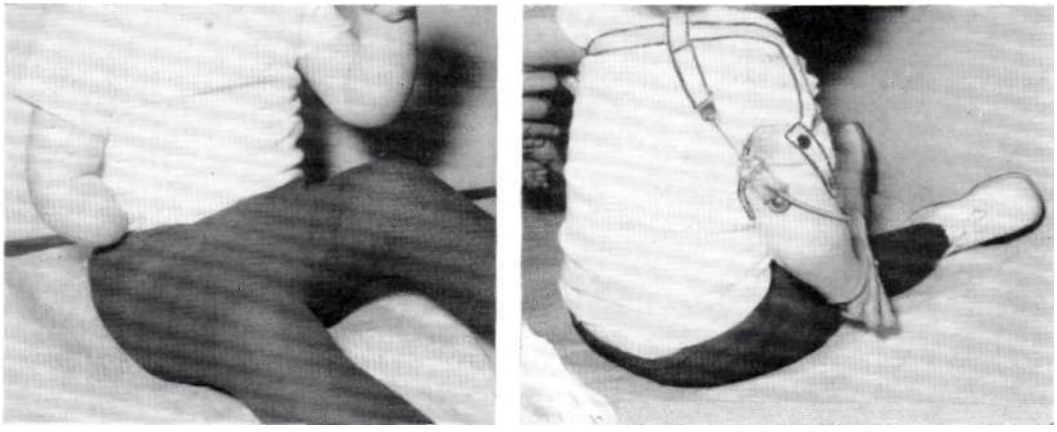

FIG. 3. Nine-month-old female infant (P.M.) with short below-elbow stump fitted with triceps pad and figure-eight harness for additional suspension.

special attention was given to certain specific items: range of motion with and without prosthesis, stability, and control-system efficiency. These data are summarized in Table 1.

Terminal-device openings were recorded for all patients within the limits of 30 deg. and 90 deg. of elbow flexion and were considered acceptable. The number of rubber bands varied between one-half a band to three, depending upon the functional requirements of the patients.

The recorded ranges of elbow motion without the prosthesis illustrate the hyperextension so characteristic of upper-extremity terminal transverse partial hemimelia. Maximum flexion varied from 80 deg. to 100 deg. with the prostheses for most patients. In all instances, full terminal-device opening was obtained at maximum forearm flexion. The test of full terminal-device opening at the mouth did not apply, because the terminal device could not be brought to the mouth. However, since all the patients were unilateral amputees, the flexion ranges were considered acceptable.

Retention of the prosthesis under axial load testing revealed suspension stability to be excellent, as most prostheses tolerated one-third of the child's weight without excursion of the socket. The greatest slippage recorded was one-half in.

Control-system efficiency was better than 80 per cent in one-half of the prostheses, and in no instance was the percentage less than the 71 per cent recorded in one case.

Perspiration has not been a problem even during humid summer days. All patients used cotton stockinette stump socks for insertion of the stump, with the ends tucked back into the forearm shell after donning. It is believed that the opening provided in the medial socket wall for this purpose may have been a significant factor in heat regulation.

SUMMARY

An analysis of experience in fitting a total of 23 Miinster-type prostheses to 13 patients has been presented. The prostheses were fitted, with very minor modifications in casting technique, according to the New York University fabrication manual. Actually, the differences were more quantitative than qualitative.

It should be mentioned that the clinic prosthetist attended the pilot course in Miinster-type fabrication technique at New York University. This technique is best acquired through firsthand instruction rather than by reading a manual.

The results have been gratifying. The parents and patients found the prcsthesis acceptable, and in seven cases preferred it to other types that had been previously worn.

TABLE 1. FITTING DATA ON MÜNSTER-TYPE SOCKETS (N = 13)

Patient	Age at Fitting (yr.)	Length of Stump (in.)	Date of Fitting	Elbow Range without Prosthesis (deg.)	Elbow Range with Prosthesis (deg.)	Socket Displacement* (in.)	Control Efficiency (per cent)
S.M.	3	2½	10/10/67	0 to 135	30 to 80	0	75
			3/14/68		20 to 80	0	91
E.B.	6	2	6/ 8/67	−15 to 125	28 to 100	¼	75
J.R.	3	3¼	5/18/66	−15 to 135	50 to 90	¼	75
			12/ 7/67		25 to 90		
T.P.	9	7	3/23/66	0 to 145	13 to 100	¼	71
			8/24/67		0 to 140	¼	75
A.L.	9	2¾	2/ 5/65	−15 to 135	35 to 105	1/16	85
			5/11/66		35 to 105	0	75
T.F.	4	2½	2/16/66	−10 to 128	36 to 96	0	75
M.C.	6	2	6/13/66	−28 to 90	27 to 82	¼	75
R.R.	3	1¼	10/11/67	−15 to 130	30 to 90	0	91
P.M.	¾	1½	10/ 5/67	−10 to 135	50 to 85	0	100
B.H.	6	3¾	8/24/67	−40 to 120	25 to 90	0	80
			3/ 8/68		25 to 90	0	80
M.R.	11	3¾	4/ 1/66	0 to 120	45 to 100	0	86
			2/24/67		36 to 100	0	75
			9/12/67		35 to 90	0	80
J.D.	11	1⅞	7/11/67	−10 to 135	15 to 85	½	78
			1/31/68			¼	100
S.P.	9	4	6/ 9/65	−28 to 125	50 to 102	¼	75
			5/ 3/67		30 to 76	0	94
			10/ 5/67		30 to 76	0	94

* Socket displacement with axial load equal to one-third the weight of the patient

Although the range of motion in the prosthesis did not always equal the expected 70 deg. of active flexion, function was acceptable. The stability achieved was excellent. In no case was there more than 1/2-in. displacement of socket on the stump with one-third of body weight in axial pull.

The control-system efficiency was within acceptable limits in all cases, with one-half checking out at 80 per cent or better.

On the basis of this limited experience, it is believed that the Munster-type prosthesis is the fitting of choice for the child with a unilateral short or very short below-elbow amputation.

LITERATURE CITED

1. Fishman, Sidney, and Hector W. Kay, The Munster-type below-elbow socket, an evaluation, Artif. Limbs, Autumn 1964, pp. 4-14.

2. Kay, Hector W., Kevin A. Cody, George Hartmann, and Dominick E. Casella, The Munster-type below-elbow socket, a fabrication technique, Artif. Limbs, Autumn 1965, pp. 4-25.
3. New York University, Adult Prosthetic Studies, Research Division, School of Engineering and Science, The "Muenster" type fabrication technique for below-elbow prostheses, June 1964.
4. New York University, Prosthetic and Orthotic Studies, Research Division, School of Engineering and Science, A fabrication manual for the "Muenster" type below-elbow prosthesis, April 1965.