

Customized Hand Crutches

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Continued use of Canadian hand crutches (Fig. 1) may, over a period of time, develop painful lesions on those parts of the hands subjected to constant irritation by the hand grips. The conventional grip resembles the standard handlebar grip of a bicycle. It performs an adequate interface function between the hand and the appliance for temporary usage but leaves much to be desired if use is continued for long periods of time. The user in this case normally resigns himself to the discomfort or pain generated by constant use of the appliance. He tells himself, "I shouldn't complain because I am better off than if I were confined to a wheel chair." The need

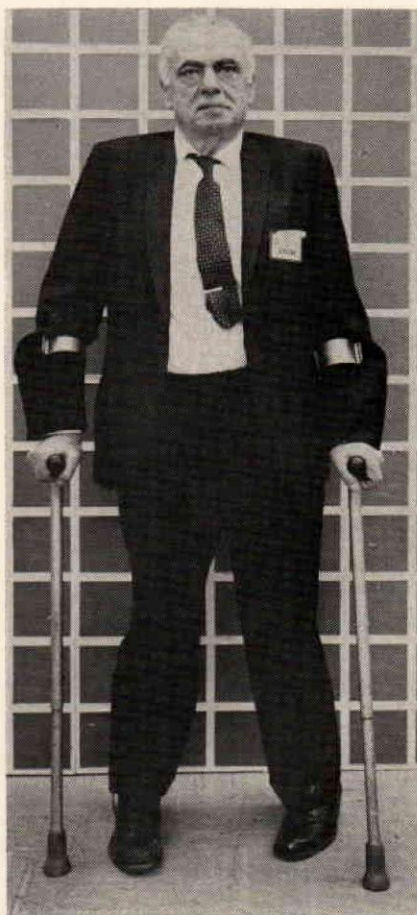


FIGURE 1

for improvement is primarily recognized by the user and has not been conveyed strongly enough to the manufacturers of the appliance to result in a modified design.

The need for improvement recently came to the attention of Litton Industries' Space Sciences Laboratories when a 72-year-old user of the hand crutches was confronted with the necessity of having a tumor removed from his left hand. A polio attack in childhood had left him a cripple requiring constant use of crutches for support during walking. Through the years a painful, callous type of growth developed on his left hand between the thumb and index finger (outlined area, Fig. 2). The growth finally developed to a point that surgery was required for its removal. The problem, as presented to us, was how to allow continued use of the crutches following the operation. A six-month healing period is normally required following such an operation before any pressure is allowed to be applied to the sensitive area. To be deprived of the crutches for this period of time would present an undue and unnecessary hardship to the patient; consideration of alternative approaches was indicated.

The approach that was finally adopted resulted in replacing the standard rubber grips with custom shaped, plastic hand grips (Fig. 3.). Machine epoxy (epoxy loaded with aluminum) was employed to make the final grips from plaster of Paris masters of the patient's hand prints.

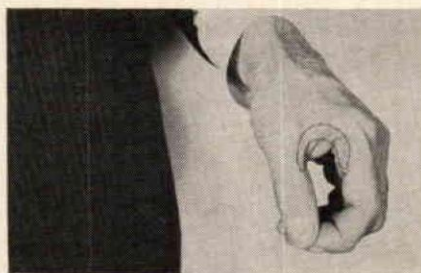


FIGURE 2

It was decided at the outset to make a plastic grip for both hands. This was suggested by Anderson¹ to assure ambulatory balance in the patient even though only one hand required the essential modifications. (The suggestion, in fact, was quite a propitious one for the patient was much more satisfied with the plastic grips than he had ever been with the standard units).

As shown in Fig. 3, the plastic grip for the left hand is relieved in the area of the thumb and index finger. For this hand the grip forces the major load on the hand to impinge on the palmar area with the third, fourth, and fifth digits used for lifting the crutch at the completion of each step.

The right hand grip is molded to contour the entire palm and digit area allowing maximum distribution of load to the hand and thus maximum comfort. In addition, the larger, more contoured design allows the body weight to be applied in a direct line from the forearm through the wrist and palm to crutch support. This is in contrast to the original design that forces the hand to be at an angle to the forearm with body load transmitted to the crutch through the first metacarpal joint. This grip is considered sufficiently superior to the original design that it is anticipated the left hand grip will be remade following post-operative convalescence to copy the design of the right hand support.

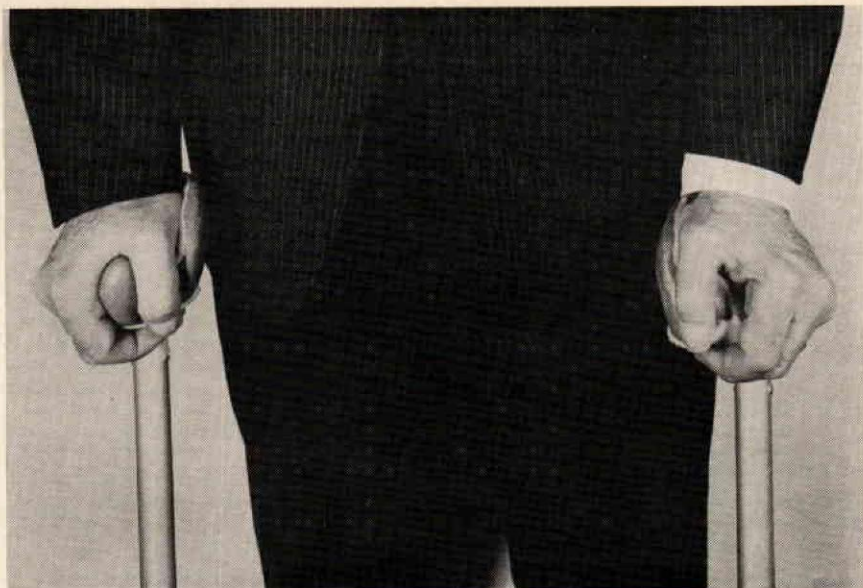


FIGURE 3

Two problems were encountered in the testing of the grips. The first of these was a tendency of the left hand to slip, especially if the hand became sweaty. A coating of polyurethane on the grip was tried but this did not adhere well to the epoxy; moreover, the surface was still too slippery for comfort. The technique finally adopted was to bond (using rubber cement) a thin sheet of polyurethane foam on an initial surface of Caran adhesive. This approach appears to offer an acceptable solution to the slipperiness and as well provides a comfort liner between the hand and the grip that can be replaced every month or so as required by considerations of cleanliness. The second difficulty was a result of the added weight of the structure. As initially cast the grips weighed approximately $1\frac{1}{2}$ lb. each with the added weight becoming tiring to the arm muscles. This problem was remedied by removing excess material resulting in a final grip weight of about $\frac{3}{4}$ lb. which was found to be satisfactory to the patient.

In summary, it is our finding that substantial improvement can be made to the hand crutch by providing a grip that more closely conforms to the shape of the palm. Distribution of the body load over a larger area results in increased patient comfort as well as increased control in the use of the appliance. Of particular importance is that the contoured grips allow the weight of the body to be applied in a direct line through the wrist rather than at an angle to it. Also, from our experience, it would appear that three or four standard sizes of grips could be manufactured that would fit almost all patient populations. This factor should significantly reduce the cost of the grips and still provide a customized support structure.

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