The CAPP Adjustable-Friction Wrist Unit

by
Carl Sumida, C.P.O. *
and
Julie Shaperman, M.A., O.T.R. **

Introduction

A plastic adjustable constant-friction wrist rotation unit has been developed at the Child Amputee Prosthetics Project, UCLA, under Grant #C-199 from the Department of Health, Education and Welfare, Children's Bureau. This wrist unit was designed by Carl Sumida, and has been tested at CAPP and fourteen other clinics. This is the final report on the development and testing of the unit.

* Research Prosthetist, Child Amputee Prosthetics Project, UCLA.
** Research Occupational Therapist, Child Amputee Prosthetics Project, UCLA.

DESIGN FEATURES

The design features of this wrist unit are illustrated in a diagram of a cross-section of the unit (see Figure 1) and the specifications as listed in Table I.

DESIGN REQUIREMENTS

One objective of the design was to provide smooth even friction around the entire circumference of the stud of the terminal device. To achieve this, two slots were designed into the threaded portion of the plastic. These slots extend approximately halfway through the thickness of the plastic, and provide the needed displacement to increase

CROSS SECTION OF THE WRIST UNIT

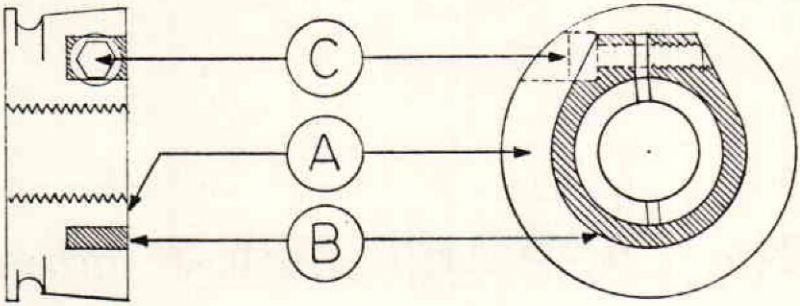

Figure 1

Side View End View

A. Main Body

B. Ring Clamp

C. Friction Adjustment Screw

TABLE I

Material	Delrin (natural color): product of E. I. DuPont de Nemours and Co., available from plastics distributors.		
Ring Clamp	Aluminum 356, heat-treated and anodized		
Adjustment Screw	Socket head screw, 6/32 x ½"		
Adjustment Wrench	Allen wrench, size 7/64"		
Sizes (diameter)	1½"	1¾"	2"
Weight (ounces)	0.78	1.16	1.48
Thickness	⅝" — all sizes		
Internal Thread	½ x 20		

or decrease the friction as the adjustment screw is turned to close or open the ring clamp. A relatively gross turning of the Allen screw changes the friction in small increments. Furthermore, these slight changes in friction are evenly distributed around the stud of the hook, allowing the amputee to easily and accurately select the precise amount of friction he desires.

Other design objectives were to provide a unit that would be low in cost, lightweight, and require minimal maintenance. The use of Delrin plastic and the simplicity of the de-

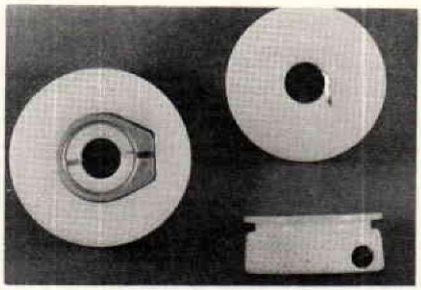

Figure 2

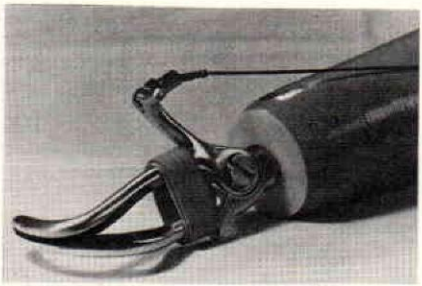

Figure 3

sign have resulted in a lightweight unit which can be easily and inexpensively produced and should pose minimal maintenance problems (see Figures 2 and 3). This unit can be fabricated into any prosthesis; however, because of its light weight it is especially useful for the amputee with a short stump — for whom weight at the distal end of the prosthesis is often a problem. Furthermore, the development of this unit is consistent with the shift toward more use of plastics in prosthesis design.

FABRICATION

A procedure for fabricating the plastic wrist unit into a prosthesis was developed during the test period. The major change from conventional fabrication technique is that the back of the wrist unit must be carefully protected from filling with laminate or plaster. At CAPP, the technique used is to cover both flat surfaces of the unit with two layers of masking tape, and to plug the adjustment screw hole with modeling clay, wax, or crepe foam. The unit is then easily adaptable to any individually preferred method of fabrication. The position of the adjustment screw must be well marked before pouring the plastic laminate. After lamination, the hole for the adjustment screw must be cut out.

Reports from several prosthetists who have used the plastic wrist unit reveal that each has developed his own method of protecting the back of the unit, adapting it to his own fabrication technique, and exposing the adjustment screw on the finished prosthesis.

CLINICAL EVALUATIONS

The Prosthetics and Orthotics Department of New York University has conducted a field test of the Delrin Wrist Unit, in which fourteen clinics fitted twenty-nine children between the ages of one and twenty-one years. The results of this test were published by Barbara Gehant [1] who states:

> "Therapists reported that ten of the children seldom or never pre-positioned their terminal devices, while nine children did so frequently. . . . In the units that were pre-positioned frequently, friction rarely or never required readjustment. Once the friction was adjusted for a particular terminal device, the unit maintained fine degrees of adjust-

ment. The only disadvantage mentioned was the need to release friction whenever one terminal device was interchanged with another.*

"All of the investigators praised the lightness of the unit; the Delrin units being approximately 50 percent lighter than the presently available wrist units of like size. Most respondents cited the smoothness and reliability of the friction and the superior cosmesis of the plastic wrist. The Delrin unit, when installed into the forearm, fits flush with the distal edge of the laminated forearm, leaving only the distal surface of the unit exposed."

The CAPP Evaluation. Over 150 of these wrist units have been fitted to patients at the Child Amputee Prosthetics Project at UCLA. All of these patients have been monitored for development of problems with this unit. Eighty-one patients (utilizing eighty-six units) participated in a very detailed evaluation program which included completing NYU data forms.

These eighty-one patients included thirty-seven males and forty-four females between nine months and twenty years of age. Three had bilateral prostheses requiring two wrist units; one child had two prostheses for the same extremity; one child had two wrist units on the same prosthesis (one was a shoulder unit), thus bringing the total number of units evaluated to eighty-six. The majority (fifty-eight) of the patients participating in the evaluation had unilateral below-elbow prostheses. All but twelve of the eighty-one patients wore their prosthesis full waking hours Thirty-three of the eighty-one patients prepositioned the terminal device frequently.

Results of the CAPP Evaluation

Problem: Of these 150 patients, very few had any problem with the wrist unit: all of the units remained functional for the life of the prosthesis, with only a few exceptions. Two minor problems were: 1) the need for cleaning or re-tapping (3 patients); and 2) the need to have the adjustment screw replaced because the slot in the screwhead was stripped (two patients). An additional problem occurred because eight units were damaged in central fabrication. Three of these required re-fabrication because plaster of paris had filled the back of the unit, freezing the adjustment mechanism. The other five could be cleaned enough to get adjustable friction, although they could not be tightened enough to lock out motion completely. If the back of the unit is filled with wax before sending it for central fabrication this can be avoided.

Only four other patients had problems with the unit, and these may have been due to negligence or extreme forces placed on the unit. One oiled the hook stud and then tried to forcefully tighten friction against it, causing the adjustment screw to break inside the unit. Two units were cross-threaded, and de-

* AUTHORS' NOTE: The requirement that friction be released when interchanging terminal devices was imposed by CAPP as a precaution against cross-threading, and was considered good practice for care and maintenance of any wrist unit.

veloped a crack across the face after one year. One other unit that was not cross-threaded developed a "wiggle" of the terminal device within the unit, and a slight crack after one year. A new hook reduced the wiggle somewhat, but could not eliminate it entirely.

Advantages: The Delrin wrist unit provides even pressure around the entire circumference of the stud of the terminal device, thus assuring smooth and even friction throughout the turning arc of the hook. The constant-friction wrist units formerly used produce friction by applying pressure at one point along the hook stud; this often results in a "bump" or uneven friction at some point in the turning arc. This unevenness disappears if the friction is tightened, but young children cannot turn their own hooks if this is done. At CAPP, this "bump" or uneven friction has often been traced to "out-of-round" hook studs. With the Delrin unit, even the flattened portions of the hook stud—although still perceptible—are less of a problem than with units that apply pressure only at one point.

Functional evaluation also confirmed an important design feature of this wrist unit: it permits fine degrees of friction adjustment. The child amputee often needs to achieve a balance between the amount of wrist friction small enough to allow him to turn the hook with his sound hand, but still great enough to prevent the hook from turning inadvertently from a pronated position when he places tension on the cable. Also, since the child ordinarily maintains minimal friction at the wrist, any variation in the amount of friction when the hook is in different positions is more noticeable.

Conclusions from the CAPP Evaluation. From an evaluation of 150 patients wearing this unit for periods of time ranging from three to eighteen months, it was concluded that the unit meets the design criteria and provides excellent function for the child amputee. This lightweight, simple design has been very well received by the patients and prosthetists in the Southern California area who have used it.

The smooth, constant friction around the full circumference of the terminal device stud was maintained at an optimum level over long periods of time. Few problems were encountered, and those related to fabrication were easily solved by minor changes in technique. The large size has been used as a friction shoulder joint for two children, with good results.

This wrist unit is now used routinely by CAPP patients.

SUMMARY AND RECOMMENDATIONS

A plastic constant-friction wrist rotation unit has been designed at the Child Amputee Prosthetics Project, UCLA, under a Department of Health, Education and Welfare grant. Results of field-testing at CAPP and fourteen other child amputee clinics demonstrate that the unit meets the need for which it was designed. Fine degrees of friction adjustment can be obtained by gross turning of the Allen screw, with exceptionally smooth and constant friction throughout the entire

turning arc. This adjustment is maintained well over a period of time without need for re-adjustment. Parents and children have stated that the unit is more appealing visually than the metallic, mechanical appearance of the conventional wrist unit.

This unit was discussed and evaluated by the Subcommittee on Child Prosthetics Problems of the Committee on Prosthetics Research and Development, at a meeting in Toronto, Canada, during June, 1970. The members of the subcommittee concluded that this unit is very acceptable and should be commercially available.[2] Arrangements with a manufacturer are now being concluded.

REFERENCES

1. Gehant, Barbara A., B.S., "Field Evaluation: Delrin Plastic Wrist Unit," a report prepared by the Department of Prosthetics and Orthotics, New York University, Post-Graduate Medical School, July, 1970.
2. Reported in "Abstract of Minutes of Meeting, Subcommittee on Child Prosthetics Problems, Committee on Prosthetics Research and Development, Division of Engineering, National Research Council, National Academy of Sciences, National Academy of Engineering; *Inter-Clinic Information Bulletin,* New York University; Volume IX, No. 12, September, 1970, p. 15.