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Lightweight prostheses*

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Because the research programme in artificial limbs in the United States was initiated primarily for the benefit of young amputees from World War II and because amputations due to vascular disease were not as common as is now the case, very little attention was given to the effects of weight of the prosthesis for the first years of the programme. This is not to say that weight was not considered at all. It was always recognized that artificial legs could be too heavy even at weights considerably less than the lost limbs, and efforts were made to keep the weight reasonable. There were also those who felt that artificial legs could be too light which probably contributed to the lack of interest in weight reduction.

The fact that during the course of evaluation of the Henschke-Mauch devices (Lewis and Bernstock, 1968) amputees reported feeling that the heavier new limbs felt the same or lighter, no doubt owing to better fitting, alignment, and function, added no incentive to conduct studies concerning reduction in weight of lower-limb prostheses.

However, about 1960, the so-called geriatric amputee problem began to be recognized and the report of nearly every workshop and conference since that time has included a recommendation that lighter limbs are needed for the older weaker patients. But until recently, very little attention has been given to this matter.

The reasons for this are not apparent. However, experience with Dr. J. Barredo (1975), a BK amputee himself and a retired physicist, the work of Wollstein (1972) (Fig. 1), and the introduction of vacuum-formed polypropylene lower-limb orthoses prompted experimentation at the Moss Rehabilitation Center in 1975 that has produced an extremely light below-knee prosthesis (Wilson et al, 1976).

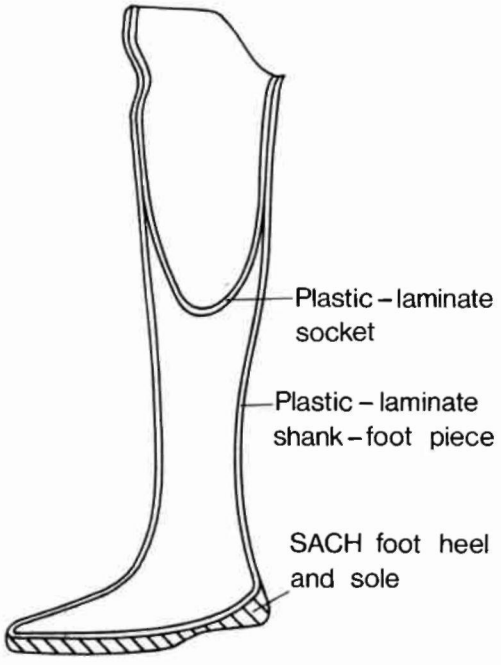

Fig. 1. Cross section of the Wollstein below-knee prosthesis.

The crustacean design was selected because it is inherently lighter for the same structural strength than the so-called pylon construction. The result is a below-knee prosthesis that weighs two-thirds less than the standard PTB with the same or better function since suspension becomes less of a problem (Fig. 2).

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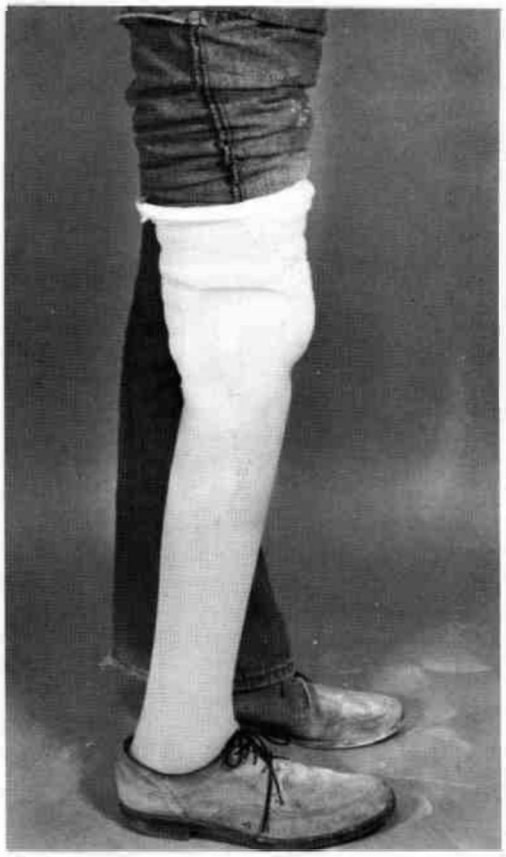

Fig. 2. Ultralight below-knee prosthesis on patient. Note that suspension is by flexible supracondylar tabs and that auxiliary suspension is not needed.

Although the design was developed primarily for the geriatric amputee the experimental units were tried on a 22 year old, very energetic male with a below-knee amputation due to a motorcycle accident. This patient was selected because his work schedule made him available during the day and because it was felt that he could report his findings more objectively than most of the old patients that were available.

We were pleasantly surprised to find that not only the initial patient but other young patients appreciated the substantial reduction in weight.

At the present time the Rehabilitation Engineering Center at the Moss Rehabilitation Hospital with the co-operation of six local private prosthetics facilities, the Veterans Administration Regional Amputee Clinic, and several private clinics, is in the last stages of a clinical study involving approximately 36 patients nearly all of whom had previously been satisfied with the conventional PTB prosthesis. There seems to be no doubt that the reduction in weight is greatly appreciated. An unexpected result is the favourable reaction of the patients to the "feel" of the polypropylene sockets.

Our next project will be to study the effects of weight and weight distribution in above-knee legs. The first step will be the development of a limited function leg as light as can be devised. We hope that the immediate result will be a design that will be useful to the geriatric amputee. The second phase will include the introduction of more functional knee-control devices and measuring the biomechanical results as weight is increased in different areas. This approach has been proposed before, but it now becomes feasible to provide at a reasonable cost extremely light legs to which weight can be added gradually to study the effects of weight change, since here-to-fore it has been very costly to provide such experimental devices. Furthermore, with the advent of our force-line visualization equipment (Wilson et al, 1979) and our proposed accelerometer configuration to provide quickly an index of efficiency (Moss Rehabilitation Hospital, 1979) the likelihood of success is increased greatly.

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