Clinical Prosthetics and Orthotics, Vol. 11, No. 4, pp. 251–253

An Above-Elbow Electrically Controlled Prosthesis Complicated by the Presence of a Cardiac Pacemaker

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It is the purpose of this paper to present problems attendant upon the selection of an appropriate upper extremity prosthesis for the amputee who has an implanted cardiac pacemaker. In view of the increasing use of pacemakers, the case to be reported may not be an isolated instance. The solution and the reasons for deciding on the prosthesis described will be outlined.

M.C. was initially referred to this center's Clinic Team on November 2, 1978, at which time he was 36 years of age. The patient sustained multiple shell fragment wounds in 1967, as a result of which he was amputated above the elbow on the left. He had wounds of the right elbow as well, with resulting limitation of motion on that side.

On examination, there was a 10-″ left above-elbow residual limb in good condition, except for a distal, tender bone prominence. The residual limb was powerful with a good range of shoulder motion. On the right side, the elbow was thickened; there was crepitus on motion and motion was limited to a range of 45° to 100° when full extension is considered to be 0°. Elbow motion produced discomfort, but the patient was able to reach his mouth with his right hand.

He reported that he had been able to use a conventional body-powered prosthesis until he developed a cardiac problem, which required the implantation of a pacemaker in the right pectoral area eight months before evaluation at our center (i.e., in early 1978). The distal tender bone prominence had not been a problem when fitted without pressure on that area. Since that time, he has been unable to wear a prosthesis. He works in a supervisory capacity and indicated a preference for a hand rather than a hook. He was informed elsewhere that he could not wear a prosthesis because of the pacemaker.

There were two basic considerations that required resolution in the opinion of the Clinic Team.

1. Excessive body movements for the control of the prosthesis should be avoided to prevent breakage of the fine cardiac wire components of the pacemaker. Such body movements would be required by conventional figure-of-eight body powered harnessing.
2. A harness must be fabricated to avoid pressure on the pacemaker.

To avoid excessive body movements, the clinic team decided to provide the patient with a switch controlled, electrically operated prosthesis which would require ⅛″ excursion of the switch components. This could be accomplished with such limited motion as to preclude the likelihood of breaking the cardiac wire.

Having made this proposal, the Clinic Team had to determine the compatibility of the pace-

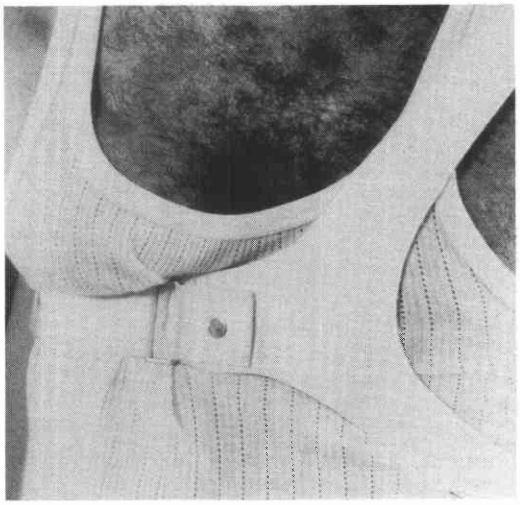

Figure 1. Note that the frame harness frees the right pectoral area with its underlying implanted pacemaker.

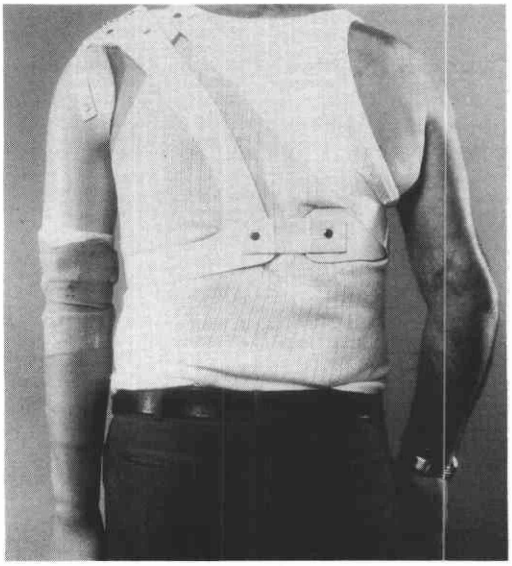

Figure 2. Posterior view of frame harness.

maker with the switch controlled electrical prosthesis. Carl Mason, Chief Engineer at the Center and the Electrical Engineer in charge of upper extremity unit development, was asked to join the Clinic Team. A chest x-ray was taken to view the pacemaker. Mason's opinion was that the pacemaker was a lithium powered unit recently developed and was properly shielded, and that it would not interfere with the prosthesis. He confirmed this by telephone communication with the hospital at which the pacemaker was implanted.

The Clinic Team decided to fabricate a harness frame of thermoplastic material which would be windowed over the pacemaker and would not shift significantly with body movements (Figures 1 and 2).

When this proposal was outlined to the patient, he indicated that he would prefer an electrically operated hand as well as an electric elbow. The final decision was to fit the patient with a VAPC switch controlled elbow and an Otto Bock myoelectric hand, employing biceps and triceps control. The prosthesis was delivered in 1979 (Figure 3). The amputee learned to use this prosthesis well and required replacement in July, 1981. In the interim, he had surgical intervention to correct the limitation of right elbow motion and, as a result, that situation was greatly improved.

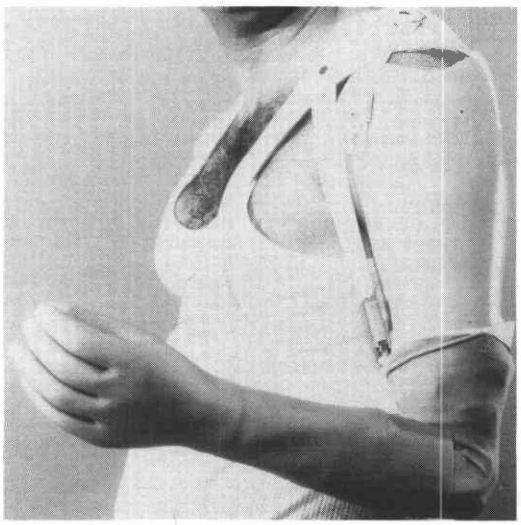

Figure 3. Note switch control element for elbow. The Bock myoelectric components have been utilized for the hand.

In 1984, because of the unavailability of VAPC elbow components, the elbow components were changed to the Boston elbow unit. The Otto Bock hand system was continued. Carl Mason had indicated that there would be no electrical incompatibility problems with the Boston elbow, and there were none.

Summary

A switch controlled electric elbow and a myoelectric hand were provided for an above-elbow upper extremity amputee after these components were found to be compatible with the electrical system of an implanted cardiac pacemaker. Over a five year period of use, there have been no problems. The amputee had been denied a body powered prosthesis elsewhere because of the possibility that cardiac wire breakage might be caused by the more extensive body movements required to control the elbow and terminal device of a conventional artificial limb.

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