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Prosthetic Management of High Bilateral Upper-Limb Amputees

A Case Report

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In the December 1977 issue of Orthotics and Prosthetics, LeBlanc (1) noted that one of the future goals for upper-limb prosthetics is to give the bilateral, high level, upper-limb amputee a significant measure of independence. It is obvious that this type of patient has sustained a considerable loss, and clinically presents a very difficult problem. The Department of Prosthetics and Orthotics at the Medical Center Rehabilitation Hospital of the University of North Dakota has developed a prosthetic system that has been used with good success for amputees in this category (Fig. 1). Particular success has been noted with the bilateral upper-limb amputee with an above-elbow amputation on one side and an inter-scapulothoracic amputation on the other side. The prosthesis as developed, combined with a total comprehensive amputee rehabilitation program, has provided a significant level of independence for those amputees using it.

The case presented is that of a 24-year-old white male (Fig. 2) who sustained

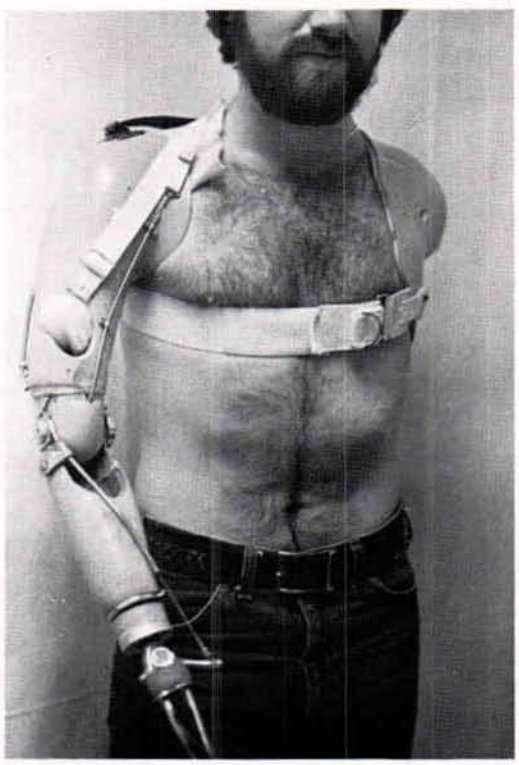

Fig. 1. Anterior view of amputee wearing prosthesis.

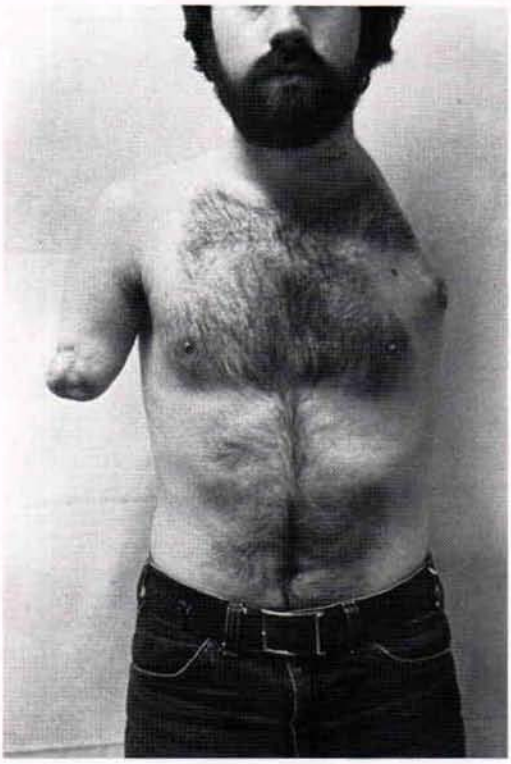

Fig. 2. Anterior view of amputee without prosthesis.

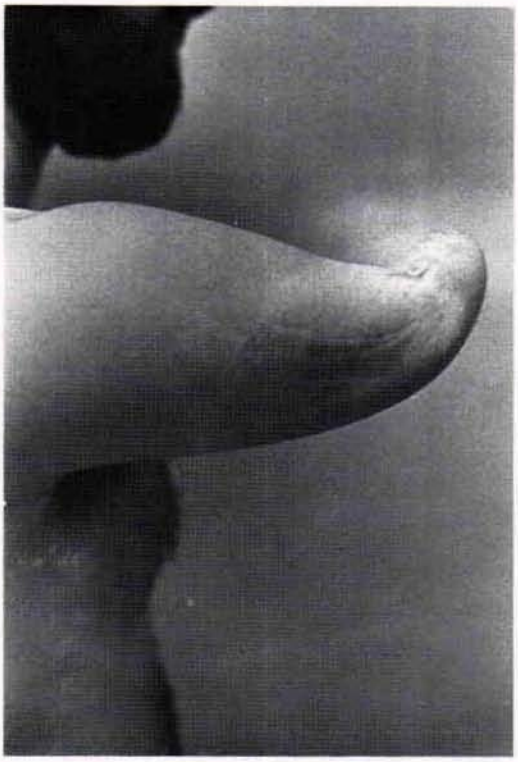

Fig. 3. Lateral view of stumps showing effect of humeral osteotomy

traumatic injuries in a farming accident. Clinical examination revealed a forequarter amputation on the left. Skin coverage is good with a minimal amount of scarring. On the right side is an above-elbow stump approximately five inches long. A wedge osteotomy had been performed on the distal three centimeters of the humerus resulting in an anterior angulation of approximately 55 degrees (Fig. 3). Range of motion and strength of the shoulder were essentially normal.

The primary goal of prosthesis system design centered around providing this amputee with optimal appliance function without sacrificing his functional level of independence. It was obvious that included at this level of function is the necessity of donning and doffing the prosthesis without assistance. Preliminary research also dictated that a stable point of fixation must be included in the design to provide two essential functions: 1) support and suspension of the appliance when being worn and used, and 2) maximal efficiency of the cable-type control system.

An above-elbow prosthesis was fabricated for the right side. The design took advantage of the presence of the humeral osteotomy, which proved to be very valuable in facilitating "live lifting" and control of rotation of the socket about the humeral axis.

Because the patient placed very heavy demands on the appliance, specific consideration had to be given to the function and effect of the wrist unit. Initially a

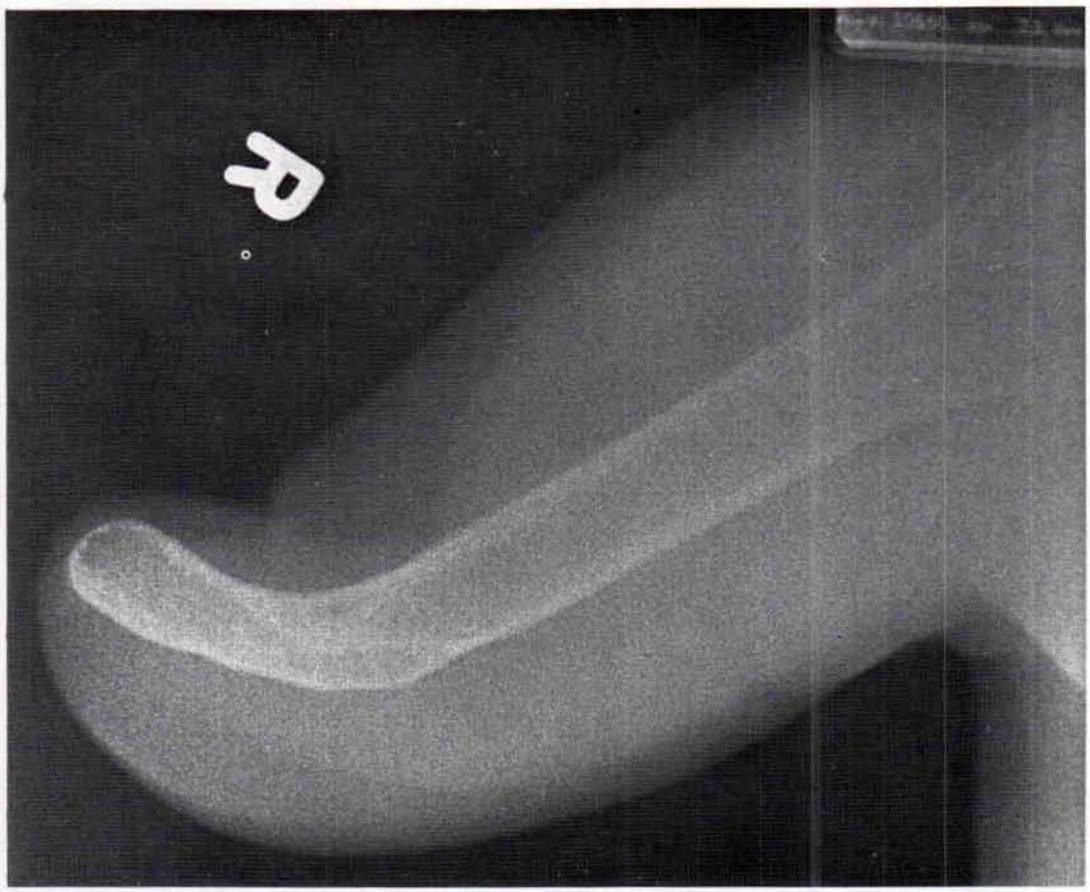

Fig. 4. X-ray view of stump showing humeral osteotomy

Hosmer Flexion Wrist (FW-500) was used, and it provided adequate accessability to the body with use of the prosthesis in the areas required for personal hygiene and eating, but finite control of wrist rotation was not consistent. It was also very difficult for the patient to be adjusting the friction mechanism constantly. In order to remedy the problem, a Hosmer Quick Change Wrist (FM-100) was used for attachment of the flexion wrist (Fig. 4). With this adaptation, terminal device flexion could still be accomplished with the rotation locked out of the flexion unit, and control of pronation-supination was then managed with the FM-100 rotation element. This combination ultimately proved to be very satisfactory.

With the appliance properly fabricated, emphasis was shifted to a harness system that would offer an effective point of fixation without impeding the amputee's ability to get into and out of the unit independently. A shoulder cap that provided three functions was fabricated for the left side. First, it serves as a cosmetic body build-up. Second, because approximately three and one-half pounds were incorporated into it during fabrication, the patient feels that he has proper body balance when wearing and using the

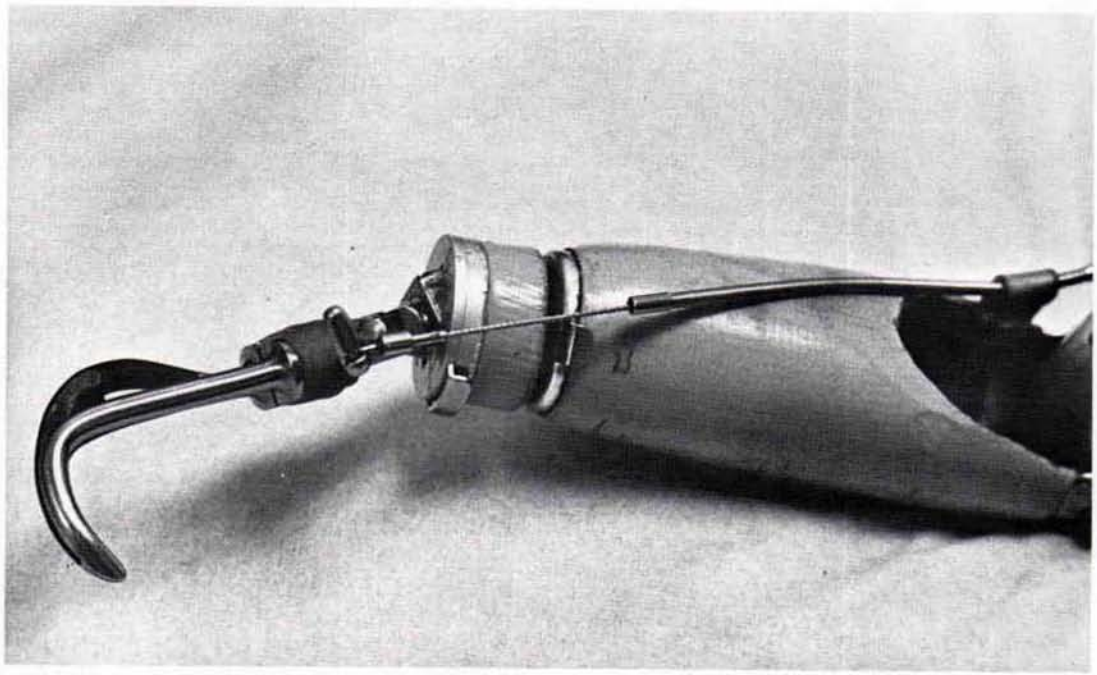

Fig. 5. View of prosthesis showing wrist components.

prosthesis. Third, it was designed to serve as a stable point to properly support and suspend the appliance and to provide an anchor point for the control system.

Some problems soon became evident, however. When only a chest strap harness was used, the shoulder cap migrated posteriorly when the prosthesis was activated, the motion being caused by the forces transmitted from the control attached to the shoulder cap, and the other end attached to the above-elbow steel strut, (Fig. 6), with one end being attached to the shoulder cap, and the other end attached to the above-elbow socket. It should be noted that the point of attachment on the socket is critical, since it must be located as near as possible to the center of rotation of the shoulder when viewed from the transverse plane. This connection was made possible by the design and fabrication of a shoulder joint (Fig. 7) which allowed for shoulder flexion, extension, and rotation (Fig. 8). Abduction and adduction are possible because of the spring in the strut.

With the strut and shoulder joint fixed in proper alignment, a constant distance between the fixed point of the control strap on the shoulder cap and the above-elbow socket is guaranteed. With this insurance, all excursion generated by the motions of humeral flexion and shoulder protraction is available to operate the elbow mechanism and the terminal device, with no loss of effort due to excessive harness migration (Fig. 9).

Donning and doffing the prosthesis was not a problem. The chest strap harness was modified so that it can be opened and closed by using the prosthesis. Because of the rigidity of the posterior strut, both sockets became essentially one integral part in a functional position, thus allowing the amputee to get into and out of the appliance without assistance.

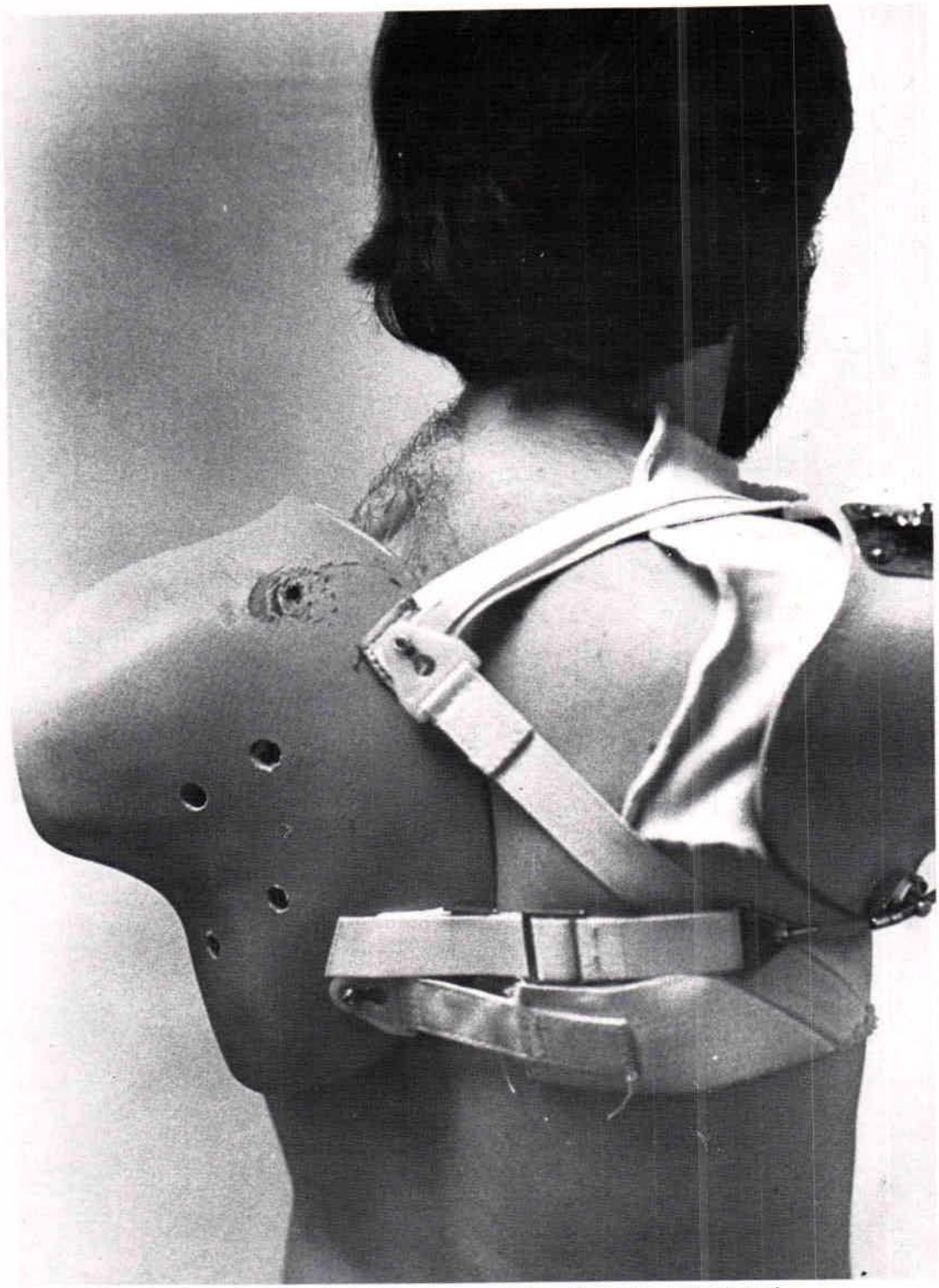

Fig. 6. View showing migration of shoulder cap when conventional harnessing is used.

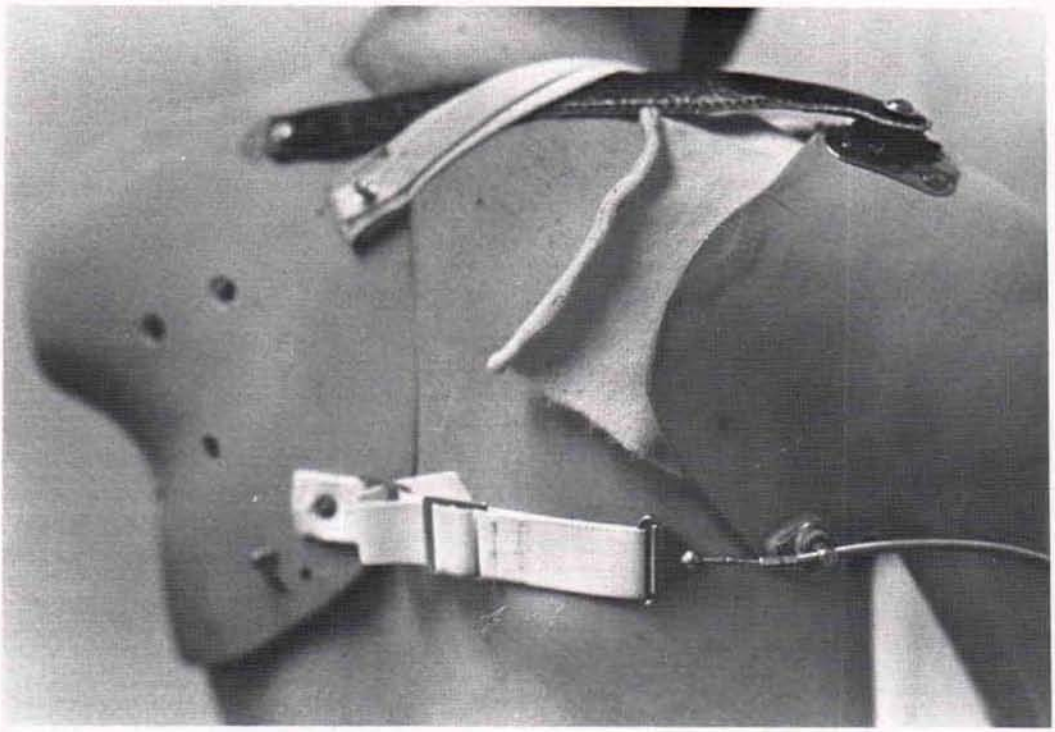

Fig. 7. The posterior strut in place.

Fig. 8. Lateral view of prosthesis showing shoulder joint.

Results and Conclusions

This case report demonstrates the adaptation of a prosthetic device for the high level, bilateral, upper-limb amputee. The client, a 24-year-old white male, with traumatic, bilateral, upper-limb amputations, had attempted to use commercially available electric elbow-hand components on the left side. However, because of recurring mechanical failures of the elbow, and because of a decreased level of independence, especially in the areas of dressing and undressing, it was his desire to go on with only the unilateral appliance which has been presented. This particular amputee has been using the prosthetic system described here for the past two and one-half years. He has demonstrated a very significant, high level of independence. He has now graduated from the University, and during his last two years as a student was indepen-

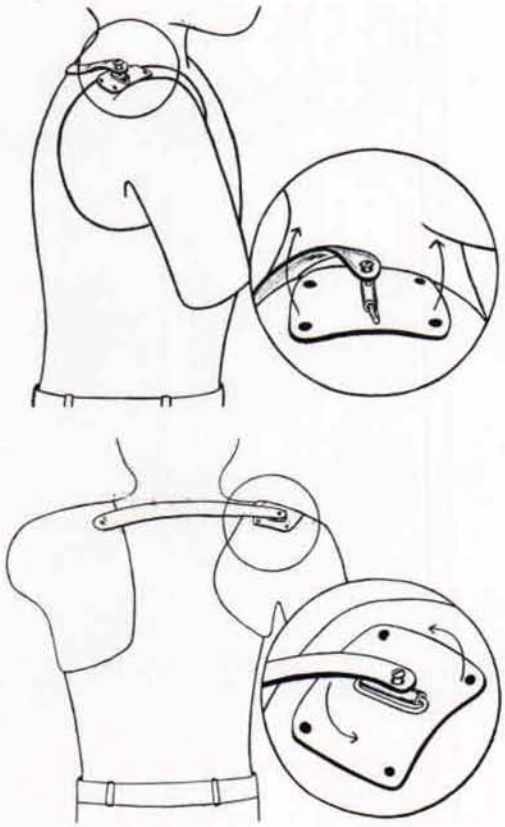

Fig. 9. Two schematics demonstrating motion allowed by shoulder joint and strut.

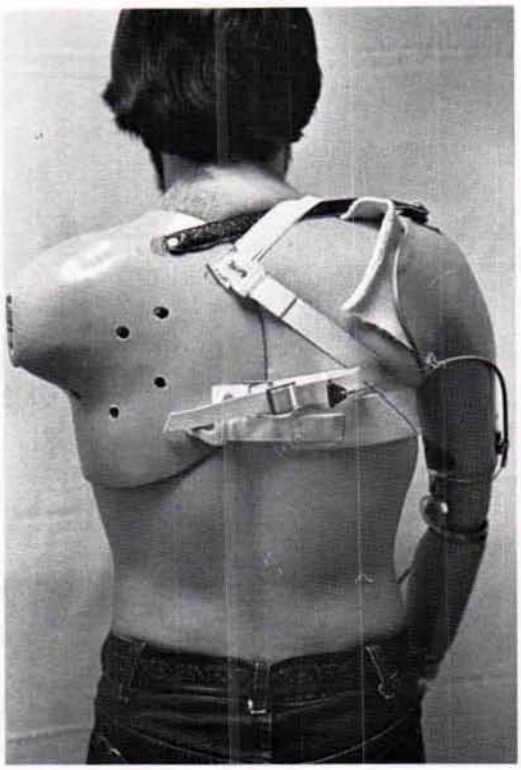

Fig. 10. Posterior view of the prosthesis.

dent in all self care skills. Summer employment has consisted of maintenance work for a custodial firm. His hobbies continue to be those of skiing, hunting, and fishing.

Footnotes

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References

(1) LeBlanc, Maurice, *Upper-limb prosthetics—current status and future needs,* Orthotics and Prosthetics, Vol. 31, No. 4, December 1977.