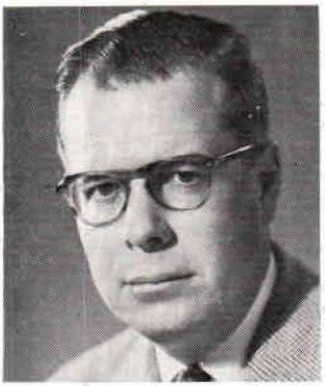
The Patellar Tendon Bearing Total Contact Prosthesis for Below-Knee Amputees



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Homo sapiens is a very perverse creature. It has often been said, "What is sometimes one man's meat is another man's poison." In any sufficiently large group of amputees may be seen a cross section of humanity, and so an amputee's reaction to any single environmental change may ranged from complete acceptance to complete rejection. Thus, when from several sources, [1, 2, 3, 5,] came reports that claimed almost universal acceptance of the new total contact patellar-tendon-bearing prosthesis (Fig. I) by below-knee amputees, the author began to wonder about this seeming inconsistency in human beings.

Prior to 1959, the basic prosthesis for the average below-knee amputee consisted of a thigh corset attached by steel hinges at the knee, to a rigid shank (wood or metal); a single axis ankle joint; and a wooden foot (or its counterpart). This type of prosthesis had been in routine use for at least the past hundred years. The literature[8] mentions that in 1826, Serre revived the principle of thigh support in B-K amputations. There are also available references that J. E. Hanger, about 1861, introduced the wood socket for the below-knee amputee.[3] This basic type of prosthesis had been refined about as much as possible and had become more or less accepted as the standard prosthesis for the usual below-knee amputee. However, in past years, a number of amputees have had difficulty tolerating the concentrated weight bearing required over the tibial condyle flares. Various

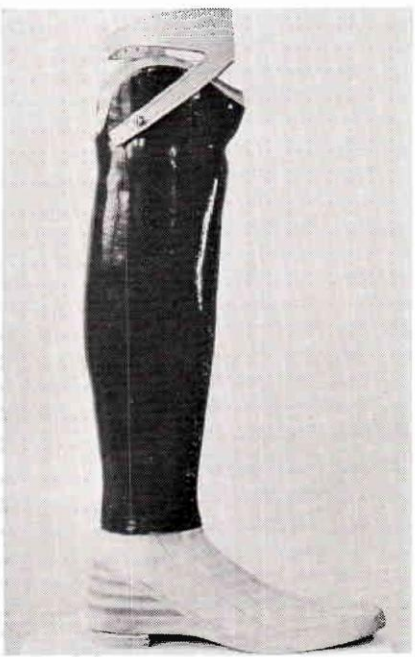

FIGURE 1

types of soft linings were used in the socket of this standard prosthesis including piano felt, sponge rubber, yielding plastic; even an all plastic total contact socket was used.[7] Most of these linings were found to have objectionable limitations when subjected to considerable wear by the amputee.

In 1959, a new approach to the subject was announced utilizing the principle of an older type of prosthesis, namely the Muley leg. The Muley prosthesis was a rigid below-knee socket prosthesis suspended by a simple condylar strap above the patella. This prosthesis, in practice, had serious limitations. The amputee usually had walked with an extended knee, and because of the lack of "back check" or hinge limitations to extension of the knee, the posterior elements of the knee joint gradually stretched, and a hyperextended or "back knee," resulted. To overcome this defect, the new prosthesis was so aligned that the patient passed through the entire phase of stance with his knee in flexion, thereby limiting the stretch on the posterior structures of the knee joint. This flexion attitude also provided a second effect, that of cushioning the downthrust of the stump (during stance) into the socket by controlled elongation of the quadriceps muscle. This new prosthesis provided for the greatly increased use of the patellar tendon and the popliteal area for weight bearing as well as the anteromedial and lateral tibia. Extension of the socket proximally not only enlarged the weight bearing surfaces somewhat, but supplied important stabilization of the stump. Mediolateral stability was also enhanced by using pressure along the lateral aspect of the fibula (sparing the cut end and the fibula head). The socket was closed over the distal stump to provide contact on the soft tissues. The stump was maintained in its position against the patellar tendon bulge in the socket by anterior-posterior pressure in the popliteal area. This is similar to the way the Berkeley suction socket maintains an above-knee stump in its position on the ischial seat by the anterior socket wall bulge in Scarpa's triangle. Fabrication problems of this new prosthesis were quickly resolved, and in 1960, the technique of fabrication of the total contact patellar-tendon-bearing prosthesis for below-knee amputees began to be taught in the prosthetic schools. The Veterans Administration early became convinced of the value of the new prosthesis, and contracts for its fabrication were let to various prosthetic facilities throughout the country.

In the Chicago area, there are five cooperating limb facilities which are qualified to manufacture the new type of prosthesis. The Veterans Administration Central Office published guide lines for its prescription, primarily limiting its use to patients who were unilateral amputees; who had at least a four inch below-knee stump; and who had a sound knee without ligamentous relaxation.

In spite of the fact that this prosthesis has now been in use for several years throughout the country, only the most general and fragmentary statements have been forthcoming as to its efficiency in any large group of amputees. ([1, 2, 3, 4, 5, 6, 8.])

In an effort to find out how effective this new prosthesis was, all of the patients who had had below-knee prostheses issued to them from the Amputee Clinic of the Chicago Regional Office of the Veterans Administration during the period from August 1, 1960, to May 31, 1962, were surveyed. This study yielded a total of one hundred and twelve below-knee amputees who had received a new prosthesis from this Amputee Clinic of the Veterans Administration. The average below-knee amputee in this clinic

is employed, has a family, uses his prosthesis fourteen to eighteen hours a day, rarely, if ever, uses crutches or cane, and has usually adjusted well to his disability. It was noted that of the group of one hundred and twelve amputees, there were forty-seven "standard" or old-fashioned types of B-K prostheses issued. There were fifty-three PTB prostheses with condylar straps issued in the same period. Four patients had the new PTB prosthesis issued with corset and side hinges applied at the time of manufacture. Three patients were found who had both a PTB prosthesis and a standard type of prosthesis issued during this study period. Five of this group of one hundred and twelve had been issued a slip-socket type of prosthesis.

In reviewing the reasons why the "standard, or "old-fashioned" types of prosthesis were issued during this modern era, they were found to run as follows. 1) Lack of motivation to try something new, and/or a desire not to lose any more time than absolutely necessary from a job, were the main reasons for supplying a standard type of prosthesis to twenty-eight of these amputees. 2) Six of the patients lived sufficiently far from the limb shop that it would not be feasible for them to make the round trips necessary for the possible multiple initial changes in the socket fit or alignment. 3) Stumps in six of the cases were too short (less than four inches) for issuance of the new prosthesis under the VA regulation. 4) Four patients had stumps which were too painful to palpation at the time of initial prescription and evaluation to wear probably successfully a total contact PTB prosthesis. 5) Three patients stated that they needed a leg that would stand up under very heavy laboring activities and felt that the new leg (which they were shown) would not be adequate in strength. 6) Two of the patients were bilateral amputees who stated that they wanted to retain the stability and the security of their previously-worn, standard types of prosthesis. 7) Two patients had an excessive sweating problem, and the clinic team felt that with the use of the closed leather rubber lined socket this sweating problem might be aggravated. 8) One patient stated that he was "too active" for the new type of leg. 9) Another patient had a dermatitis problem that the attending surgeon felt would contraindicate the use of the closed socket prosthesis. 10) A single patient had relatively recently fractured his femur, and needed the thigh corset for support. 11) One patient had a stump that changed quite frequently in shape and it was felt advisable not to issue a closed end, critical fitting socket to him. 12) Another patient had a fluctuating weight problem. These, then, were some of the reasons why the new prosthesis was not issued to this group of forty-seven patients.

The five patients who had prescriptions for slip-socket prostheses all had short stumps, one and one-half to three inches, too short under the VA regulation for the PTB prosthesis. These five patients had used slip-socket prostheses before and had been completely satisfied.

Of the three patients who had both a PTB prosthesis and a standard leg, one patient found that he was not able to use his PTB prosthesis for heavy lifting activities, and used a standard prosthesis on his job, reserving the PTB prosthesis for non-work activities. Two patients were unable to tolerate the patellar-tendon-bearing prosthesis after it was prescribed and fabricated. Because the previous prosthesis had been condemned, new "standard" prosthesis with thigh corset, side hinges and willow socket was made for both. The PTB prosthesis with a corset was initially prescribed for four patients. This was used in one patient because of excessive scar tissue on his stump which was intolerant of weight bearing. One patient's

stump was covered with extremely thin skin without subcutaneous fat padding, and he had had a great deal of trouble, prior to the PTB prosthesis, in wearing a leg without an ischial weight bearing corset. Two patients wished the added security of a thigh corset. These last two patients were truck drivers and wanted the response of the prosthesis that they obtained with a thigh corset rather than the perhaps inadequate response of a prosthesis with only a condylar strap. All four of these patients were found to be wearing their prosthesis on a full time basis on a three to four month follow-up examination.

Four patients originally fitted with PTB prostheses and condylar straps were seen at a later date, at which time a thigh corset addition was prescribed. One of these patients was a bilateral amputee with eight-inch below-knee stumps. He was a surgeon and found that after prolonged standing, his stumps became too sensitive for comfort. The thigh corsets were added, and a four month check-up indicated that the prostheses were then completely acceptable. A second patient wore a PTB prosthesis for three months during which time his weight fluctuated considerably. He further noted that on heavy lifting he had considerable stump discomfort, and it was the consensus of the clinic that a thigh corset would aid his further rehabilitation. A third patient, truck driver with a Chopart amputation on one side and a seven-inch below-knee amputation on the other, wanted the additional security of the thigh corset. This was added two weeks after he had obtained his PTB prosthesis. A fourth patient, after four months of endeavoring to wear his prosthesis, had so much difficulty with tender skin, aggravated by sweating, that he wished the addition of a thigh corset. A five month check-up on this patient revealed that this had effectively solved his stump skin sensitivity problem.

Fifty-one patients in the group of one hundred and twelve were found to have been issued a total contact PTB prosthesis with condylar strap. Of this group, sixteen were followed for an insufficient time to warrant any sort of end result pronouncement, and four patients were lost to follow-up. Of this remaining group of thirty-one, six patients were followed from one to six months, fourteen patients were followed from seven to twelve months, eight patients were followed from thirteen to eighteen months, and three patients had a nineteen month or longer follow-up. There were four total failures in the group of thirty-one. One patient, after five months of full time satisfactory wear, suddenly developed a contact dermatitis of the stump. It was found that the patient was allergic to the Kemblo lining. He was not sufficiently motivated to try other solutions and demanded a return to his old willow type prosthesis. The patient made a subsequent complete recovery from his allergy problems wearing a standard type prosthesis. Three patients were unable to adjust to the PTB prosthesis while still on the adjustable leg. No attempts at relief or lining seemed to make them sufficiently comfortable that they could wear this type of leg. These three did not have sufficient motivation to wish to continue attempting to adjust to the prosthesis even with the addition of a thigh corset. They were all returned to their standard prostheses.

Of the group remaining (twenty-seven patients) it was found that only sixteen of this group wore their total PTB prostheses with condylar straps full time; whereas eleven patients, even after prolonged attempts at breaking them in, were only able to wear them part-time. Various reasons were given by the part-time wearers for their inability to wear the prosthesis full-time. Four patients stated that they were not able to tolerate their new

prosthesis for more than a few hours at a time because of stump discomfort or pain. These patients had had repeated attempts at relief and/or lining to make them comfortable, but still could never get the complete comfort that they desired. These four patients alternated with their standard prosthesis. Three patients complained that their thigh muscles became quite tired during wearing of the PTB prosthesis, and particularly so when they attempted to wear the prosthesis to work. To them this was a very distracting situation. Three patients complained that whenever they wore the PTB prosthesis for any prolonged period they developed blisters on the stump. Although the stump pumping situation was minimized by the pelvic strap, this condition could not be completely eliminated. Two patients complained of severe discomfort in the stump whenever they were called upon to do heavy lifting, and were only part-time wearers. These two did not wish the addition of a thigh corset, as during the time they were not obliged to do heavy lifting, the new prosthesis was quite advantageous without the thigh corset addition. One patient wore his prosthesis only part-time because he liked the security of his old leg for certain activities such as mowing the grass, heavy lifting or driving an automobile. One patient stated that he was not able to kneel for sufficient periods in this type of prosthesis while on his job as a maintenance man. He therefore did not wear his new prosthesis for work. One patient stated that wearing his total contact prosthesis all day made his stump numb. He thus wore it only in the evenings, and weekends.

Approximately thirty-five of the amputees were further queried by questionnaire. A question, "Is your new prosthesis better for the following activities" listed walking, stairs, ramps or inclines, sitting, kneeling and lifting, and the following answers were obtained. On walking, twenty-eight patients felt they did better, four felt they did not show any improvement; and three patients did not respond. On stairs, seventeen felt they were able to negotiate stairs in an improved manner over their old prosthesis; whereas thirteen did not feel this was true. Five did not respond. Ramps or inclines were negotiated better by twenty of the patients, less well by ten, no response by four; and one patient stated that this answer could be either yes or no. Sitting found twenty-nine amputees with a "yes" answer for an improvement; whereas five stated that there was no improvement, and one patient did not respond. Seventeen patients found that kneeling was less comfortable with the new prosthesis; whereas fourteen felt that it was improved over the standard type of prosthesis. Four patients did not respond. Lifting again found the "no's" predominant with twenty patients who stated lifting was more difficult and painful with the new prosthesis; ten found it was improved; and five did not respond. To the question, "Would you want another prosthesis of the same type," twenty-two patients of this group answered yes, five answered no, and eight did not respond to this question.

In evaluating the above patients with PTB prostheses, certain things were noticed that we felt were important attributes of the new prosthesis. Several of the patients were found to have actually hypertrophied their quadriceps muscle by using this prosthesis without thigh corset, some as much as one inch of increased thigh circumference. This measureable hypertrophy occurred after two to six months of usage. It was further noted that skin problems due to chronic venous stasis such as verrucous hyperplasia showed improvement after wearing this type of prosthesis. (Figures II and III) It was also of interest to note that none of the PTB prosthesis

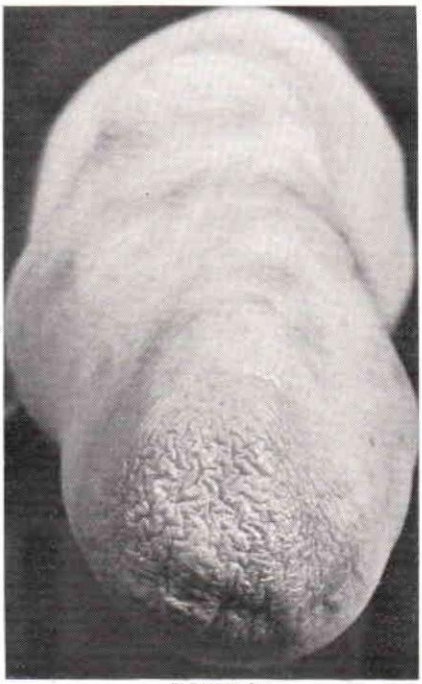

FIGURE 2

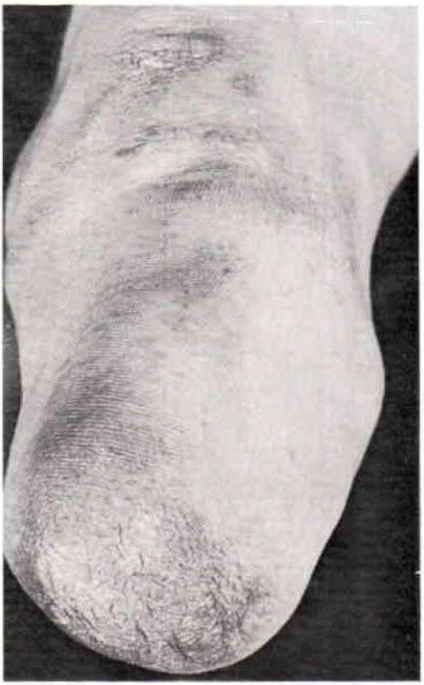

Figure 3

wearers developed any evidence of infrapatellar bursitis such as one might expect from concentrated weight bearing in this area. After reviewing our experience, it was the opinion that the total contact patellar-tendon-bearing prosthesis was definitely a new development for the below-knee amputee worthy of consideration when prescribing a leg for either a new or an old amputee. The full-time wearers of the PTB prosthesis in our clinic were quite enthusiastic in their response to the prosthesis, indicating that it was a definite improvement over the previously worn type of prosthesis. However, those who were not able to wear it were equally sure that the old style prosthesis was more to their liking than this new prosthesis. In other amputee clinics where predominately new amputees are seen, it has been our *impression* that the new amputee takes to the PTB prosthesis a great deal easier than does an old wearer such as we encountered in our VA Amputee Clinic. In reviewing this series of cases our prescription indications would seem to be confined to a below-knee amputee, either unilateral or bilateral, preferably who has not worn a prosthesis prior to his appearance at the prescription clinic. The patient ideally should have a stump which is four to seven inches in length or longer, with adequate knee stability, his job should not require heavy lifting or heavy laboring activities, and he should not require excessive stability of his prosthesis. Those amputees who do a great deal of kneeling or standing in their occupation should be carefully evaluated before prescribing this new prosthesis. In addition, the amputee patient should be within a reasonable distance from the limb shop. Arbitrarily a distance of fifty miles is about the maximum the patient should be expected to travel for the necessary fittings.

In summary, 112 below-knee amputees were evaluated. 51 of whom were issued the new patellar tendon bearing prosthesis. Of 31 patients with

an adequate follow-up, only 16 were full-time wearers. This prosthesis, however, is a definite addition to the armamentarium for the below-knee amputee.

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