

IMMEDIATE POST-SURGICAL PROSTHETIC FITTING

Prosthetic Research Study Report ^a

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Ernest M. Burgess, M.D., Principal Investigator

Robert L. Romano, M.D., Associate Investigator

Joseph E. Traub, Director

Prosthetics Research Study

1102 Columbia, Room 409

Seattle, Washington

PURPOSE OF THE PROJECT

The purpose of the research being conducted at the Prosthetics Research Study in Seattle, Washington is to investigate the concept and practical application, if any, of Immediate Post-Surgical Prosthetic Fitting in lower-extremity amputees with early ambulation consistent with individual patient circumstances. Basic guidelines for this investigation were derived from the reports of Marian A. Weiss, M.D., Director of Konstancin Rehabilitation Hospital, Warsaw, Poland. Dr. Weiss' investigations in this field indicated the feasibility in his hands of the immediate post-surgical fitting of a temporary prosthetic socket. He advocated, and had practiced in a limited number of cases, in addition to immediate socket fitting, early ambulation with partial weight bearing. Amputee management as advocated by Weiss implied a radical departure from accepted techniques used in this country and around the world.

In order to evaluate accurately the ideas advanced by Weiss, it was determined that amputees of all ages, disabilities, and circumstances must be studied. Accordingly, in May of 1964, a contract to conduct such a study was awarded to Ernest M. Burgess, M.D. of Seattle, Washington, by the Veterans Administration Prosthetic and Sensory Aids Service, Washington, D.C. with the cooperation of the Seattle Veterans Administration Hospital.

Initially, the staff of the Prosthetics Research Study was provided office space in the Smith Tower quarters of the Veterans Administration Out-Patient Division. It was soon apparent that in order to function effectively in this investigation, laboratory facilities must be available. Accordingly, efforts were made to establish a working arrangement with the University of Washington Medical School. After 6 months of negotiations with the Division of Orthopedics and the Department of Physical Medicine of the

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Medical School for cooperative use of their Prosthetic-Orthotic Laboratories for research, it became apparent that no satisfactory arrangements could be made. In light of this, a request was made of the Veterans Administration Prosthetic and Sensory Aids Service for additional funds to establish a comprehensive laboratory in which to conduct basic research and clinical studies in Immediate Post-Surgical Prosthetic Fitting. This request for additional funds was granted, and on May 1, 1965 the Prosthetics Research Study Laboratory at 1102 Columbia, Seattle, Washington was completed and occupied. Between May 1, 1964 and May 1, 1965, the necessary facilities for construction and modification of research prostheses were provided through the cooperation of commercial prosthetic-orthotic shops in the Seattle-Tacoma area. Since this arrangement was very inconvenient for all concerned, the Prosthetics Research Study staff is sincerely grateful for the assistance provided by the Dodge and Lundquist Company and Lundberg's Inc. of Seattle and the Tacoma Brace and Limb Company of Tacoma.

Case material has been obtained from the following hospitals: the Seattle, Washington and Portland, Oregon Veterans Administration Hospitals, the Swedish Hospital, the Children's Orthopaedic Hospital, the Providence Hospital, the University of Washington Hospital, the King County Hospital, the University of Oregon Hospital, and the Washington State Institutional Hospital System (Rainier School and Hospital).

Since the beginning of this project, research has been directed along the following lines of investigation:

1. Documentation, by a review of the literature and by direct communications and visits with Dr. Weiss, of the specific technical details of his method and his experience.
2. Duplication of the Weiss techniques by our research team.
3. Technical modifications and improvements based on growing experience as caseload increases.
4. Standardization of both surgical and prosthetic management consistent with results obtained in experimental cases.
5. Coordination of studies and results with other investigators in this country and abroad.
6. Extension of the investigation into related areas, i.e., surgical techniques, prosthetic refinements, and physical and psychological rehabilitation.

CHRONOLOGICAL DEVELOPMENT OF RESEARCH

Considerable difficulty was encountered during the initial phase of the investigation in obtaining exact details of the Weiss technique. All available information was correlated including verbal reports from Americans who had heard Weiss' formal presentation and had talked personally to him. At the onset, a visit to Warsaw was not feasible. Accordingly, we drew up

a series of specifications and proceeded to test the immediate post-surgical concept within these guidelines. Several lower-extremity amputations were performed in a cross section of patients ranging from children with congenital deformities to elderly vascular amputees with diabetes and gangrene. The level of amputation in each patient was determined on the basis of accepted criteria and without regard to the post-surgical management. The surgical technique in each instance was conventional, i.e., that technique which would have ordinarily been employed had conventional post-surgical management been utilized. Surgical drainage of the wound was similarly utilized. At the conclusion of the surgery and with the patient still under anesthesia, either regional or general, a rigid plaster socket was constructed over a light Owens silk dressing and a sterile, suitably sized stump sock. No additional padding was used. The socket was deformed to comply with accepted prosthetic design and was suspended with a waist belt. A detachable temporary prosthesis was incorporated with the initial socket before the patient was returned to the recovery room and after the plaster used to form the socket had sufficiently set to permit attachment of the temporary prosthesis. The temporary adjustable prosthetic extension and foot were then removed through the component, and the patient, with socket applied and with the accompanying adjustable pylon, was returned to his or her room.

The day following surgery, when general conditions permitted, the temporary prosthesis was reattached, the patient was assisted to a standing position at bedside under the direction of a member of the research team, and minimal weight bearing through the prosthesis and socket was allowed. Prosthetic alignment corrections were made at this time, as necessary. Progressive, carefully controlled weight bearing was then allowed consistent with the patient's general condition and tolerance. The initial socket was left undisturbed except for removal of the drain, when used, through a small window, until optimum time for suture removal, usually the fourteenth post-operative day. At this time, the cast and sutures were removed, the amputation site was inspected and photographed, and a new temporary socket of the same type applied. Progressive ambulation proceeded as with the initial socket until a permanent prosthesis could be fabricated. It was the goal of the program to fit the final permanent prosthesis between the third and sixth week depending on the patient's general condition and the state of wound healing and stump maturity.

Sixteen cases of fresh lower-extremity amputations were treated in the manner outlined. Observations of these cases allowed the following impressions:

1. Wound healing was not retarded by the techniques described above.
2. Edema and other aspects of the post-surgical healing response were significantly reduced by the rigid cast dressing and by ambulation.

3. A striking decrease in the amount and duration of post-operative pain occurred.
4. The relative freedom from pain during the early post-surgical days together with the patient's ability to be standing up and partially ambulant on a prosthesis created psychological benefits not ordinarily encountered in amputations managed in the usual manner.
5. Pressure relationships were critical. In two of the initial series of cases, pressure necrosis was encountered over the anterior distal portion of the tibia with one below-knee amputation and in the other over the patella where friction of the suspensory mechanism in the patellar-tendon-bearing-type cast socket lay directly over the patella itself. Likewise, the effects of inadequate or insufficient localized pressure around the wound resulted in edema and blistering where the initial socket was not at all times firmly and smoothly in contact with the stump. Even the most meticulous cast application and deformation with the materials available did not insure equal and uniform pressure of the desirable and proper amount to all areas.
6. Hematomas and collections of fluid within the stump following surgery compromised the method significantly and led the research team early in the investigation to realize the necessity of adequate surgical post-operative drainage no matter how dry the operative wound appeared at the time of closure.
7. Removal of the initial socket for any period of time even as short as half an hour without the application of continuous pressure forces to the stump during the early days of healing permitted rapid changes in stump size and fluid retention. While stump maturation under the method proceeded more rapidly than by conventional management, maturation and stump size stability could not be achieved in the routine case under 18 to 21 days. During this critical period of wound healing and stump stability, a continuous rigid pressure dressing was necessary.
8. Prosthetic components used in the temporary prosthesis require skilled alignment. The transfer of forces through the long lever arm of the prosthesis significantly altered the pressure relationships between the temporary socket and stump. For this reason, alignment factors were as critical, or more so, than with the permanent limb.

At this point in the evolution of the research plan, it was opportune for the research team to visit Dr. Weiss in Warsaw and correlate observations directly with his experience. Upon return and resumption of the investigation, certain basic technical changes were made. These included the routine immobilization of the immediate proximal joint. They also included the addition of padding in the form of well fluffed surgical gauze between the thin silk dressing over the distal end of the wound and the wool stump sock. Specially designed felt strips were also added to protect

critical areas about the anterior tibia and patella. The initial socket was not routinely left in place a full fourteen days. The initial change of socket took place between the seventh and fourteenth day individually adjusted to the surgical circumstances prevailing at the time of the closure of the wound.

An additional thirty cases have been operated and studied with the standardized technique developed following the visit to Weiss, and a sample case report is included in this report. At the present time, the study is continuing, and the following recommendations and conclusions are submitted:

1. Immediate Post-Surgical Prosthetic Fitting can be successfully and beneficially employed in the treatment of fresh closed amputations of the lower extremities.
2. Early ambulation on the first or second post-operative day is feasible and practical with this technique.
3. It is our considered judgment, based on the preliminary results after more than a year of investigation, that this method has certain inherent advantages and possibilities which warrant further study and refinement. Avenues of investigations include technical improvements in amputation surgery, i.e., myoplasty, osteoplasty, and a varying combination of the two; observations on the basic effects of wound healing under the specific circumstances of pressure and weight bearing instituted with the method; the upgrading of initial and temporary prosthetic components; the psychological response of patients to early post-operative ambulation; evaluation of proprioceptive and other neurosensory and neuromuscular phenomena involved with the technique; the effect on the economy of amputee care; and last but not least, the coordination through combined effort, of the prosthetic and surgical professions.

CASE STUDY REPORT NO. 35

On July 30, 1965 a left below-knee amputation was performed on an 80-year-old white male with diabetes and vascular disease. Approximately five weeks previous to this amputation, the patient had been admitted to the hospital with fever and lymphangitis of the left leg resulting from stepping on a rusty nail. The patient had been given tetanus antitoxin and toxoid initially, followed by debridement of the lesion and initiation of penicillin treatment. The circulation status in the lower extremities was evaluated. Left femoral arteriogram revealed a short segmented occlusion of the distal superficial artery on the left. Plethysmography showed reduction in blood flow in the feet. The patient's first, second, and third toes became gangrenous during these first several days of hospitalization. The patient then developed femoral phlebitis of the left leg and on July 8th amputation of the left second and third toes was accomplished. Follow-

ing this, the patient had continued problems with thrombophlebitis and it was finally decided that amputation at a higher level was required.

The surgical procedure was of the myoplasty type, as follows: A fish-mouth incision was made in the skin at a point approximately 6 in. below the tibial plateau with a somewhat larger posterior flap. This incision was taken down through the fascia which was maintained as a discrete layer. The musculature was then divided transversely at this level down to and around the tibia and fibula. The vessels were tied off. The periosteum was stripped from the tibia approximately 1 in. above the skin incision and the bone transected at that level with an anterior bevel and smoothed with a file. The wound was then irrigated and hemostasis completed. Four transverse and two oblique holes were drilled through the distal tibia approximately $\frac{1}{4}$ in. above the end, and heavy nylon sutures were used through these holes to anchor the large muscle bodies under tension to the bone at this level. The muscle was then trimmed at the level of the bone end in order to reduce its bulk distally. The muscular fascia was then approximated with interrupted sutures and a small penrose drain left below the fascial closure and brought out the ends of the incision. The skin was also approximated in a "plastic" manner with fine nylon sutures. There was no tension on either the fascial layers or skin when the wound was closed. The wound was dressed with one piece of Owens silk and eight 4 in. by 4 in. fluff gauze dressings. A sterile 5-ply wool stump stocking was rolled onto the stump and pulled tight to provide constant and smooth distal pressure.

The cast-socket was applied as follows: The pressure was maintained on the distal stump by pulling on the proximal anterior edges of the stump stocking throughout the casting procedure. The knee was positioned in approximately 10 deg. of flexion and held there by directed pull on the stump sock proximally. A piece of $\frac{1}{2}$ -in.-thick medium felt was fashioned to fit around the borders of the patella and glued in place with Dow Corning Medical Adhesive. Two additional pieces of felt were fashioned to fit on either side of the anterior tibial crest to direct pressure to either side of the crest and provide pressure relief by the "bridging" of plaster directly over the crest. The piece of felt located on the anterior medial aspect also included a 2-in.-wide posterior projection at a level just inferior to the flare of the medial tibia condyle which would provide contouring in the area for weight bearing surface. These felt patches were skived at all their edges and glued in position on the stump stocking. Elastic plaster-of-Paris bandage was then applied to the stump with firm tension distally and gradually diminishing tension as the wrap progressed up the stump to the mid-thigh level where there was no tension applied to the bandage at all. The cast was contoured by hand pressure just proximal to the femoral condyles to provide suspension and eliminate the possibility of cast-socket slippage. After the initial plaster had hardened, the cast socket was reinforced with standard plaster bandage and a suspension strap was incorporated in the

wrap on the anterior-proximal surface. An adjustable temporary/permanent below-knee prosthesis with a SACH foot was attached to the cast by additional plaster bandage after having been positioned on the cast to reproduce the static alignment attitude generally accepted in the practice of lower-extremity prosthetics. The prosthesis was disconnected by a special disconnect feature at the distal end of the socket and the patient was taken to the recovery room after having tolerated the procedure quite well.

On the first post-surgical day, the prosthesis was attached and the patient assisted to a standing position at the bedside. His standing balance with a portable walker was good and he complained only slightly of pain. The alignment of the prosthesis was checked and corrective adjustments made. Following these alignment adjustments, the patient stated that he was quite comfortable and with assistance he was able to take four steps on the prosthesis. He was then assisted back to his bed and the prosthesis was again disconnected.

On the second post-surgical day, a window was cut in the cast socket and the drain was removed. The window was packed with sterile gauze fluffs and closed with standard plaster of Paris.

The third through the seventh post-surgical days, the patient was active in a wheelchair and in standing and ambulation activities in the parallel bars. The weight bearing and ambulation periods were gradually increased from 5 minutes each twice a day to 15 minutes each three times a day. Approximate weight applied during the standing and walking periods increased from 10 lb. to 50 lb., and the patient was comfortable throughout.

On the eight post-surgical day, the cast was removed and the wound inspected. This examination revealed the wound to be healing well and the stump in excellent condition. The stump was immediately recasted exactly as in the operating room and the patient was returned to his activities.

On the ninth post-surgical day, the patient complained of some pain during his ambulation. The alignment was immediately checked and faults were corrected which in turn eliminated the pain the patient had experienced.

The ninth through the sixteenth post-surgical days, the patient continued his activities increasing his weight bearing tolerance to approximately 65 lb. and was comfortable throughout.

On the seventeenth post-surgical day, the cast-socket was again removed and the wound inspected. This examination disclosed that the wound had healed primarily and the sutures were removed. The stump was immediately recasted even though appearances indicated that permanent prosthesis fitting probably could have been undertaken. This delay was the result of caution. Because of the advanced age and vascular disease of the patient it was felt that a few more days in a cast-socket would be the

safest way to proceed. The patient was discharged to his home and continued his program on an out-patient basis.

On the twenty-sixth post-surgical day, the cast was removed and the stump fitted in a permanent prosthesis. The completed permanent prosthesis was delivered the same day. A lightweight below-knee cast was made and given to the patient to be worn at all times when he was not wearing the permanent prosthesis to control edema.

On the twenty-seventh post-surgical day, the patient was referred to physical therapy for gait training on his new prosthesis, and he progressed quite well.

During the night of the twenty-eighth post-surgical day, the patient did not wear the cast. The resulting edema produced undesirable forces against the stump when the prosthesis was applied the next morning and a bruise appeared over the anterior portion of the stump. Because of the delicate nature of his skin, the lightweight cast was put on and the prosthesis withheld for three days. At the end of that time, the edema was again under control and the bruised tissue gradually clearing up. The prosthesis was reapplied without socket adjustments being necessary and he was returned to gait training on a carefully controlled program.

On the thirty-fifth post-surgical day, the patient was ambulating well with his prosthesis and two canes and was discharged from the program as being completely physically rehabilitated to his activities of daily living.

A three-month follow-up indicated that the patient was continuing to do well with his prosthesis, wearing and using it an average of 15 hours per day without difficulty.

Note: On several occasions, Dr. Weiss has pointed out to researchers from the United States that he had known of work in the field of immediate post-surgical fitting done by some French colleagues. We have not attempted to survey the history of this technique.

We are pleased to submit the following information from a letter recently received from Dr. Jean-Paul Willot, Etablissements HELIO-MARINS, Berck-Plage, France. Dr. Willot writes that Dr. Michel Berlemont of Berck-Plage, originated the immediate post-surgical fitting technique and that since 1958 has treated more than 250 amputees with this method. Dr. Willot cites three occasions when the technique was presented and also notes that in October 1962 at Berck a demonstration of Dr. Berlemont's technique was witnessed by Dr. Weiss.

We wish to thank Dr. Willot for sending us this information.

The Editors

CLINICAL ACTIVITIES

	Seattle	Portland
Unilateral patients	38	10
Bilateral	3	0
	—	—
	41	10
LEVELS OF AMPUTATION:		
Below-knee	28	10
Above-knee	9	0
Syme	4	0
Knee Disarticulation	2	0
Ankle Disarticulation	1	0
	—	—
	44	10
TYPE OF SURGERY:		
Myoplasty	20	5
Conventional	24	5
	—	—
	44	10
SEX:		
Male	34	9
Female	7	1
	—	—
	41	10
AGE DISTRIBUTION:		
1-12 years	5	0
13-24 years	3	0
25-50 years	13	4
51-75 years	17	6
76-up years	3	0
	—	—
	41	10
CAUSE OF AMPUTATION:		
Vascular disease	18	6
Trauma	8	0
Congenital deformity	5	0
Infection	9	4
Sarcoma	1	0
	—	—
	41	10
REAMPUTATED HIGHER LEVEL AS RESULT OF NON-HEALING:		
Elective site too low	2	0
Post-operative directions not followed	1	

Seattle

Portland

STUMP MATURATION DELAYED
BEYOND FIVE WEEKS:

Non-weight bearing	2 (1 bilateral)	0
Pressure necrosis—cast	1	0
Surgical closure too tight	3	0
Post-operative directions not followed	0	2