*The Surgeon's Responsibility in the Rehabilitation of the Amputee

An Evaluation of 228 Amputees as to Surgical and Prosthetic Management

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Accelerated interest and activity in all rehabilitation problems and especially in rehabilitation of amputees is one of the remarkable phenomena of post-war medicine in our country. Great strides have been made in restoration of function and increasing opportunities for amelioration of economic and social problems, especially in special centers for rehabilitation. The vast majority of civilian amputees however, remain the problem of the individual surgeon, prosthetist and the vocational counselor. If the results of a recent survey of the management of 228 amputees, evaluated by the author between January 1948 and January 1951, are an indication of the care the average amputee receives, it would appear that many individuals are not benefiting from recent advances in amputee rehabilitation. Too frequently the surgeon fails to recognize his responsibilities to the patient other than abalation of the diseased member and post-operative care of the wound, ignoring entirely the present day concept of the surgeon's role as actuator, adviser, and coordinator of a complete rehabilitation program which requires cooperation of a number of individuals for success.

Rather than present a detailed statistical survey of our findings in these 228 cases, we will consider the more significant errors of management encountered and briefly outline a comprehensive program for the management problems. Such a program can be divided into four phases: surgical management, postoperative care, prosthetic restoration plus training, and vocational guidance.

Surgical Management

If we were to select one phase of amputation management recognized by all as the primary responsibility of the surgeon it would be the actual amputation of the limb at a site acceptable for the fitting of a prosthesis. The rehabilitation of the amputee begins with the surgeon's decision to amputate. The type and site of amputation established by the pathology necessitating the amputation frequently determines the patient's entire future and always determines the amputee's ability to be fitted with, and successfully use, a prosthesis. How well is this being carried out? Evaluation of 246 stumps in the present series revealed that but 64% of the lower extremity and 41% of the upper extremity amputations had been performed at acceptable sites of election. Admittedly difficult to accurately evaluate, a review of the history in these cases revealed that the pathology necessitating abalation probably accounted for but 38% of the unsatisfactory stumps, the other 62% resulted from failure on the part of the surgeons to apply modern surgical knowledge and proper surgical judgment.

We do not intend to discuss surgical technics or various types of amputations. However, certain principles of amputation must be included to establish a standard.

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The success of the guillotine or open amputation at the level of trauma or infection followed by later reamputation or revision of the stump has been proved by vast military and civilian experience. The disadvantages of a second operation are greatly outweighed by the resultant conservation of life, limb length, and the quality of stump obtained.

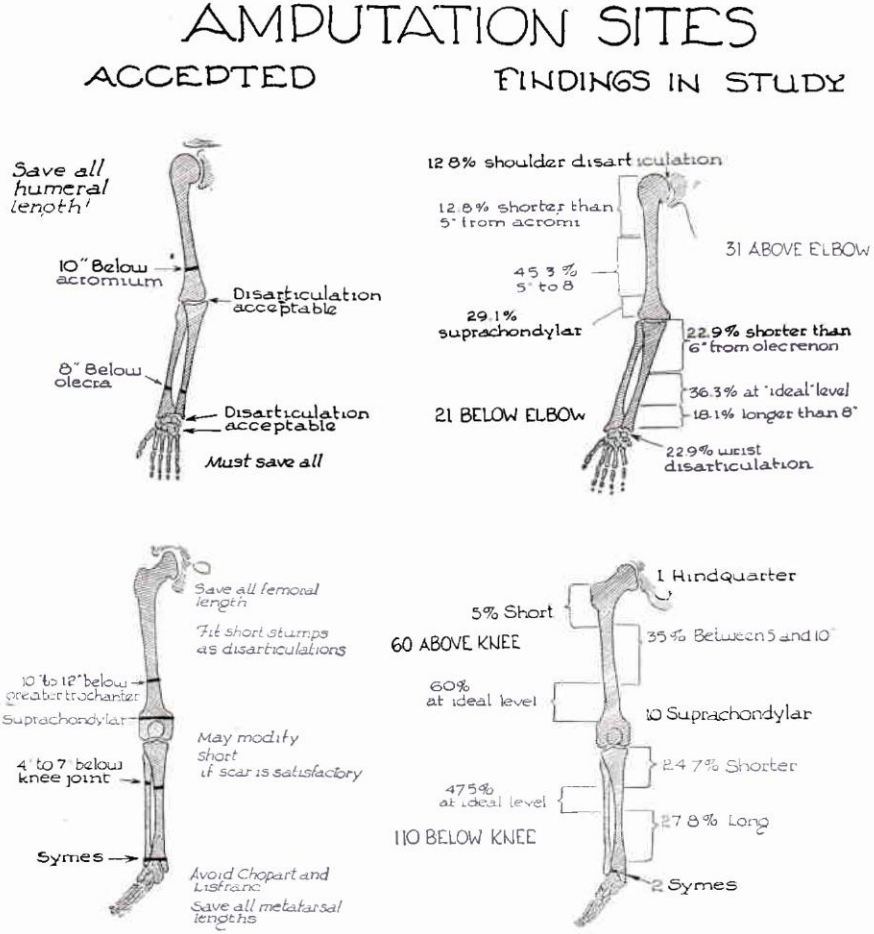
From experience gained by the surgeons and prosthetists both in this country and abroad, certain sites of amputation are obviously most satisfactory from the standpoint of function, prosthesis fitting and stump durability. Although authorities differ slightly, the following sites of election have been defined in the lower extremity. The accepted sites of election for major amputations are at Symes level through the ankle; through the lower leg 4½" to 7" below the knee joint; through the femur at the supracondylar level; and through the thigh 10" to 12" below the tip of the greater trochanter.

In the upper extremity the accepted sites of election for major amputations are through the distal third of the forearm 6" to 8" below the olecranon and through the upper arm 10" below the acromion. Disarticulations through the carpal bones, wrist and elbow have been revived recently and prove effective sites of amputation, although they present certain problems of prosthesis fitting.

Amputations which cannot be done at the sites of election should be performed according to established principles. Amputations through the foot should conserve all possible metatarsal and phalangeal length. However, amputations at Lisfranc's and Chopart's level have not proved acceptable and should be avoided in most cases. Amputations through the hand demand that all viable tissue be conserved and that no part be sacrificed except when a well planned reconstructive procedure is carried out to improve function in the remaining portion of the hand.

Modifications of the stump or the use of special prosthesis may frequently be used to compensate for amputations performed at sites other than those of election. For example, the short below-knee stump, modified by section of the medial hamstrings or by using a "slip socket," may be fitted successfully with a prosthesis that retains knee function. The short below-elbow stump may be fitted with a prosthesis that retains elbow motion by using the double socket with polycentric joints or modified by section of the biceps tendon. Amputations performed through the thigh or upper arm above the sites which can be fitted with regular above-knee or elbow prostheses, should conserve all possible bone length, rather than resort to disarticulation through the joint above, because of better stump contour and greater ease of fitting a prosthesis designed for disarticulation stumps.

The position of the scar from the standpoint of the patient's comfort as well as scar irritations and disruption is not adequately appreciated. Because of variations in circulation and soft tissue pliability, it appears less difficult to secure satisfactory scars at certain sites than others. For example, the scars were satisfactory in 89% of the above-knee stumps but were satisfactory in only 68% of the below-knee stumps examined. Some concept of scar importance can be gained from the fact that over 70% of the difficulties encountered in fitting below-knee prostheses resulted from unsatisfactory scars. In general, the stump scar should be terminal and slightly posterior, narrow, and non-adherent to nerves or bone. In planning reconstructive procedures on lower extremity amputees or potential amputees, procedures which produce scars on the thigh or lower trunk must be avoided if possible and those producing scars about the upper trunk and shoulder also must be avoided in arm amputees when possible.



The archaic practice of covering bone ends with muscle flaps to "cushion" the bone ends, only hinders stump shrinkage, adds to the difficulty of prosthesis fitting and frequently requires secondary revisions to correct. Attempts to conserve or increase stump length or secure closure of an open amputation by skin grafting, whether split or full thickness, as a definite procedure, are mentioned only to be condemned.

Post-Operative Care

In reviewing our cases it was evident that many technically correct surgical procedures were nullified by the poor quality of post-operative care. The post-operative care and preparation of stumps for the fitting of a limb remain the responsibility of the surgeon. Too frequently this care is allocated to ancillary workers and members of the house staff with insufficient knowledge of proper technique and of the importance of post-operative care.

The most frequently encountered evidence of poor post-operative care in our series was unshrunken or poorly shrunken stumps, joint contractures and excessive muscle wasting. All delay the proper fitting of prostheses and often account for subsequent difficulty in using prostheses.

The immediate post-operative care of lower extremity amputations war-

rants special consideration. After surgery the below-knee stump should be splinted with a posterior plaster slab, with the knee in extension, until complete wound healing has occurred, usually for a period of three to four weeks. This allows for proper fixation of soft tissues in the stump and healing of the skin, and also prevents flexion contractures of the knee. Other amputation stumps usually require less time to heal.

Thigh stumps must not be supported or elevated on pillows at any time during their post-operative course because of the marked tendency for flexion and abduction contractures to develop at the hip. As soon as the above-knee stump is healed, and decrease in tenderness will allow, the patient should spend at least half of his time while in bed lying prone. The avoidance of prolonged sitting in managing the above-knee stump to prevent flexion and abduction contractures of the hip joint should also be stressed. Postoperatively, upper extremity amputees usually require only proper application of pressure dressings with elastic bandaging to the stump.

Once stump healing is complete, the only methods of physiotherapeutic consequence are the proper application of elastic bandages to secure shrinkage of the stump and intensive exercises designed to maintain muscle power and normal range of motion in the remaining joints of the extremity. Elastic bandages must be applied with great care to prevent unequal pressure, constriction of the stump end, and stumps with contours difficult to fit with prostheses. The importance of exercise is applicable to all amputees. Above-elbow and above-knee amputees especially should be forced to carry out progressive resistance exercises to prevent atrophy and loss of muscle power about the shoulder and hip. This may be secured by the use of improvised slings and pulleys arranged to accommodate each individual case.

Prosthetic Restoration

The success with which a prosthesis is used depends on the surgical and post-operative management of the amputee, the selection and fit of the proper type prosthesis and the adequacy of training in its use. The manufacture and fitting of prostheses is obviously the primary concern of the limb fitter; never-the-less, it remains the responsibility of the surgeon to prescribe the type prosthesis and to inspect and approve the fitting of the prosthesis. It demands close liaison and cooperation between surgeon and limb fitter if the amputee is to receive satisfactory prosthetic restoration.

In our series of 228 cases, 147 had been fitted with prostheses prior to our initial examination. Only 12% of these 147 patients had had their prosthesis specifically prescribed or inspected by a physician. The other 88% had been furnished their prostheses without prescription, supervision or inspection. This represents the weakest link in the chain of amputee management. Both surgeon and prosthetist can gain much from the reciprocal exchange of knowledge. The greatest beneficiary, however, is the amputee. It is impossible to properly solve many problems of limb fitting without this close liaison. Only the more general principles of limb fitting will be considered here.

The ideally successful prosthesis for the lower extremity must first of all be of the proper length, provide stability on weight bearing without discomfort or mal-alignment and provide motion at the joints in correct alignment to allow walking without an obvious limp.

The most frequently repeated errors in fitting above-knee prostheses encountered in our group of cases were insufficient length, inaccurate seating of the ischial tubercle, improper socket size, faulty alignment of hip joint, ankle and knee and absence of the proper degree of valgus at the knee.

In examining below-knee prostheses, the most commonly encountered errors of fitting in their order of frequency were improper seating of the stump in the socket, faulty contour of the socket posteriorly, improper knee joint alignment and inadequate length of thigh lacer.

The prosthesis for an upper extremity must fulfill two requirements: function and appearance. The prosthesis should be light in weight, lifelike in appearance and incorporate the structures essential to imitate the functions of the normal arm and hand and must substitute mechanical devices for muscles and joints lost at amputation, to imitate the function performed by the various elements of the hand and arm.

Careful selection of upper extremity amputees for prostheses bears consideration. Thirteen of the thirty-one above-elbow amputees and two of the 21 below-elbow amputees were rejected for prosthetic fitting because of length of elapsed time since amputation, unsatisfactory stump, inadequate initiative and cooperation, or satisfaction of their status without prostheses. The greatest difficulty encountered in fitting upper extremity prostheses was proper design, adjustments and alignment of suspension apparatus and grasp control straps, especially in above-elbow prostheses. Faulty prosthetic joint alignment at the elbow produced the greatest number of difficulties in fitting below-elbow prostheses.

The fitting of a prosthesis requires utmost skill, patience and perseverance on the part of the prosthetist with numerous minor adjustments and alterations. Once the correct fit is secured the patient must be impressed with the importance of proper care and routine checks of the stump and prosthesis by the surgeon and prosthetist, especially during the first year of wear.

Prosthetic Use and Training

All patients who are fitted with a prosthesis must receive training in use of the prosthesis. This should be carried out under the supervision of the surgeon with the assistance of a physiotherapist.

Training the amputee to use his prosthesis is much easier in properly equipped centers with adequately trained personnel. However, adequate training can be carried out anywhere with little special equipment or personnel if complete cooperation on the part of the amputee, prosthetist and surgeon can be obtained. Advanced age, obesity, debility, and inherent awkwardness and incoordination are factors which increase the amount of effort and time required in training but need not prevent the development of proficiency in the use of artificial limbs.

Only four percent of the 147 amputees who were wearing prostheses at the time of our first examination had received any type of prosthesis training other than a few pointers which the limb fitter or salesman may have made when delivering the prosthesis. This lack of training was evident from the larger number of cases with faulty habits of walking or prosthesis manipulation which we found in this group, faulty habits which frequently defied all efforts at correction.

A total of fifty-eight lower extremity amputees in our series received special training in the use of their new prostheses. Twelve had previously worn prostheses and were referred because they were poor walkers. This training started with balancing exercises, walking between parallel bars, graduating to Canadian type crutches and stair climbing instruction augmented by walking before a mirror along a chalk line at home. Approximately an hour three times weekly for three to six weeks was spent in supervised training. Fifty-five percent of these trainees became proficient walkers and were classified as good.

Twenty-four percent had persistent limps, faulty body alignment, or became fatigued, and were rated as fair. The other 20% were classified as poor because of obvious limp or lurch and inequality of stride. Nine of these had previously worn prostheses and had been referred for training as "poor walkers."

Thirty-five upper extremity amputees received some supervised training in the use of their prostheses. This consisted of manipulation of the grasp mechanism with elbow and shoulder in various positions; practice on a "gadget" board with door knobs, light switches, etc.; training in use of common hand tools, eating utensils, etc.; and demonstrations in dressing. Sixty-five percent became sufficiently proficient to use prostheses in working; twelve percent were classified as fair, remained awkward but used prostheses in working; and twenty-six percent did not use their prostheses at work or abandoned them all together. Upper extremity amputees especially exhibited striking individuality in the manner in which they manipulated their prostheses.

Vocational Planning

Securing employment which allows full utilization of the amputee's abilities and yet is adapted to the limitations imposed by his handicap requires careful cooperation between the surgeon, prosthetist, rehabilitation counselor and employer. Since each case must be individualized, only the broader principles will be discussed.

When the amputee is referred to a Vocational Rehabilitation Service, the counselor must secure information from a number of sources. This consists of the client's educational and employment record, results of aptitude, intelligence and psychological tests, general physical examination and orthopedic recommendations as to the condition of the stump, the advisability of fitting a prosthesis, the specific type of prosthesis and the limitations of activity imposed by the client's disabilities. Individual job analysis, particular job hazards and the possibility of job modification plus the type of transportation available to and from the site of employment must be considered. With this additional information available, the counselor must attempt to match the particular client's abilities and limitations with the mental, physical, and psychological requirements of a particular job. The accuracy with which he accomplishes this balance between client's abilities and job requirements determines to a large degree the client's success at becoming and remaining self-sustaining.

The following cases are cited to illustrate the complexity of problems encountered and their solution:

Case (1). E. A. 36 year white female, obese, double below-knee amputee. Amputation at age 7 (traumatic). Referred for replacement of worn prostheses. Required stump revision because of verrucoid scar and reduction of weight. Fitted with prostheses, one with ischial weight bearing thigh corset. Returned to work on assembly line against orthopedist's recommendation, work unsatisfactory. Reevaluated, trained as switchboard operator and successfully employed as such past 33 months. Only problem is control of obesity by diet.

Case (2). A. L. 32 year colored male, single, right below-elbow amputee. Traumatic amputation 1948. Fifth grade education, laborer. Aptitude revealed manual dexterity. Referred for examination prior to purchase of prosthesis, October 1949. Rejected because of median nerve neuroma and stump edema. Neouroma excised December 1949; stump shrunk, fitted with prosthesis February 1950. Employed as tool room checker after two months' prosthesis training. Returned to former job on car-loading (because of higher pay) successfully manipulating two-wheeled truck with heavy loads during past 21 months.

Some idea of the success of such a coordinated program can be gained from the fact that over eighty-nine

percent of the 228 amputees in our study completed successful employment records after having received the required stump revisions, proper prosthetic restoration and training in a job suited to their physical limitations.

Summary

The results of a survey of 228 amputees evaluated between January 1948 and January 1951 have been reviewed. The more common errors of amputee rehabilitation as seen in this series have been discussed together with an outline of a program which would have prevented many of the difficulties encountered.

The importance of recognition by the surgeon of his responsibilities to the amputee as actuator of proper surgical management and post-operative care, as consultant to the prosthetist and vocational counselor, and as coordinator of all activities designed to restore function and independence to the amputee has been stressed. Failure to recognize these responsibilities accounts for many failures in amputee rehabilitation.

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— REVIEWS —

THE EXTREMITIES

By Dr. Daniel P. Quiring, Beatrice A. Boyle, Erna L. Boroush, and Bernardine Lufkin. Lea & Febiger, Philadelphia 1952. $2.75.

Reviewed by Chester C. Haddan, Consultant to the American Board for Certification.

This is a unique book in that it has no text, being composed entirely of diagrams of the extremities, together with a descriptive legend with each plate.

The drawings are excellently executed and do not confuse the student with unnecessary detail, but rather emphasizes the major termini of muscles and the principal arteries and nerves related to them.

This book of 117 pages is a must for every student of functional anatomy, equally suited for the practicing physician, the physical therapist or the orthotist-prosthetist. It should be a required book for all orthotist-prosthetists.

It is a practical reference that should have daily usage in every prosthetic or orthopedic office. Its content table and excellent index makes it particularly useful as a daily reference.

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