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Amputations at the Middle Level of the Foot

A Retrospective and Prospective Review*†

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Abstract: **Recent trends in amputation surgery favor amputation at the most distal level to preserve the patient's ability to walk. This paper reports the results of sixty-four amputations performed at the level of the middle of the foot in fifty-eight patients. All were performed in patients with peripheral vascular disease who had a diagnosis of either gangrene or resistant, non-healing ulcers. Forty-three patients (74 per cent) had diabetes. Nutritional evaluation of the patient was used to improve the potential for healing. In the initial forty-six patients, a retrospective review of the serum albumin level, the blood total-lymphocyte count, and the Doppler ischemic index was performed. A prospective study was performed in the final twelve patients, in whom a minimum level in each of these three factors was required before the distal amputation was done. The healing rate for all sixty-four amputations was 81 per cent. When all three factors were above the minimum level, the healing rate was increased to 92.2 per cent. When one or two of the factors was below the minimum level, the rate of healing decreased to 38.5 per cent. Aggressive distal amputation can be performed with a high rate of success when the factors influencing the decision on the amputation level include non-invasive vascular testing and nutritional evaluation.**

Wagner and others have reported increasingly good results with amputations at the level of the foot and ankle in both diabetic and non-diabetic patients with peripheral vascular disease[6-10]. Several new sophisticated techniques give promise of providing the vascular and amputation surgeon with a more accurate assessment of vascularity and potential for healing in the dysvascular limb than has been previously possible[1,3,5]. While these reports are encouraging, the devices that are required to use these techniques are not readily available, nor has their accuracy and predictability been clearly determined.

Wagner[7,8], however, has reported a high rate of success in amputations at the level of the foot and ankle using the more readily available criteria of clinical examination and the Doppler ischemic index as predictors of tissue viability. In studying limbs with diabetic and dysvascular ulcers, it was found that healing could be predicted if a certain minimum ratio existed between the pressures of the brachial artery and the systolic pressures at the site of the lesion[8]. The Doppler ischemic index is derived by dividing the systolic pressures in the lower extremity by that in the brachial artery. Healing is predicted at the level where the flow is pulsatile and the ischemic index is at least 0.45.

Similarly, Dickhaut et al. have attempted to improve the predictability of success by using two readily available laboratory values, the serum albumin level and the total lymphocyte count, in addition to clinical and non-invasive vascular examination. The serum albumin level is considered to be a measure of the patient's nutritional status, and the total lymphocyte count is evidence of the patient's capacity to resist infection. Using this readily available information, they were able to improve their success rate with the Syme ankle-disarticulation amputation from 43 per cent

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limb-salvage program for patients with diabetes and peripheral vascular disease at the Hines Veteran's Administration Hospital and Loyola University Medical Center.

Materials and Methods

During a five-year period, sixty-four feet in fifty-eight patients with peripheral vascular disease were found to have the indications for amputation at the level of the middle of the foot. These indications were either gangrene of the fore part of the foot or non-healing ulcers that had been resistant to all prior operative and non-operative methods of treatment. All patients were community walkers before the amputation. The initial management of these sixty-four patients was based on previous reports by Wagner[8] and by Jacobs and Karmody. If there was evidence of local or surrounding soft-tissue infection, the patient was first admitted to the hospital for care of the local wound with gauze dressings soaked in povidone-iodine (Betadine) and parenteral cephalosporin therapy. Consultation by the vascular surgery service was obtained in order to select those patients who were candidates for vascular reconstruction. The Doppler ischemic index was recorded for each patient.

In the forty-six patients who had an amputation and constituted the group studied retrospectively, determination of the level of amputation was based solely on the clinical examination and measurement of the Doppler ischemic index. These patients' charts were reviewed retrospectively to determine what the serum albumin level and total lymphocyte count had been at the time of surgery.

In the prospective study, carried out on the last twelve patients, the amputation level was dependent not only on the clinical examination and minimum ischemic index, as in the patients in the retrospective group; performance of the procedure also required that the patient meet specific standards of serum albumin level and total lymphocyte count. Before surgery, Doppler pressures of the dorsalis pedis or posterior tibial artery were expressed as the ratio of the dorsalis pedis or posterior tibial arterial pressure to the brachial arterial pressure. To be consistent with Wagner's guidelines, we required a minimum value of 0.45 in non-diabetic patients and 0.5 in diabetic patients[8]. The total lymphocyte count was determined by multiplying the total white blood-cell count by the percentage of lymphocytes in the most recent differential white blood-cell count. A minimum value of 1500 was needed. While Dickhaut et al. required that their patients have a serum albumin level of 3.5 grams per deciliter, this would have been extremely difficult to accomplish in our population of patients, and a minimum value of 3.0 grams per deciliter was used. When the serum albumin level was less than this minimum acceptable value, oral or, rarely, parenteral hyperalimentation was given until the value reached the minimum level of 3.0 grams per deciliter. This was necessary in four of the twelve patients in the prospective group.

of twelve consecutive patients who were not operated on until the minimum standards for serum albumin level, total lymphocyte count, and Doppler index had been met. Thirty-four patients (73 per cent) in the retrospective group and nine (75 per cent) in the prospective group were diabetic. The patients' ages ranged from fifty-one to sixty-six years (mean, fifty-seven years). The length of follow-up ranged from twelve to fifty-one months.

A transmetatarsal amputation through the proximal metaphysis of the metatarsal shafts was done when possible. If local conditions required a more proximal level, a tarsometatarsal (Lisfranc) amputation was combined with a percutaneous lengthening of the tendo achillis in an attempt to prevent a postoperative equinus deformity. Percutaneous lengthening of the tendo achillis was performed using two medial incisions and one lateral incision. The decision to lengthen the tendo achillis and the type of skin-flap to be used was based on the presence of local necrosis or infection and the apparent viability of the local skin. The skin flaps were generally plantar based, although equal dorsal-plantar-based fish-mouth skin-flaps were also used if the absence of local infection and good viability of the skin permitted. Anesthesia was generally provided by an ankle block. All wounds were closed primarily. Suction drains were inserted before closure of the wound, and a well padded short cast was applied in the operating room. The drains were removed twenty-four hours after the surgery, and the initial cast was changed three to five days later.

Weight-bearing with a cast-shoe and crutches, or a walker when necessary, was generally allowed after the initial change of cast, and a second cast change was done ten to fourteen days after surgery. The sutures were removed at three or four weeks and the patients were allowed to wear standard laced oxford shoes between four and six weeks postoperatively. At this time, a neoprene filler was fabricated for the part of the shoe distal to the amputation. The operative wound was considered to be healed only when the patients exhibited complete wound-healing without tissue breakdown and had regained the same walking status that they had had before the ulcers or gangrene of the fore part of the foot had developed.

Results

In the retrospective group of fifty-two amputations through the middle of the foot, forty-one (79 per cent) healed. Eleven of the twelve amputations in the prospective group also healed, so that the over-all rate of success for

TABLE I

ASSESSMENT OF HEALING BY INDIVIDUAL FACTORS IN SIXTY-FOUR FEET

Index Minimum Met	Total No.	Healed	
		No.	Per Cent

TABLE II

MULTIPLE-FACTOR ANALYSIS

No. of Factors above Minimum	Total No.	Healed	
		No.	Per Cent
3/3	51	47	92.2
2/3	8	3	37.5
1/3	5	2	40.0

the sixty-four amputations was 81 per cent. All of the patients whose amputation healed returned to their preoperative community-walker status. There were no differences in time to healing or rate of healing when comparing diabetic with non-diabetic patients. Standard laced oxford shoes with a Plastazote liner were used by all patients except for those who required a custom-fabricated shoe for the contralateral foot.

Evaluation based on individual criteria revealed that the amputation healed in fifty-one (83.6 per cent) of the sixty-one feet in patients in whom the preoperative level of serum albumin was more than 3.0 grams per deciliter, in forty-six (90.2 per cent) of the fifty-one in patients in whom the total lymphocyte count was more than 1500, and in fifty-eight (96.7 per cent) of the sixty in patients in whom the ischemic index was 0.5 or better (Table I). Of the twelve feet that required revision to a higher level, the total lymphocyte count was less than 1500 in seven patients, the serum albumin was less than 3.0 grams per deciliter in three, and the ischemic index was below 0.5 in two (Table III). Two of the twelve early wound failures were subsequently successfully salvaged by a Syme ankle disarticulation and nine, by a below-the-knee amputation. Multiple-factor evaluation revealed that forty-seven (92.2 per cent) of the fifty-one amputations in patients in whom all three values were above the minimum limits healed successfully. The success rate dropped to 37.5 per cent (three of eight amputations healed) when two factors were above the minimum and was 40 per cent (two of five amputations healed) when only one of the three factors was above the minimum (Table II).

TABLE III

ANALYSIS OF FAILURES

Total no.	12
Index	
Albumin <3.0 gm/dl	3
Total lymphocyte count <1500	7
Ischemic index <0.5	2
No. of factors above minimum	
3/3	4
2/3	5
1/3	3

To date, only one wound that had initially healed has broken down and required revision to a below-the-knee amputation four years later. A late equinus deformity has not developed in any of the patients. In nine patients in the retrospective group, a late dynamic varus deformity of the fore part of the foot with lateral plantar pressure ulcers developed. Seven resolved with local wound care and use of a custom-made orthosis. Two were resistant to conservative measures but resolved with repeat percutaneous lengthening of the tendo achillis. Late dynamic varus deformity was not seen in the prospective series, in which lengthening of the tendo achillis was sufficient. We now think that adequate lengthening of the tendo achillis in the patients who need a Lisfranc procedure to prevent late equinus deformity, with particular attention to adequate lengthening of the medial portion of the tendon to prevent late varus angulation, is essential for the best long-term results.

There were no deaths or major systemic complications related to the surgery in any of the patients.

Discussion

Recent advances in knowledge that have established vascular and physiological criteria for amputation surgery have made it possible to successfully perform lower-extremity amputation in the patient with peripheral vascular disease at a more distal level than was previously considered possible. When an amputation can be performed distally in the foot or ankle, the increased energy expenditure that any amputation requires of a patient when walking can be kept to a minimum. In addition, these patients require minimum supervised physical therapy or gait-training postoperatively and readily resume or exceed the level of activity that they had preoperatively.

We are hopeful that percutaneous lengthening of the tendo achillis eliminated the development of late equinus deformity, which was not seen in this series. We think that the two late dynamic varus deformities that developed were due to inadequate lengthening of the medial portion of the tendo achillis. These two deformities resolved with repeat percutaneous lengthening of the tendo achillis, paying special attention to the medial portion of the tendon. With the use of nutritional supplementation (usually oral) when indicated, we have been able to perform more distal amputations with a predictably high rate of success. This was seen in the twelve patients in whom the three factors were used prospectively to select the level of amputation. In this group, in which all three factors exceeded our minimum levels before surgery, all but one amputation healed primarily, and the one early failure was later successfully salvaged by a Syme ankle disarticulation.

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Loosening of the Femoral Component after Use of the Medullary-Plug Cementing Technique

FOLLOW-UP NOTE WITH A MINIMUM FIVE-YEAR FOLLOW-UP*

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ABSTRACT: **Of the 171 total hip replacements reported on previously that had had a minimum length of follow-up of two years[3], 117 replacements in 104 patients were analyzed at a minimum of five years postoperatively (average, seventy-four months; range, sixty to ninety-four months) to assess the rate of loosening of the femoral component. At the time of cementing of the femoral component, the medullary canal had been plugged with a bolus of bone cement and then filled with doughy Simplex-P methylmethacrylate in a retrograde fashion using a cement gun. The femoral components, made of a chromium-cobalt alloy, had a rectangular cross-sectional shape to the stem and a medial collar.**

Three categories of loosening were used: definite (requiring radiographic evidence of migration of the component or the cement), probable (requiring evidence of a complete radiolucent zone at the bone-cement interface on one radiograph or more), and possible (a radiolucent zone at the cement-bone interface of more than 49 per cent but less than 100 per cent on one radiograph or more).

One femoral component had been removed for aseptic loosening at another hospital, leaving the patient with a resection arthroplasty. One other (1.7 per cent) was definitely loose. No femoral component was categorized as probably loose, and only two were possibly loose.

Aseptic loosening of the femoral component continues to be the most common long-term complication of cemented total hip replacement. Many studies have reported rates of loosening of the femoral stem of more than 20 per cent at five-year follow-up[1,2], and some studies have indicated rates of 30 per cent or more at ten-year follow-up[6,7]. These series, however, reflect the cementing techniques and designs of the implant used during the early 1970's. New designs for the stem and improved cementing techniques have been developed to reduce this high incidence of loosening of the femoral component.

An earlier follow-up study of 171 total hip replacements revealed a 1.1 per cent incidence of definite loosening of the femoral component at an average duration of follow-up of 3.3 years[3]. None of the femoral components were probably loose and seven (4 per cent) were possibly loose. We are now reporting a study on the rate of loosening of the femoral stem in 104 of the same 171 patients who have now been followed for at least five years.

Methods and Materials

Two hundred and thirty-four total hip replacements were performed in 206 patients between January 1, 1976

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