

# THE IMPORTANCE OF AMPUTATION-LEVEL DETERMINATION

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... *guest editorial*

The objectives in selecting a level for lower-limb amputation include the removal of the gangrenous, infected, or traumatized portion of the limb while preserving the maximum length consistent with primary healing and successful prosthetic rehabilitation.

An assessment as to the adequate removal of the diseased tissue usually presents no problem in surgical judgment. In those cases in which amputation is done for trauma, the blood supply above the area of trauma is usually intact and healing of the amputation will not be compromised by vascular insufficiency. This picture is quite different in evaluating patients with occlusive vascular disease in whom the need for amputation is precipitated by rest pain, gangrene, or infection. In these instances, the likelihood of healing at the level immediately proximal to the diseased area is compromised by poor bloodflow. Since a greater blood supply is required to heal an incision than to simply maintain viability of intact skin, the presence of intact skin at a proposed level of amputation is no guarantee that the blood supply is adequate to heal an amputation at that level.

Until relatively recent times two alternative surgical approaches for amputation level selection existed. One approach was to carry out the most distal amputation that would circumvent the disease process, and then to simply carry out proximal revisions as would be necessary until an ultimate level was found at which healing

occurred. The second approach was to carry out a very high amputation, usually above the knee, on the thesis that this level could usually be depended upon to heal primarily, and thus the patient's hospital stay and morbidity would be minimized. Both of these methods of amputation selection are equally poor and are to be deplored. In the first instance, healing failure leading to subsequent proximal revision requires multiple anesthetics and surgical operations. These repeated exposures to surgical and anesthetic trauma must ultimately lead to increased morbidity, duration of hospitalization, and mortality. In addition, the final successful level may be considerably higher than what it would have been had the appropriate level been selected initially. In the second instance, routine above-knee amputation is associated with an unacceptably high mortality rate, and a poor success record for prosthetic rehabilitation in geriatric amputees.

In an attempt to establish amputation level criteria, various parameters of patient evaluation have been studied. These include the level of the most distal palpable pulse, skin temperature at the level of proposed amputation, and the angiographic patterns of collateral circulation. None of these parameters have provided the kind of quantitative criteria necessary to determine a sharp endpoint for healing results and, hence, amputation level selection.

Approximately 10 years ago my team began to investigate the measurement of skin bloodflow at a proposed amputation level as a possible means of predicting success or failure of primary healing following lower-limb amputation. The radioactive isotope, Xenon<sup>133</sup>, was injected locally in the skin at a point along the course of the proposed amputation incision. The rate at which the isotope was removed was monitored by a counting device sensitive to radioactive emission, and was directly proportional to capillary bloodflow in the skin at that level. This method, first in a retrospective study, and subsequently a prospective study, has been shown to be a remarkably accurate means of level selection for primary healing. The technique was initially explored as a way to screen patients for proposed amputation at the below-knee level. Currently, we are using this technique to screen all amputation levels, including toe, Syme's amputation, transmetatarsal amputation, below-knee amputation, and knee-disarticulation amputation.

The net result has been not only that we are doing fewer above-knee amputations in favor of more below-knee amputations, but also that some patients who might otherwise have had a below-knee amputation are found to have a blood supply adequate to heal at an even more distal level such as transmetatarsal or Syme's amputation. Using this method for amputation level selection, amputation

at the above-knee level has become a relatively rare occurrence in our practice. For every above-knee amputation done and successfully healed in our program, there are 12 or more amputations done at some level that spares the knee joint.<sup>a</sup>

The improved healing rate seen in our program has been made possible not only by applying quantitative methods for amputation level selection, but also from improved surgical technique and post-operative care. The use of immediate postoperative prosthesis (IPOP) as modified and popularized by Burgess has had a monumental effect upon improving healing, reducing morbidity and mortality, and improving the extent and quality of prosthetic rehabilitation.

Since the ultimate goal of amputation is the rehabilitation of the patient on a permanent prosthesis, the likelihood of achieving this goal can be advanced in large part by using tests that will provide quantitative criteria for selecting the amputation level at the most distal portion of the limb that will heal, while at the same time encompassing the disease process. The use of this approach in an enlarging number of amputation centers will have far-reaching effects upon the quality of life, and the socio-economic independence, of a growing amputation population.

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<sup>a</sup> In the last 30 amputations in which Xenon<sup>133</sup> was used prospectively for level determination, there has been primary healing without revisions.