AMPUTATION ABOVE OR BELOW THE KNEE FOR PRIMARY PERIPHERAL VASCULAR DISEASE

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It was found at Queen Mary's Hospital that many patients with below-knee amputations for primary peripheral vascular disease returned with ulcerated and painful stumps. Most of these patients had undergone sympathectomy which, it was supposed at first, might have some connection with their subsequent troubles. An investigation was held, therefore, during which ninety-five patients were seen who had suffered amputation for thrombo-angiitis obliterans or arterio-sclerosis in many different hospitals. There was no selection of cases except that diabetes and other causes of gangrene were excluded. The inquiry into the cause of painful ulceration of the below-knee stump, though it failed to show a correlation with sympathectomy, revealed a method for determining the proper level of amputation.

Distinction between thrombo-angiitis obliterans and arterio-sclerosis—The diagnostic criteria used to distinguish these two conditions were: 1) *The age at the onset of the disease*—Leriche (1947), quoted by Boyd *et al.* (1949), says that "true thrombo-angiitis obliterans occurs before the age of thirty-five. Arterio-sclerosis occurs over the age of fifty, but in between there is a group of cases showing features common to both." All these three groups were found in the present series. 2) *Impairment of the circulation in the hand*—Allen, Barker and Hines (1946) have pointed out that in arterio-sclerosis impairment of circulation in the hand is rare; in thrombo-angiitis obliterans, nevertheless, it was found in 40 per cent. of their cases. A like proportion was found in the present series. 3) *Hypertension*—This is rarely found in the early course of thrombo-angiitis obliterans, but is frequent in arterio-sclerosis. 4) *Calcification of arteries*—Calcification is more common in arterio-sclerosis than in thrombo-angiitis obliterans. 5) *The gross and microscopic appearances of the vessels in the amputated limbs*—These are almost conclusive, though this view is challenged by Boyd *et al.* (op. cit.).

The ninety-five cases studied included forty-three bilateral amputations, and so there were 138 stumps. Apart from three amputations of toes only, eighty-three stumps were above the knee, and fifty-two below. Twenty-nine unsatisfactory below-knee stumps had already been re-amputated above the knee, making a total of eighty-one primary below-knee stumps.

Classification of stumps—Three criteria were used: *The state of the skin* (3=normal; 2=thin, shiny or scaly; and 1=ulcerated). *Pain* (3=none; 2=occasional; 1=persistent). *The ability to wear an artificial limb* (3=unimpaired; 2=impaired for some of the time only; 1=impossible). Stumps graded 3 under each heading were classed as satisfactory. Of the eighty-three above-knee stumps, seventy-five were satisfactory and eight were not. Of the eighty-one below-knee stumps, twenty-nine had already been re-amputated above the knee, twenty-seven were satisfactory and twenty-five remained unsatisfactory. What is striking is not so much the preponderance of good above-knee amputations, as the fact that one-third of the below-knee stumps remained satisfactory. Thus, in a disease notoriously affecting both lower limbs there is sometimes a reasonable chance of conserving a substantial part of the limb and so avoiding the great disability caused by amputation through both thighs.

The cases in which below-knee amputation offers a reasonable prospect of success—Relevant factors in selecting these cases are: 1) *Age*—All the satisfactory below-knee stumps were in patients under fifty-two years at the time of amputation; all of the nine patients older than this had defective stumps. 2) *The popliteal pulse before operation*—Of fifteen patients

in whom the pulse was known to have been present before operation, only one showed an unsatisfactory stump. In all fifteen cases bleeding at operation was very brisk. The single unsatisfactory stump ulcerated eighteen months after amputation during a recrudescence of thrombo-angiitis which also involved the fingers of both hands. Popliteal pulsation was seldom found in these patients later than six months after amputation: the post-operative absence of a pulse is therefore of little significance. The pre-operative absence of the popliteal pulse is not in itself an omen of failure, however, for there were thirteen satisfactory stumps in this group. At operation bleeding had again been profuse and the muscles had appeared healthy. 3) *The vascularity of the part as seen at operation*—This was the crucial factor. If bleeding had been brisk the stump proved satisfactory, but after little or no bleeding the stump proved unsatisfactory. This applied to both above- and below-knee stumps. Survival depends therefore on the state of the circulation, main or collateral. Some simple and reliable means of assessing the circulation before operation should indicate when a below-knee amputation is likely to be successful.

Assessment of circulation before operation—Three tests were employed: 1) *The skin temperature as determined by palpation*—An obvious boundary between warmth and cold is frequently found in limbs when symptoms and signs indicate amputation. 2) *Reactive hyperaemia* (Lewis 1946)—The limb is elevated until it is pallid, and a sphygmomanometer is then placed round the thigh and inflated to above the systolic pressure. After an interval of not less than five minutes, during which the limb is kept warm, the sphygmomanometer is released and the zone of flushing that occurs within five minutes is observed. 3) *Oscillometry*—This provides useful but only confirmatory evidence, particularly of the absence of pulsation immediately above and below the knee.

Assessment of circulation at operation—The final criterion, if the tests indicate the possibility of a successful below-knee amputation, is the state of the circulation as observed at operation. In order to eliminate the possibility of vascular spasm, no tourniquet should be used. Free bleeding shows that the stump should survive. The appearance of the muscle is also important. If it is pinkish-grey, homogeneous, and does not bleed, it is useless to proceed with amputation below the knee. There must inevitably be borderline cases, but it should be safe to proceed if the colour of the muscle is normal, and if the cut surface is covered by an ooze of blood immediately after swabbing.

In this series, four cases examined fully before amputation satisfied the criteria both before and at operation, and all have satisfactory below-knee stumps. It was noted in each of them that the temperature boundary found at palpation and the lower limit of the rapid hyperaemic flush coincided with the level below which the muscle was ischaemic. *In each case the site of amputation was more than six inches above this zone.*

The length of the stump—This has some bearing on the survival of the stump, which should be as short as can be compatible with satisfactory limb-fitting. The lengths of the satisfactory below-knee stumps, measured from the joint line, varied from four to six inches. A four-inch stump seldom presents any problem to the limb fitter, and does not reduce the efficiency of the artificial limb. Stumps shorter than this do present problems. The four-inch stump is rather more square than the conical one after amputation at the site of election, but tight bandaging produces good distal shrinkage. There is no indication for excision of the fibula, which provides an eccentricity of outline tending to prevent rotation of the prosthesis—a matter of particular importance if the amputation is bilateral.

Unsatisfactory below-knee stumps—The fifty below-knee stumps which actually ulcerated were all ischaemic, that is to say they were cold and there was no demonstrable circulation. Forty-two ulcerated within a year of amputation. Three stumps broke down after two years as a result of direct accidental injury. Figure 1 shows the time at which stumps broke down and also the length of survival of the other below-knee stumps in the series. It seems that if a below-knee stump is going to give trouble spontaneously, it will do so *within the first year.*

Furthermore, re-amputation below the knee offers little prospect of success. There were seventeen cases in which this had been done and *none was successful*; two of them had been trimmed more than once—a finding that does not encourage the practice of making a stump long enough to allow below-knee trimming in the event of failure.

Unsatisfactory above-knee stumps—Of the fifty-four unsatisfactory below-knee stumps, twenty-nine had been re-amputated above the knee; twenty-three of these were satisfactory. The remaining six re-amputations were not, again because of ischaemia; all the stumps were long, and four of these patients had pain indistinguishable from that of intermittent claudication. It is clear, therefore, that even in thigh amputations the state of the circulation must be the guide to the level of resection.

FIG. 1

A histogram to show: the six-monthly periods during which fifty out of seventy-eight below-knee stumps ulcerated; and the length of survival of the remaining satisfactory stumps.

SUMMARY

1. An attempt has been made to rationalise the selection of the site of amputation for gangrene in primary peripheral vascular disease.
2. There is a good chance of the survival of a below-knee stump if the circulation in the skin of the proposed flaps appears adequate clinically, and if the blood supply to the muscles is obviously good at amputation.
3. If the popliteal pulse is present before operation, below-knee amputation should succeed. The absence of a popliteal pulse, however, does not exclude below-knee amputation.

4. Below-knee stumps should be about four inches long in amputations for peripheral vascular disease.
5. Tests for determining the state of the circulation are also necessary before choosing the level for above-knee amputations.

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