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Partial Foot and Syme Amputations: An Overview

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Historical Aspects

Until the middle of this century, partial foot and Syme amputations were done almost exclusively as a sequel to trauma. The presumption was that the normal vascular supply of the remaining foot would usually lead to healing. Both dry gangrene due to peripheral vascular disease and wet gangrene, related to infection superimposed on dysvascularity, were commonly treated by above-knee amputation or below-knee amputation, the choice often being dictated by local surgical prejudice.[3] The rationale was to amputate at the level where one could anticipate primary healing. This had considerable validity in the pre-antibiotic era, when failure of primary healing might mean death of the patient from secondary infection. However, in the United States at the present time, a growing number of partial foot amputations are being done for patients with arterial and/or capillary blood vessel disease, the majority of whom have diabetes mellitus.

This major turnaround in attitude on the part of progressive surgeons is due to a number of technological breakthroughs of the past two decades. These may be characterized as follows:

1. A proliferation of antibiotics to cover most aerobic and anaerobic bacterial infections, largely eliminating the specter of death following failure of an initial procedure.
2. Development of techniques to measure limb blood flow, both in small distal arteries by means of the Doppler effect and at the tissue level, by determination of transcutaneous oxygen perfusion and other methods.[1]
3. The evolution of the operating microscope, which has led to the development of evermore distal arterial bypass procedures, including ankle to foot jump grafts.[6] These often allow healing of distal amputations which would not have healed prior to bypass.
4. Development of new plastics with a variety of production-controllable characteristics in liquid, sheet, and foam versions. This has led directly to the design of more physiologic and cosmetic partial foot prostheses.
5. Studies of energy consumption during gait which demonstrate the physiologic advantages of distal amputations such as the Syme.[7]

With the risk to the patient minimized and the probability of better function, the surgeon should now be willing to risk the occasional failure, that is, the need for a secondary procedure, in order to better assist the vast majority of his or her patients.

Advantages of Partial Foot and Syme Amputations

The partial foot amputee continues to bear weight on the residual foot in a manner which approximates the normal in regard to proprioceptive feedback, as opposed to the below-knee

level in which an entirely new feedback pattern must be interpreted. The great majority of adult onset diabetics with peripheral neuropathy also retain sensation in the arch and heel areas. The heel-lever is intact and variable portion of the toe-lever remains. This will range from full-length, as in the case of a ray (toe and metatarsal) amputation, to virtually none in the case of a Chopart (midtarsal) amputation. The ease of restoration of a normal gait pattern is largely dependent on the length of toe-lever remaining. Whenever possible, therefore, toe-lever length should be preserved by election of a longitudinal (ray) amputation rather than a transverse level (transmetatarsal, tarsometatarsal (Lisfranc) or midtarsal). A further advantage is, in an emergency, the partial foot amputee is not dependent on a prosthesis.

There are also two distinct psychological advantages of partial foot amputations. The less drastic alteration of body image as compared to the below-knee level may decrease the sense of loss as well as produce a smaller disruption of an active life-style. The less conspicuous and more cosmetically acceptable prostheses available today, even for the more radical partial foot amputations, may also help reduce the impact of the psychological loss.

There has been disagreement about whether the Syme amputation qualifies as a partial foot amputation because all the bony elements of the foot have been removed. The preservation of the heel pad, a major soft tissue component of the foot, in the Syme amputation is what confers full weight-bearing capability and distal proprioceptive benefits on the residual limb. The notion that the heel pad is not an important element of the foot is easily dispelled by observing the difficulty in effectively reambulating a person who has lost the heel pad in an otherwise intact foot. Studies of gait parameters including oxygen consumption, cadence and velocity have shown the advantages of the Syme over the below-knee level.[7] The benefits noted are not diminished by the need for a more extensive prosthesis than is necessary for less radical partial foot amputations.

Etiology

Trauma continues to result in a significant number of these amputations. In wartime, booby-traps and land-mind explosions are frequent, while in peacetime, accidents with motor vehicles, especially motorcycles and lawn mowers seem to be the most frequent causes. In northern latitudes, frostbite remains a common etiology.

However, the majority of partial foot and Syme amputations in our institution are an indirect result of inadequate protective sensation to the feet, secondary to peripheral neuropathy. This loss of normal sensation is commonly associated with diabetes mellitus, alcoholism, Hansen's disease (leprosy), or myelomeningocele (spina bifida). The difficulty starts with injury to the foot, either acutely as a laceration, puncture or burn or, more commonly, from pressure or shear forces associated with ill-fitting shoes, and/or chronic overuse of the foot. In response to these forces, areas of skin over bony prominences develop calluses which then break down to form ulcers. These are most common under the metatarsal heads or on the toes. Infection ensues, progressing from cellulitis to abscess formation to septic arthritis and osteomyelitis, resulting in amputation.

Circulatory factors also play a role, especially in diabetic patients. Small vessel disease results in restricted passage of oxygen and antibiotics, across the capillary basement membrane, to damaged and infected tissues. Atherosclerotic changes in the arterial tree can produce major blockage of blood flow correctible only by arterial reconstruction or by-pass. Smoking can play major roles both in the onset and aggravation of atherosclerotic arterial disease and in delaying or preventing wound healing after injury or surgery.

In persons with neuropathy, compliance with a careful routine of foot care is mandatory if major problems are to be prevented. It is easy to deny that a problem exists when no warning pain is felt. Depression over the long-term possibility of limb loss may so depress many diabetic patients that they are immobilized, unable to protect themselves and to prevent what they most fear, amputation. Psychological counseling, individual or group, can aid in breaking patterns of denial and in dealing with the subsequent depression. Ultimately, the patient must accept the responsibility for foot care if amputation is to be avoided.[2]

Surgical Considerations

Partial Foot Amputations

The surgeon should attempt to preserve as much length and width of the foot as possible commensurate with:

1. Healing potential of the soft tissues as determined by circulatory evaluation;
2. Eradication of the local disease process, i.e., removal of all necrotic and infected tissues;
3. Closure of the wound with local skin flaps over all surfaces subject to major weight-bearing or shear forces (Split thickness skin grafts may be used elsewhere, such as the dorsal surface and arch of the foot.); and
4. Good function. A lesser toe should not be left as the only remaining toe because of its increased susceptibility to injury. A second ray amputation is preferable to a second toe amputation alone because of the loss of lateral support to the great toe, which may result in a secondary bunion deformity. This constitutes a new bony pressure point likely to result in another ulcer.

With amputation at or proximal to the tarsometatarsal (Lisfranc) joint, care must be taken to balance the motor (muscle) function of the foot to prevent contractural deformity. At or above this level, release of dorsiflexor and evertor tendons without their reattachment leads to a severe equinovarus deformity due to the unopposed action of the triceps surae (gastrosoleus). Even with reattachment of the muscles at the more proximal level, their effective force is lessened due to shortening of the toe-lever. To overcome this advantage of the triceps surae, it is recommended that a fractional percutaneous heel cord lengthening of the Hoke-Hatt type be done as part of the initial surgery.[4] Even short transmetatarsal amputations may benefit from this procedure.

Syme Amputation

Full end weight-bearing on the heel pad with normally-channelled proprioceptive feedback is what distinguishes the Syme amputation from below-knee amputation. The three keys to success in Syme amputation are selection of the proper candidate, meticulous surgery to preserve the Syme's unique characteristics and maintenance of the weight-bearing heel pad in a centralized position. Since the heel pad is dependent on the posterior tibial artery for its blood supply, preoperative evaluation of the heel pad blood supply by Doppler or other means is recommended in order to reduce the chance of failure to 20% or less. Meticulous surgical technique is required throughout to avoid damage to the posterior tibial artery and to the vertically oriented, fat filled chambers of the heel pad, which provide the cushioning, allowing comfortable and long-lasting end-bearing.[5] Painful incisional neuromas are avoided by finding and cutting short all sensory nerves in both wound edges. Excessive laxity of the heel pad, which will cause difficulty in fitting, is avoided by several means. First, accurately planned incisions will avoid tissue redundancy. At closure, any excess skin should be trimmed, but closure under tension must be avoided. Second, suturing the deep fascial tissues of the heel pad to the anterior fascia or to the anterior tibial cortex will hold it firmly in place. Third, a light-weight carefully padded plaster cast (two 4″ rolls) will prevent pad shift during the first four to five weeks of healing, when a snug walking cast can be applied. This is changed every two weeks until shrinkage has slowed. From this point on, centralization of the heel pad is a function of a carefully fit and maintained prosthesis.

Basic Problems to be Solved

Despite the obvious physical and psychological benefits of partial foot and Syme amputations, these procedures have not enjoyed wide popularity. In my opinion, this is largely due to a failure of dissemination of information regarding these advantages to the two groups most involved: amputation surgeons and prosthetists/orthotists. On the one hand, amputation surgeons must be able to recognize potential candidates for conservative procedures and be willing to try them. On the other hand, the prosthetist or orthotist to whom he refers his patients must be able and willing to accept the challenge of fitting these sometimes difficult cases, e.g., producing a prosthesis which adequately meets the suspension needs of a Chopart amputation residual limb. Parenthetically,

both the techniques and materials used put this area of expertise somewhere between prosthetics and orthotics, hence the name "prosthoses" for the devices constructed.

Further refinement of present designs, especially in regard to cosmesis, and development of new concepts to produce better suspended and lighter prostheses are needed. Studies of gait patterns using these devices will assist in this effort and will help select the most physiologically effective designs. Elimination of shear forces, a function of both suspension and fit, will eliminate most of the criticism of these devices common in the past.

Summary

At the present time, partial foot and Syme amputations are considered viable alternatives to the below-knee level. This is true not only in trauma cases, but in diabetic patients with arterial and/or capillary blood vessel disease. Technological advances which have produced this change over the past two decades include: improved broad-spectrum antibiotics; effective devices for measurement of arterial blood flow and tissue oxygenation; development of arterial by-pass procedures, including the ankle and foot; and more physiologic and cosmetic partial foot and Syme prosthetic designs made possible by development of new plastics in a variety of physical forms. The end weight-bearing and proprioceptive benefits of these amputations lead to low excess energy demands on the amputee as compared to higher amputation levels. A major psychologic benefit is the relatively small alteration of body image. The etiology of these amputations and the surgical details to be observed and pitfalls to be avoided are discussed in some detail. Better dissemination of information to amputation surgeons and prosthetists/orthotists regarding the benefits of these amputations is recommended. There is a need for the refinement of present designs as well as development of new concepts to produce better suspended, lighter and more cosmetic prostheses.

References

[1] Burgess, E.M. and F.A. Matsen, III, "Determining Amputation Levels in Peripheral Vascular Disease," *J. Bone and Joint Surgery*, 63A:1981, pp. 1493–1497.

[2] DiCowden, M.A., personal communication.

[3] Glattly, H.W., "A Statistical Study of Twelve Thousand New Amputees," *Southern Medical Journal*, 57:November, 1964, pp. 1373–1378.

[4] Hatt, R.N. and T.A. Lamphier, "A Simplified Procedure for Lengthening the Achilles Tendon," *New England J. Med.*, 236:1947, pp. 166–169.

[5] Harris, R.I., "Syme's Amputation: The Technical Details Essential for Success," *J. Bone and Joint Surgery*, 38B:1956, p. 614.

[6] Taylor, L.M., Jr., E.S. Phinney, and J.M. Porter, "Present Status of Reversal Vein Bypass for Lower Extremity Revascularization," *J. Vascular Surgery*, 3:1986, pp. 288–297.

[7] Waters, R.L., J. Perry, D. Antonelli, and H. Hislop, "Energy Cost of Amputees: The Influence of Level of Amputation," *J. Bone and Joint Surgery*, 52A:1976, pp. 42–46.

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