When to Salvage and When to Amputate

It's often about balancing between functional outcomes and quality of life.

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Limb Salvage vs. Early Amputation

Patient selection plays a key role in deciding between limb salvage and proximal amputation. For properly selected patients, limb salvage often provides a better quality of life than amputation, but for others, a primary amputation can be a life-saving and function restoring procedure. The goal is to maintain independence in daily living activities and avoid being wheelchair-bound at all costs. The limb salvage surgeon must always keep in mind that many patients tend to fare better with amputation than limb salvage. This group of patients has a different goal in mind when it comes to returning to normal activities. Early amputation offers shorter hospital stays, allowing these patients to start rehabilitation measures sooner and often recover daily functionality faster than salvage.[1] Realizing the patient and family goals in terms of functional status at baseline and the level they want to achieve ultimately helps tailor decision-making when choosing limb salvage versus amputation.

Limb salvage is often complicated by co-morbidities that yield a higher rate of complication and eventual conversion to amputation. Many patients in wound care centers face not only one but many complex medical problems that potentially delay wound healing and ultimately prolong their hospital stays. As a result, wound care and limb salvage require a multi-disciplinary team approach to best optimize patient care and reduce wound complications, thus decreasing duration of hospitalization and risk of proximal amputation.

Published research at Georgetown University Hospital by Attinger and Brown on limb salvage vs. amputation in diabetic patients showed a 64% ambulation rate and an 80% two-year survival rate for patients who underwent limb salvage. On the other hand, patients who underwent below-the-knee amputation experienced a much lower two-year survival rate at 52%; and a similar ambulation rate.[1] The results published from this study strengthen the idea that limb salvage, especially in the properly selected patient population, should be assessed before pursuing amputation.

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Limb Salvage

Wound care and limb salvage can be debilitating and frustrating for patients and their caregivers. It often requires participation and patience from both parties, as wound healing requires time and effort to adequately heal without further complications or amputation. From the patient's standpoint, compliance with weight-bearing status and their wound care routine is crucial. From a provider standpoint, a multidisciplinary approach involving podiatric surgery, vascular surgery, plastic surgery, and infectious disease colleagues is essential for the best outcomes.

In an article by Attinger et al., they describe the four tenets of wound healing: adequate blood flow, infection control, biomechanical restoration, and a stable soft tissue envelop. For a limb to survive, tissues must have adequate blood flow. A thorough physical exam to assess temperature, pulses, and hair quality is a readily available and inexpensive method for evaluating arterial flow. Additionally, Doppler machines, toe pressures, and ankle-brachial indices are available in most medical offices and emergency departments.

Understanding Angiosomes

Understanding angiosomes of the lower extremity can help guide a surgeon on incision planning, as well as determine reconstruction plans down the road. Attinger and colleagues also described the six angiosomes from three major arteries and how they contributed to the

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blood supply of the lower extremity. The anterior tibial artery ultimately branches into the dorsalis pedis artery, giving blood supply to the dorsum of the foot. The peroneal artery becomes the lateral calcaneal artery to supply the plantar heel and lateral ankle, giving two additional angiosomes. The posterior tibial artery has three branches—the calcaneal branch, and the medial and lateral plantar branches. The calcaneal branch supplies the medial side of the ankle, while the medial plantar branch supplies the medial plantar side of the foot, and the lateral plantar branch supplies the lateral plantar side of the foot. These angiosomes work in conjunction with one another to provide adequate blood flow to the lower extremity.[2]

When blood vessels are occluded, vascular surgery colleagues can offer procedures such as an angiogram and bypass techniques to restore blood flow.[1] A diagnostic angiogram can also offer insights on wound healing capabilities and help guide surgeons' incision planning. For example, a transmetatarsal amputation incision is best made horizontally between two angiosomes so that the blood supplies from the dorsal flap through the anterior tibial artery and the plantar flap through the posterior tibial artery can simultaneously provide nutrients and give the amputation stump the best chance to survive.

Infection Control

Infection control is another important component to prevent further complications that could potentially lead to proximal amputation. Manual debridement with a blade or scalpel has been shown to be effective in removing non-viable, infected tissues by removing thin layers of tissue until healthy, bleeding tissue is reached. Grossly infected wounds may require multiple trips to the operating room for surgical debridement to keep infection control at bay. Post-debridement culture can also be used to help guide our infectious disease colleagues to tailor antibiotic treatment to the patient's specific needs.[1] Wound healing is better achieved when infection is under control and the most recently post-debridement cultures come back with no bacterial growth.

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The Role of Biomechanics

A foot with biomechanical disadvantage often creates pressure points that lead to ulceration and wound formation. A transmetatarsal amputation commonly leaves the foot in an equinovarus deformity due to loss of extensors that are responsible for dorsiflexing and everting the foot. Studies have shown that tendo-Achilles procedures in conjunction with a transmetatarsal amputation (TMA) can lead to a 91% healing rate.[1] This adjunctive procedure for tendon balancing can provide relief from the equinus deformity on a tight Achilles tendon, and can provide a 26% reduction in plantar forefoot pressures during gait. A tibialis anterior tendon transfer is another procedure that can be performed in conjunction with the tendo-Achilles lengthening procedure that will correct the foot out of varus deformity. In this procedure, part or all of the tibialis anterior tendon is detached from its original insertion on the navicular and anchored to either the lateral cuneiform or the cuboid bone. Thus, the foot will evert and yield relief from the varus deformity, offloading pressure on the lateral aspect of the foot and bringing the foot back to a neutral position.

The more proximal the level of the amputation, the more the foot becomes biomechanically unstable. For example, a Lisfranc amputation or a disarticulation at the level of the tarsometatarsal joint (TMTJ) is more proximal than a TMA, therefore requiring heavier modifications to preserve the biomechanics of the foot. In a systemic review by Van Der Wal and colleagues, they recommend preserving the base of the first and fifth metatarsals to maintain ankle dorsiflexion to prevent a plantigrade foot. Similar to a TMA, an Achilles tendon lengthening procedure is also recommended to prevent equinus contracture. Other modifications include anchoring the tibialis anterior tendon to either the cuboid bone or the talus neck to correct varus deformity.[3]

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The goal of limb salvage is to preserve as much viable tissue as possible to allow primary closure. A stable soft tissue envelop will allow primary wound closure and prevent skin from breaking down after an amputation, thus preventing wound dehiscence around the surgical site.[1] Having excess skin around the amputation stump can also cause impingement to the prothesis device, leading to skin breakdown and increase the risk of proximal amputation. Published work by Pascale and Potter found an increased number of patients with skin breakdown and ulceration to the stump site in patients with diabetes.[4] Additionally, hematoma formation around the stump site and post-operative edema can further disrupt the stability of the soft tissue envelop, resulting in further wound healing complications.[4]

Ultimately, the combination of adequate blood flow, infection control through serial debridement and anti-

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biotics, a biomechanically stable foot, and a stable soft tissue envelop are fundamental elements of limb salvage.

Amputation

When all attempts at limb salvage have failed, the next treatment protocol to consider is a more proximal amputation. This topic is never easy to discuss with patients but one that should always be included in the initial conversation, so patients are aware and prepared for the ultimate outcomes. Be as transparent as possible so that patients can fully grasp at their chance of limb salvage. Carroll and colleagues proposed a two-stage below knee amputation (BKA), starting with an ankle disarticulation, followed by a definitive below-knee amputation as opposed to a single-stage below-knee-amputation. Their data showed a 97% healing rate versus a 78% healing rate when performing the two-stage procedure over the one-stage amputation. Other data found a 25% increase in complication rates in the one-stage group.

Additionally, 11% those who underwent the single-stage procedure went on to have an above-knee-amputation (AKA).[4] Cheun and colleagues found that patients with staged amputation had a lower 30-day re-admission rate and 30-day unplanned proximal amputation than those with primary amputation.[6] Furthermore, the two-stage procedure showed great benefits for rapid source control and decompression of severe infection such as soft tissue emphysema. Infectious disease colleagues also utilize culture data gathered from the initial ankle disarticulation to tailor antibiotics to target the appropriate bacteria. In addition, our hospitalist colleagues will have more time to medically optimize patients prior to their definitive amputation.[5] Overall, the two-stage BKA is a great option for patients who failed limb salvage and ultimately require a more proximal amputation.

Unfortunately, survival rate decreases with each subsequent amputation, and are even worse when complicated by medical comorbidities. Zambetti, et al. conducted a study that includes 14,500 patients who underwent either a BKA or an AKA. In this study, 8,306 had a BKA, while 6,367 had an AKA. Analysis from the study shows a higher rate of 30-day mortality in the AKA at 9.4% versus 3.9% in the BKA group. However, the BKA group had 2.5% early re-amputation within 30 days from the initial amputation compared to 0.8% in the AKA group. Stump complications from the BKA amputee group experienced as high as a 34.1% conversion rate to an AKA. Overall, the amputation in both groups was reported at 1.8% out of a total of 14,500 amputees. While uncommon, re-amputation is mainly due to wound dehiscence secondary to infection, pressure at the surgical site, or inadequate blood flow to allow wound healing. Moreover, patients who experience early re-amputation are often complicated by comorbidities including smoking and increased age.[7]

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Conclusion

Limb salvage versus amputation continues to be major a topic of discussion in wound care. Balancing between functional outcomes and quality of life becomes an important factor when selecting patients to optimize surgical planning and technique. Our task as physicians is to appropriately determine the solution that best fits the patient's needs and presenting circumstances while allowing them to return to their normal activity as soon as possible. While there have been many attempts at developing a scoring/grading system to evaluate for salvage vs. amputation at the initial patient presentation, this question still remains a highly subjective and often controversial treatment pathway decision. **PM**

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