The Angiosome Concept in Clinical Practice

Implications for patient-specific recanalization procedures.

BY MARIANNE BRODMANN, MD

Below-the-knee disease with the clinical presentation of critical limb ischemia is associated with a high rate of limb loss due to minor and major amputations. The consequences that these patients face are loss of mobility and social interaction, as well as higher mortality rates compared to patients whose limbs can be saved. Therefore, even aggressive attempts for limb salvage are justified in critical limb ischemia patients, either by vascular surgery or endovascular procedures.

Over the past years, especially with the improvement of endovascular techniques, the limb salvage rate was improved to a certain degree, especially in diabetics with foot ulcers, but amputation rates still remain too high. In cases when revascularization procedures cannot be applied, the rate of major amputations is > 50% at 5-year follow-up, but with direct revascularization, it can be reduced to 8.2% to 21.1%.[1]

The main problem is finding a way to optimize blood flow to the ischemic area. Different concepts exist as to how this can be achieved, either by treating as many vessels as can be reopened by an endovascular procedure, by treating the two main below-the-knee vessels, or in an outstanding situation, also treating the inflow of collaterals to achieve as much blood flow down the foot as possible.[2,3]

THE ANGIOSOME CONCEPT

The angiosome concept was derived from plastic surgery for the purpose of healing of skin flaps.[4] An angiosome is an anatomic unit of tissue (consisting of skin, subcutaneous tissue, fascia, muscle, and bone) fed by a source artery and drained by specific veins. The entire body can be divided into 40 angiosomes, and the foot itself consists of six. The posterior tibial artery feeds three angiosomes, the anterior tibial feeds one, and the peroneal artery feeds two. The posterior tibial artery gives rise to a calcaneal branch, which supplies the medial ankle and lateral plantar heel, a medial branch that feeds the medial plantar instep, and a lateral branch that supplies the lateral forefoot, plantar midfoot, and entire plantar forefoot. The anterior tibial artery continues on to the dorsum of the foot as the dorsalis pedis. The peroneal artery supplies the lateral ankle and plantar heel via the calcaneal branch and the anterior upper ankle via an anterior branch.

From that point of view, it can be presumed that revascularization of the source artery to the angiosome might result in better wound healing and limb salvage rates. The angiosome treatment concept for below-the-knee disease refers to a concept in cardiology in which discrimination of reversible ischemia areas is made, and respective vessels leading to these areas are treated in a distinctive way. For peripheral arterial occlusive disease, such reversible ischemia areas might be open wounds at the foot level. A proof for this concept might be the fact that ischemic heel ulcerations perfused by the dorsalis pedis are able to heal in approximately 86.5% of cases.[5] This demonstrates that intra-arterial connections exist between the dorsalis pedis and the peroneal artery and the medial and lateral plantar branches of the common plantar artery. Therefore, direct revascularization (DR) of arteries supplying the target angiosome (wound area) might be more successful for complete wound healing than indirect revascularization (IR) (Figure 1).[6]

RESULTS IN THE LITERATURE

There has been much discussion regarding the angiosome concept and many published case series. Attinger et al showed a 9% healing failure rate when using the angiosome concept compared to a 38% failure rate when wounds were revascularized indirectly.[7] In accordance with this difference in wound healing, they were able to show a worse limb sal-

Figure 1. Clinical case images.

vage rate when DR was not possible. In a larger cohort study with 203 limbs consecutively treated, limb preservation was possible in 86% with DR compared to 69% with IR.[8] These findings have been confirmed by many other investigators in high-quality case series.[9]

Currently, only one trial exists that compares DR and IR of the ischemic angiosome with the prospect of wound healing.[6] This was a prospective trial of 64 patients with single-vessel runoff to the foot in the setting of critical limb ischemia. DR was performed in 61%, and IR was performed in 39%. In 39.1%, the endovascular procedure was the method of choice compared to open surgery in 60.9%.[6] Of all the patients, 81.2% had forefoot ischemia, 17.2% had ischemic heel, and 1.6% had midfoot nonhealing ischemic ulcers. In most of the cases, the anterior tibial artery was the leading artery to the foot (42.2%), followed by the posterior tibial artery (34.4%) and the peroneal artery (23.4%). Ulcer healing at all follow-up time points (1, 3, and 6 months) was superior with DR than with IR. No statistically significant difference could be seen in regard to limb salvage, although there was a trend of advantage for DR.

This study shows in direct comparison that DR leads to better ulcer healing, which was statistically significant (P = .021), although the limb salvage rate was not statistically significantly improved, as shown in the study by Neville et al.[10]

CLINICAL PRACTICE

The profound problem in daily clinical practice is that DR might not be possible in every or most of our patients.

In every case, we should treat the patient with the utmost effort and try to open as many vessels down the foot as we can. The theory of that concept has also been proven. Berceli et al[5] reported on the efficacy of dorsalis pedis bypass for ischemic forefoot and heel ulcerations. According to the angiosome concept, the forefoot would be a DR, whereas the heel would be an IR. They were able to show an 86% limb salvage rate for heel ulcerations when relying on either of the two perfusion routes, indicating that wound healing of heel ulcerations is possible even in the absence of an intact pedal arch, thus relying on either the intact pedal arch or interangiosome connections for perfusion.

To conclude, I pose the question, what should we do in the real-world clinical scenario? Any investigator treating below-the-knee lesions in critical limb ischemia patients should try to identify the source artery of the wound area. If this is possible, this should be the target vessel in which to intervene. In cases when that is not possible, every effort should be undertaken to restore the most blood flow possible down to the foot. We must acknowledge that reopening procedures are only useful if dedicated wound care is applied to patients during follow-up. ■

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