International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Angiosome Concept: Myth or Reality

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Abstract: ***Vascular surgery has dramatically changed during the past two decades. However, despite the emerging technologies and new endovascular options and devices critical limb ischemia is still a challenging task due to the significant rate of unhealed wounds and secondary amputations despite apparently successful revascularization. The angiosome concept focuses on direct revascularization of the affected part of the foot. But will this lead to improved ulcer healing and limb salvage?***

Keywords: angiosome, revascularization, critical, ischemia**.**

1. Introduction

Vascular surgery has dramatically changed during the past two decades. However, despite the emerging technologies and new endovascular options and devices critical limb ischemia is still a challenging task due to the significant rate of unhealed wounds and secondary amputations despite apparently successful revascularization. With the introduction of the angiosome concept the decision is far from open vs endovascular. We have turned back to the fundament level of anatomy in order to better dictate perfusion area. It has been reported that up to 15% of bypasses to the foot fail to heal wounds despite remaining patent [1], [2]. Nevile et al. reported that up to 25% of patients with heel ulcers ultimately receive proximal leg amputation despite a palpable pedal pulse2 These failures may be partially due to inadequate postoperative wound care or simply because these bypasses failed to revascularized the affected angiosome [3], [4].

2. Literature Survey

The vascular society has always asked the question: What is enough, where to stop the revascularization procedure? This is the most difficult question and there is no correct answer for now since we do not have the tools to measure the result and predict the outcomes.

3. Methods/Approach

A systematic literature review was undertaken, using search terms including 'angiosome', 'revascularization', 'critical AND limb AND ischemia', and 'direct AND revascularization'. No date limit was set, and all papers were fully accessed. Studies were included if they reported results of the angiosome approach to revascularization of ischemic lower limb ulceration by surgical, angioplasty or hybrid methods.

4. Results/Discussion

In order to fully understand the topic we must first answer the question: "What is an angiosome?". An angiosome is a 3-dimentional anatomic block of tissue (including skin, subcutaneous tissue, fascia, muscle and bone), fed by a source artery [5].

Taylor and Palmer used ink injection studies, dissection, perforator mapping, and radiographic analysis of cadaveric specimens. They defined the angiosome as a three-dimensional network of vessels not only in the skin, but in all tissue layers between the skin and the bone. The primary supply to the skin was found to come from direct cutaneous arteries, which vary in diameter, length, and density in different areas of the body. These are reinforced by small, indirect vessels that tend to be the terminal branches of arteries that primarily supply the deeper tissues. In the zone between adjacent angiosomes, they identified reduced caliber ("choke") or similar caliber ("true") anastomotic arteries that provide redundant conduits to allow a given angiosome to receive blood flow from an adjacent neighboring angiosome if the source artery is compromised. Ultimately, at least 40 angiosomes in the human body were characterized, with six identified in the foot based on the three main arteries to the foot [5], [6], [7].

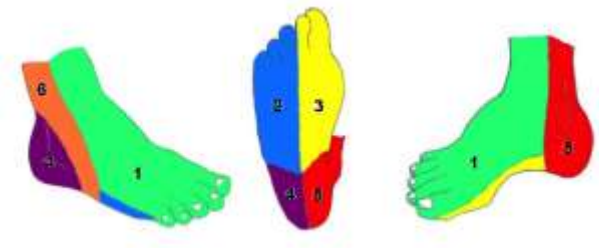

Figure 1: Angiosomes of the foot – Dorso-lateral view (a), Plantar view (b), Medial view (c); 1 -Dorsalis pedis angiosome, 2 - Medial plantar artery angiosome, 3 - Lateral plantar artery angiosome, 4 - Medial calcaneal artery angiosome, 5 – Lateral calcaneal branch angiosome, 6 – Anterior perforating branch angiosome.

Given the numerous anastomotic options despite the occlusion of one or more main arteries to the foot, numerous indirect arterial- arterial connections can allow alternative routes of blood flow if the direct route is disrupted or compromised. In that case the blood flow to the angiosome block is shifted into terminal like circulation. That is why the angiosome concept might work!

In current surgical bypass or endovascular practice, it is generally accepted that the outflow vessel and appended run-off (based on angiographic or duplex findings) represent the major decision-making factor in arterial reconstruction. The distal ischemic wound territory is eligible for revascularization either directly (angiosome-dependent) or, quite often, indirectly (without angiosome orientation) via the surrounding collaterals of the available target vessel [8], [9]. Indications for the type of revascularization to be performed are currently deduced from an iconographical point of view depending on the most "suitable" artery to be reopened, or "patent" distal vessel to anchor the bypass [10], [11], [12].

Ferraresi et al. points the three distinct approaches to revascularization of the leg. The complete approach states that one vessel is better than none, two or three vessels are better than one and targeting tibial arteries is better than peroneal artery. Angiosome theory itself insists on direct revascularization is better than indirect and the "old" concept linked to limb salvage directed to patency of a single vessel [13].

The angiosome concept focuses on direct revascularization of the affected part of the foot. But will this lead to improved ulcer healing and limb salvage? In order to answer this question we need to have patients divided in two groups. One treated with indirect revascularization (ulcerated angiosome fed by collaterals from other angiosomes) and the other with direct revascularization [14], [15]. In 2009 Neville et al concluded a study with 48 patients with 52 non healing wounds. The patients were divided in two groups: the first one were treated by direct revascularization (DR) - 51%, and the other with indirect revascularization (IR) – 49%. The results showed better wound healing in the DR group rather than IR group 91% vs 62% and also high percentage of limb salvage (9% DR vs 38% IR amputation rate) [3].

In another study 329 patients treated interventionally we see even higher rates of limb salvage. At the fourth year the DR group had only 28% amputation rate compared to IR group with 51% amputations [1].

But these were all retrospective studies. This year a prospective study was published by Elbadawy et al and suggests that the complete wound healing rate is better when the target foot lesion receives direct perfusion following the angiosome concept, whereas limb salvage and amputation free survival rates were not significantly different among the DR and IR groups. Direct flow to the foot wounds based on the angiosome principle was achieved in 117 legs (55.2%) versus 95 legs (44.8%) that represented the IR group. Seventy-three matched pairs were obtained to minimize intergroup differences in baseline characteristics. Twelve months after angioplasty, the complete wound healing rates were 80.8% and 63.0% (p = .02), AFS rates were 72.6% and 61.6% (p = .164), and limb salvage rates were 90.4% and 82.2% (p = .148) in the DR and IR groups, respectively [16].

A systematic review published in 2014 concluded that DR of the tibial vessels appears to result in improved wound healing and limb salvage rates compared with IR, with no effect on mortality or reintervention rates. However, the quality of evidence on which these conclusions are based on is low.
Fifteen cohort studies reporting on 1,868 individual limbs were included (endovascular revascularisation, 1,284 limbs; surgical revascularisation, 508 limbs; both methods, 76 limbs). GRADE quality of evidence was low or very low for all outcomes. DR resulted in improved wound healing rates compared with IR (odds ratio [OR] 0.40, 95% confidence interval [CI] 0.29-0.54) and improved limb salvage rates (OR 0.24, 95% CI 0.13-0.45), although this latter effect was lost on high-quality study sensitivity analysis. Wound healing and limb salvage was improved for both open and endovascular intervention. There was no effect on mortality (OR 0.77, 95% CI 0.50-1.19) or reintervention rates (OR: 0.44, 95% CI 0.10-1.88) [17].

5. Conclusion

Before starting a procedure we should always ask ourselves should we take the angiosome concept into account in our revascularization strategy. But how often we really have the choice? Given those results for better wound healing should we still perform IR? Too many questions but just a few answers. The key point to all these questions is the outflow because foot arteries are the border between two completely different worlds, two different diseases in terms of biology and clinical evolution: big artery disease (BAD) and small artery disease (SAD).

6. Future Scope

Our opinion is that an effort should be made to develop a tool that could measure the tissue oxygenation of different areas of the foot on the table in the operating room or in the angio suite.

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