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Complex Lower Limb Revascularization Based on Angiosomes Concept: A Case Report

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Abstract

Introduction: The angiosome concept was first described in 1987, defining an angiosome as an area of tissue comprising skin, subcutaneous tissue, fascia, muscle and bone supplied by a specific artery and drained by a specific vein. We report a case of a patient who was successfully complex revascularized by open surgery and endovascular techniques based on angiosome concept.

Case presentation: A 73-years-old male patient with critical limb ischemia and type 2 diabetes, presented increasing resting pain in the lower right limb during the last 3 months, followed by necrosis of distal phalanx of I and II toes, wet interdigital necrosis of toes I-II on the right leg, with absence of distal pulses on both limbs. Direct flow into affected angiosome was successfully achieved with right proximal femoral-popliteal saphenous vein bypass and ATA balloon dilatation angioplasty.

Conclusion: The vascular patient with critical ischemia associated to diabetes currently requires a complex treatment including open surgery, endovascular technique and negative pressure therapy to save the lower limbs. The angiosome concept is useful during both open and endovascular tibial revascularisation.

Keywords: Bypass • Endovascular • Angiosomes • Critical limb ischemia • Diabetes

Abbreviations: PAD: Peripheral Arterial Disease • ATA: Anterior Tibial Artery • PTA: Posterior Tibial Artery • PA: Popliteal Artery • CLI: Critical Limb Ischemia • DR: Direct Revascularization • VAC: Negative Pressure Therapy • ABI: Ankle-Brachial-Index

Introduction

The angiosome concept was first introduced in 1987 by Taylor and Palmer in plastic surgery; it defines essential 3D anatomical blocks of tissue fed by specific arterial and venous sources [1]. This concept may provide new information applicable to improving targeted revascularization of ischemic tissue lesions [2]. Angiosomes communicate with each other through 'choke vessels' [3]. There are 6 angiosomes of the foot which derives from 3 arteries (ATA, ATP, PA): angiosome of the medial calcaneal artery (PTA), angiosome of the medial plantar artery (PTA), angiosome of the lateral plantar artery (PTA), angiosome of the pedicular artery (ATA), angiosome of the lateral calcaneous artery (PA), angiosome of anterior Perforating Artery (PA) (Figure 1). Attinger and colleagues transferred this concept to critical limb ischemia by defining the direct and indirect revascularization of the affected angiosomes of the foot with ulcer or tissue necrosis [4-9]. Most of them found that indirect revascularization leads to poorer outcomes when compared to Direct Revascularization (DR), especially in endovascular procedures. Diabetes is one of the strongest predictors of peripheral arterial disease [10-12]. Peripheral Arterial Disease (PAD) is increasing in prevalence worldwide, affecting 12% to 20% of the elderly (aged 65 and over) [13]. CLI is the most severe form of PAD and is characterized by rest pain, ulcers or gangrene [14-17].

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Case Report

A 73-years-old male patient with peripheral arterial disease: Leriche-Fontaine stage IV or Rutherford 5 on the lower right limb and stage IIB Fontaine, (or Rutherford 3) for the left limb, W2I3fi-3-high risk of amputation, clinical stage 4 right foot and W2I1fi-0 moderate risk of clinical stage 3 amputation left foot, presented increasing resting pain in the lower right limb during the last 3 months, followed by necrosis of distal phalanx of I and II toes, wet interdigital necrosis of toes I-II on the right leg, with absence of distal pulses on both limbs. Doppler exploration showed absence of flow on the right distal leg with 0.45 ABI on the right and 0.5 on the left side (Figure 2). Patient had the following commorbidities: hypertensive heart disease, chronical ischemic heart disease, grade III hypertension with high cardiovascular risk, type 2 diabetes mellitus, mild mitral regurgitation, mild aortic regurgitation, right branch block, ischemic stroke (2016), mixed deteriorative syndrome, secondary depression, secondary anemia, leukocytosis, and carotid disease. Angio-CT revealed: distal Superficial Femoral Artery (SFA) oclusion, right Posterior Tibial Artery (PTA) and Bilateral Peroneal (PA) occlusions, right Anterior Tibial Artery (ATA) severe 95% sub occlusion parallel to 70% stenosis on the opposite left ATA (Figure 3).

Based on the clinical examination, the affected angiosomes were medial Plantar Artery Angiosome (PTA)-(toe I) and dorsalis pedis artery angiosome (ATA)-(dorsal face of toes I, II and III) and lateral plantar artery angioosome (ATP)-toes II and III. Considering the recommendations from the ESC Guidelines for diagnosis and treatment of peripheral arterial disease, a multidisciplinary team was established: vascular surgeon, dialectologist, cardiologist, radiologist, infectious diseases specialist. The radiography of the right foot revealed: diffuse bone demineralization, narrowing of the tarsus-metatarsal joint spaces, osteophytosis with a tendency to form metatarsal I-II and IV-V base bridges. Leukocyte=14.9 mm^3 -13.4 mm^3-13.73 mm^3, Hemoglobin: 12.3 g/dL-11.7 g/dL, Glucose=175-197-122 mg/dL, Protein C=16.03 mg/l-9.13 mg/L, Triglyceride=253 mg/dL. In the wound secretion

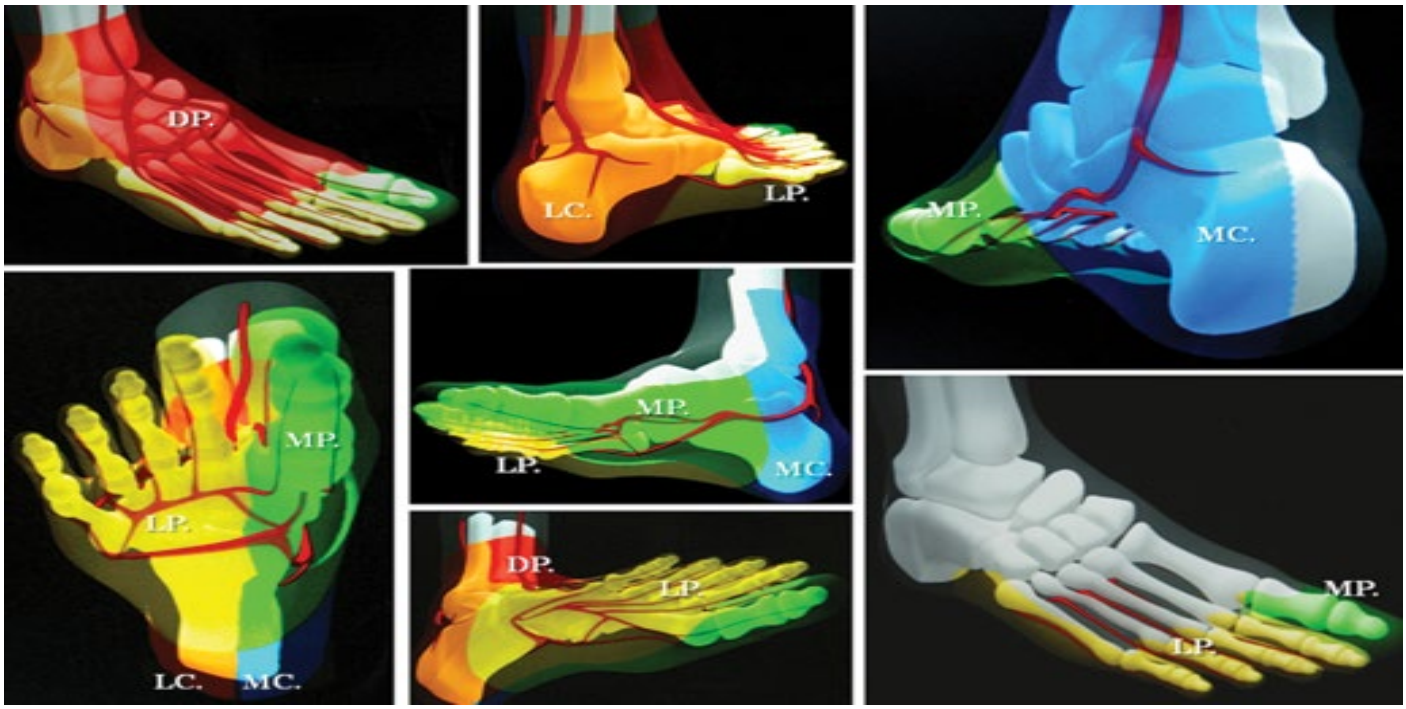

Figure 1. Angiosome of anterior perforating artery.

Figure 2. Pattern of tissue loss in the right foot of a patient with critical ischaemia; He is a smoker and diabetic.

Figure 3. Distal Superficial Femoral Artery (SFA) oclusion, right Posterior Tibial Artery (PTA) and Bilateral Peroneal (PA) occlusions, right Anterior Tibial Artery (ATA) severe 95% subocclusion parallel to 70% stenosis on the opposite left ATA.

culture Staphylococcus spp. was found, being a Fluoroquinolone-resistant phenotype sensitive to Cefoxitin, Clindamycin, Erythromycin, Penicillin, Teicoplanin, Gentamicin. A right proximal femoro-popliteal saphenous vein bypass was performed according to the class I level B recommendation of the 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS) (Figures 4-6). After 10 days the patient returns with dehiscent wound, infected with Staphylococcus aureus and Enterococcus Spp. Leukocyte: 13.5 mm^3-10.95 mm^3-13.1-8.6 mm^3; Hemoglobin: 11.4 g/dl-11 g/dl-10.4-10.2 g/dl; C-reactive protein-9.13 mg/l; Rx foot reveals osteolysis of the ends of the metatarsals I and II right leg. Diagnostic angiography is performed that reveals the bypass patent. ATA balloon dilatation angioplasty was performed;

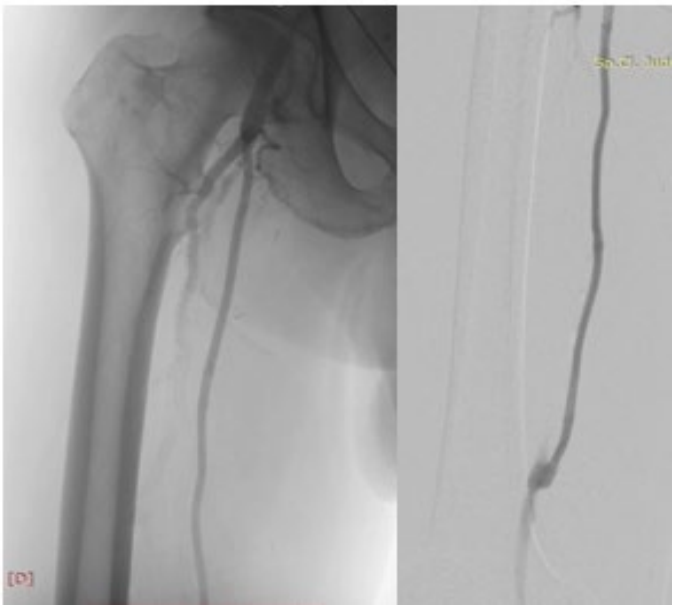

Figure 4. Diagnosis and treatment of peripheral arterial diseases, in collaboration with the European Society for Vascular Surgery (ESVS).

Figure 5. It is practiced right toe amputation.

Figure 6. Antibiotic treatment was conducted according to the antibiogram with Ciprofloxacin.

according to the class I level C recommendation for revascularization of the infrapopliteal occlusive lesions of the ESC Diagnostic Guideline and treatment of peripheral arterial disease in collaboration with ESVS. It directly revascularizes the angiosome of the pedicular artery (from the ATA) and indirectly the angiosome of the medial plantar artery (ATP) through retrograde circulation of the plantar arch. At approximately 6 months, the patient returns to the clinic with dehiscence wounds with secretions (Figures 7-12).

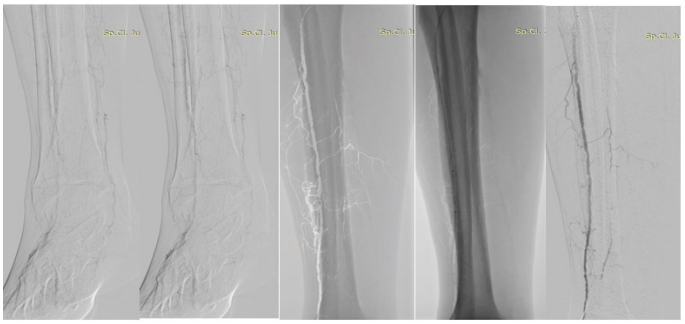

Figure 7. Right toe amputation and adjustment of metatarsal bone stumps I,II with 3 series of excisional debridement and negative pressure therapy were performed.

Figure 8. 3 series of excisional debridement and VAC mounting was performed. The third right finger was amputated due to the humid gangrene from the level of the distal phalanx and necrosis from the level of the metatarsal-phalangeal joint.

Figure 9. Antibiotic treatment via intravenous perfusion was administered according to the antibiogram as well as vasodilating prostaglandins, analgesics and anti-inflammatories. The patient was discharged after 10 days with a healing wound, without secretions or blemishes, with Doppler ATA and ABI flow of 0.8.

Figure 10. Follow-up at one month: plague with the minimum dehiscence of 1 cm, without secretions.

Figure 11. At the follow-up of 3 months the wound is healed. Right ABI: 0.8, left ABI: 0.45, femoro-popliteal bypass as patent.

Figure 12. Follow-up of 6 months wound healing. ABIright: 0.8, ABI left: 0.3, femoro-popliteal bypass as patent.

Main diagnosis

Peripheral arterial disease. Critical ischemia bilateral lower limbs. Dehiscence wound after amputation finger II left foot with secretions and nipples. Transmetatarsal amputation toes I, II, III right leg. PTA with right ATA balloon. Proximal femoral-popliteal bypass with venous graft patent.

Secondary diagnosis

Hypertensive heart disease. Ischemic heart disease. Grade III hypertension with high cardiovascular risk. Type II diabetes mellitus treated with ADO. Mild mitral regurgitation. Mild aortic regurgitation. Right branch block. Stroke (2016). Mixed deteriorative syndrome. Secondary depression. Secondary anemia. Leukocytosis.

Biological leukocyte

9.9-11.3-11.34-18.6-10.9, Hemoglobin-13.5-11.9, Prot C-1.92. Harvest the secretion of the wound that reveals the presence of Staphylococcus aureus MRSA sensitive to Linezolid and Ciprofloxacin. Psychiatric consultation reveals diagnosis of Mixed Dementia Syndrome, secondary depression with Coaxil recommendation 12.5 mg 1-0-1. Diagnostic angiography and PTA with balloon (Admiral Xtreme 6/80 mm) were performed. PTA attempts are performed with the left ATA balloon for direct revascularization of the pedicle artery angiosome (ATA) but the occlusal lesion at the ankle level of the ATA cannot be crossed. Excisional debridement and plantar abscess removal are practiced. 2 excisional debridement and VAC mounting are practiced. It is practiced amputation transmitted fingers I and II left foot. Excisional debridement and tarsus-metatarsal disarticulation of the left foot and secondary suture with unfavorable evolution are practiced due to the impossibility of direct revascularization of the affected leg angiosomes. Wound secretion culture: Staphylococcus aureus-MRSA, methicillin-resistant, Macrolide resistance phenotype. Sensitive to: Ciprofloxacin, Linezolid Teicoplanin. It is practiced 1/3 middle left leg amputation after one week. At 2 years of follow-up the patient has a healed left stump and a right 0.7 ABI, from patent femoro-popliteal bypass, without any residual ischemic signs (Figures 13 and 14).

Discussion

Iida et al. defines targeted direct angiosomal revascularization as an open arterial line flow from the abdominal aorta to the foot arteries, including the targeted angiosomal vessels [18]. However, there is no mention about eventual strategy in cases in which ulcer affect 2 or more angiosomes. Another study published by Soderstrom et al. points out that the wound can be located across more than one angiosome, but do not provide clear definition of targeted revascularization in those cases [19]. Although we believe that the angiosome concept is scientifically valid,and has considerable therapeutic potential, we still face uncertainties in defining angiosomal borders and necrotic tissue distribution since trying to apply it in the treatment of CLI. It is known that the forefoot ischemic trophic lesions currently assemble 2, or 3 ischemic angiosomes manifestations. Precise recognition of each angiosome participation (one dorsal and two plantars) simply by clinical means can be arduous in these cases. Main necrotic zones may not correspond to the highest ischemic regions, since concomitant neuropathy, infection, inflammatory edema, and local foot compartment syndromes add, almost in equal participation, complementary tissue destruction. For such patients the terms “angiosome direct revascularization” should be rather replaced by “Wound Targeted Revascularization” (WTR) because of the huge changes that CLI inflicts to “normal” angiosomal “source arteries” and their appended collaterals. In fact, for these complex cases, the common angiosomal borders (such as Tailor and Attinger initially described) and their collateral vessels are “reshaped” by local CLI tissue destruction. This does not mean that angiosome topographic orientation is losing in interest for revascularization. The prepared interventionist can use the basic angiosomal partition for identifying remnant arterial trunks and groups of collaterals for orienting the closest possible to the wound the newly regained arterial flow, in a WTR strategy [20]. Bypass and angioplasty are rather complementary than concurrent tools for revascularization. Each provides advantages and inherent drawbacks. Distal foot bypass, for instance, brings a more pulsatile arterial flow towards the wound zone thus induces by higher vessel shear-stress, the local arteriogenesis and superior development of larger collaterals. Nevertheless, this higher arteriogenesis works even better if diligently oriented towards the wound, as Neville showed in his article. Even if more demanding in realization, the angiosome-oriented, or topographic bypass appears to afford better clinical success and limb salvage than totally nonspecific, surgical revascularization in the diabetic foot [21].

Figure 13. Patient femoro-popliteal bypass.

Figure 14. Patient femoro-popliteal bypass, without any residual ischemic signs.

Conclusion

In diabetic critical limb ischemia, more than one angiosomes are affected by tissue injury. It is very important to place the lesion in concordance with the affected angiosomes for correct diagnosis and accurately defined direct, or indirect revascularization. It appears that in patients with diabetes, indirect endovascular revascularization leads to slower healing and a lower salvage rate of the limb. Therefore, endovascular revascularization can be more easily oriented directly on the affected angiosomes. In the case of open surgical revascularization, only slight differences in clinical success were evinced concerning direct and indirect revascularization. This may eventually be the effect of a more pulsatile flow provided by bypass that enhances a superior arteriogenesis in the lasting collaterals of the diabetic foot. The multidisciplinary team appears very important in the treatment of diabetic critical ischemia, often concerning vascular surgeon, diabetologists, infectionists, orthopedists, cardiologists, radiologists. The vascular patient with critical ischemia associated to diabetes currently requires a complex treatment including open surgery, endovascular technique and negative pressure therapy to save the lower limbs.

References

1. Taylor Gaud and Palmer Jones. "The Vascular Territories (Angiosomes) of the Body: Experimental Study and Clinical Applications." *Br J Plast Surg* 40 (1987): 113-141.
2. Christopher E. Attinger, Karen Kim Evans, Erwin Bulan and Peter Blume, et al. "Angiosomes of the Foot and Ankle and Clinical Implications for Limb Salvage: Reconstruction, Incisions and Revascularization." *Plast Reconstr Surg* 117 (2006): 261-293.
3. Christopher Attinger, Paul Cooper, Peter Blume and Erwin Bulan. "The Safest Surgical Incisions and Amputations Applying the Angiosome Principles and using the Doppler to Assess the Arterial-Arterial Connections of the Foot and Ankle." *Foot Ankle Clin* 6 (2001): 745-799.

4. Vlad Alexandrescu and Gerard Hubermont. "Primary Infragenicular Angioplasty for Diabetic Neuroischemic Foot Ulcers Following the Angiosome Distribution: A New Paradigm for the Vascular Interventionist?" *Diabetes Metab Syndr Obes* 4 (2011): 327-336.
5. Kimmo Spillerova, Fausto Biancari, Alback Leppaniemi and Akram Alback, et al. "Differential Impact of Bypass Surgery and Angioplasty on Angiosome-Targeted Infrapopliteal Revascularization." *Eur J Vasc Endovasc Surg* 49 (2015): 412-419.
6. Bauer E. Sumpio, Rachael O. Forsythe, Kenneth R. Ziegler and Jeff G. van Baal, et al. "Clinical Implications of the Angiosome Model in Peripheral Vascular Disease." *J Vasc Surg* 58 (2013): 814-826.
7. Fausto Biancari and Tukiainen Juvonen. "Angiosome-Targeted Lower Limb Revascularization for Ischemic Foot Wounds: Systematic Review and Meta-analysis." *Eur J VascEndovasc Surg* 47 (2014): 517-522.
8. David Bosanquet and Jones Glasbey. "Systematic Review and Meta-analysis of Direct *Versus* Indirect Angiosomal Revascularisation of Infrapopliteal Arteries." *Eur J VascEndovasc Surg* 48 (2014): 88-97.
9. Hidde Jongsma, Joost A. Bekken, George P. Akkersdijk and Sanne E. Hoeks, et al. "Angiosome-directed Revascularization in Patients with Critical Limb Ischemia." *J Vasc Surg* 65 (2017): 1208-1219.
10. Thejasvi, Thiruvoipati. "Peripheral Artery Disease in Patients with Diabetes: Epidemiology, Mechanisms and Outcomes." *World J Diabetes* 6 (2015): 961-969.
11. Yan, Huang. "Call for Data Contribution to the IDF Diabetes Atlas 9th Edition 2019." *Diabetes Res Clin Prac* 140 (2018): 352.
12. Jaffer A. Dormandy and Ron B. Rutherford. "Management of Peripheral Arterial Disease (PAD): TASC Working Group." *J Vasc Surg* 31 (2000): 1-296.
13. Véronique L. Roger, Alan S. Go, Donald M. Lloyd-Jones and Emelia J. Benjamin, et al. "Heart Disease and Stroke Statisticse 2012 Update: A Report from the American Heart Association." *Circulat* 125 (2012): 2-220.
14. Novo Salvatore, Coppola Giuseppe and Milio Glauco. "Critical Limb Ischemia: Definition and Natural History." *Curr Drug Targets Cardiovasc Haematol Disord* 4 (2004): 219-225.
15. Norgren Lars, William R. Hiatt, Dormandy John and Nehler Mehak, et al. "Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II)." *J Vasc Surg* 45 (2007): 5-67.
16. Paul C.Y. Tang, Karim Ravji, Jonathan J. Key and David B. Mahler, et al. "Let Them Walk! Current Prosthesis Options for Leg and Foot Amputees." *J Am Coll Surg* 206 (2008): 548-560.
17. Powell, Richard. "Update on Clinical Trials Evaluating the Effect of Biologic Therapy in Patients with Critical Limb Ischemia." *J Vasc Surg* 56 (2012): 264-266.
18. César Varela, Francisco Acín, Joaquín de Haro and Silvia Bleda, et al. "The Role of Foot Collateral Vessels on Ulcer Healing and Limb Salvage after Successful Endovascular and Surgical Distal Procedures According to an Angiosome Model." *Vasc Endovasc Surg* 44 (2010): 654-660.
19. Osamu Iida, Shinsuke Nanto, Masaaki Uematsu and Kuniyasu Ikeoka, et al. "Importance of the Angiosome Concept for Endovascular Therapy in Patients with Critical Limb Ischemia." *Cathet Cardiovasc Intervent* 75 (2010): 830.
20. Maria Söderström, Anders Albäck, Fausto Biancari and Kimmo Lappalainen, et al. "Angiosome-targeted Infrapopliteal Endovascular Revascularization for Treatment of Diabetic Foot Ulcers." *J Vasc Surg* 57 (2013): 427-435.
21. Kristyna Spillerova, Maria Sorderstrom, Anders Alback, and Maarit Venermo, et al. "The Feasibility of Angiosome-Targeted Endovascular Treatment in Patients with Critical Limb Ischemia and Foot Ulcer." *Ann Vasc Surg* 30 (2016): 270-276.

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