The great saphenous vein *in situ* for the arterialization of the venous arch of the foot

Utilização da safena magna in situ *para arterialização do arco venoso do pé*

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Abstract

Background: Critical lower limb ischemia in the absence of a distal arterial bed can be treated by arterialization of the venous arch of the foot.
Objetive: The objective of this paper was to present the technique and the results of the arterialization of the venous arch of the foot with the *in situ* great saphenous vein.
Methods: Eighteen patients, 11 with atherosclerosis (AO), 6 with thromboangiitis obliterans (TO) and 1 with popliteal artery aneurysm thrombosis (TA) were submitted to venous arch arterialization. The *in situ* great saphenous vein was anastomosed to the best donor artery. Arterial flow derived from the venous system progresses through the vein whose valves were destroyed. The collateral vessels of the great saphenous vein are linked from the anastomosis to the medial malleolus and preserved from this point onward.
Results: Limb salvage was achieved in 10 (55.6%) patients, 5 with AO and 5 with TO. Seven (38.9%) patients were amputated, 5 with AO, 1 with TO and 1 with TA. One (5.5%) patient died.
Conclusion: Arterialization of the venous system of the foot should be considered for the salvage of limbs with critical ischemia in the absence of a distal arterial bed.

Keywords: Thromboangiitis obliterans; limb salvation; temporal arterialization; limb amputation.

Resumo

Contexto: O tratamento da isquemia crítica de membros inferiores sem leito arterial distal pode ser realizado por meio da inversão do fluxo no arco venoso do pé.
Objetivo: O objetivo deste trabalho foi apresentar a técnica e os resultados obtidos com a arterialização do arco venoso do pé, mantendo a safena magna *in situ.*
Métodos: Dezoito pacientes, dos quais 11 com aterosclerose (AO), 6 com tromboangeíte obliterante (TO) e 1 com trombose de aneurisma de artéria poplítea (TA) foram submetidos ao método. A safena magna *in situ* foi anastomosada à melhor artéria doadora. O fluxo arterial derivado para o sistema venoso progride por meio da veia cujas válvulas são destruídas. As colaterais da veia safena magna são ligadas desde a anastomose até o maléolo medial, a partir do qual são preservadas.
Resultados: Dos pacientes, 10 (55,6%) mantiveram suas extremidades, 5 com AO e 5 com TO; 7 (38,9%) foram amputados, 5 com AO, 1 com TO e 1 com TA; houve 1 óbito (5,5%).
Conclusão: A inversão do fluxo arterial no sistema venoso do pé deve ser considerada para salvamento de extremidade com isquemia crítica sem leito arterial distal.

Palavras-chave: Tromboangeíte obliterante; salvamento de membro; arterialização temporal; amputação de membro.

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No conflict of interest was declared concerning the publication of this article
Presented at the VII Meeting of Vascular and Endovascular Surgery, São Paulo – São Paulo; Presented at the XXI Scientific Conclave of Medical Students, Curitiba – Paraná
Received on: Feb 24, 2010. Accepted on: May 31, 2010
J Vasc Bras. 2010;9(3):119-123.

Introduction

In critical ischemia without arterial run-off, one of the ways to irrigate the ischemic limb is to turn the course of the flow reversely through the venous system to treat rest pain or to promote healing of ulcers and amputations.

Atherosclerosis obliterans (AO), especially associated with diabetes mellitus, *thromboangiitis obliterans* (TO) in most cases, and popliteal artery aneurysms with distal bed thrombosis are conditions that justify the indication of this procedure.

The first experiments of therapeutic arteriovenous fistulas were made on the proximal portion of the lower limbs, in the beginning of the past century, but no favorable results were obtained. Since 1970, with the pioneer work by Lengua[1], the fistulas have been extended to the foot, and good results have been reported in many publications with the use of reversed[2-16] and *in situ*[11,17-20] great saphenous vein.

Objective

To describe the technique and to present the results obtained after arterializations of the venous arch of the foot with great saphenous vein maintained *in situ*.

Methods

Angiography and arterial duplex scan were performed as routine examinations in search of the vascular run-off for treatment with conventional graft and of a satisfactory donor artery. The venous duplex mapping studied and marked preferentially the great saphenous vein and its extension into the foot venous arch, as well as determining patency of the remaining veins of the deep venous system of the foot to assure the return of the blood hyperflow generated by performing an arterio-venous fistula.

The great saphenous vein was then anastomosed end-to-side to the best donor vein (Figure 1).

The arterial flow into the venous system progressed through the vein whose valves had been destroyed by the Mills valvulotome (Otemac®), which was introduced through collateral veins until the medial malleolus (Figure 2).

At this point, the anterior perforating vein of the malleolus was invariably found, and all the other foot collateral veins were then preserved. By means of phlebotomy in the dorsal venous arch, at the level of the first interdigital space, the destruction of the valves was completed, thereby allowing arterial blood flow to the dorsal portion of the foot (Figure 3). All side branches of the great saphenous vein

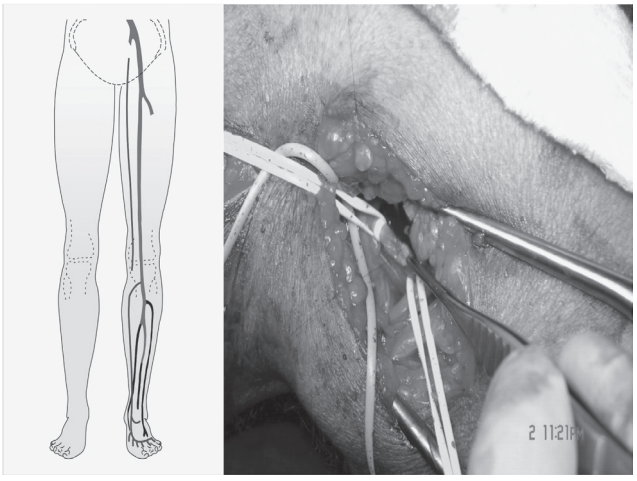

Figure 1 – Great saphenous vein in anastomosis end-to-side to the best donor artery.

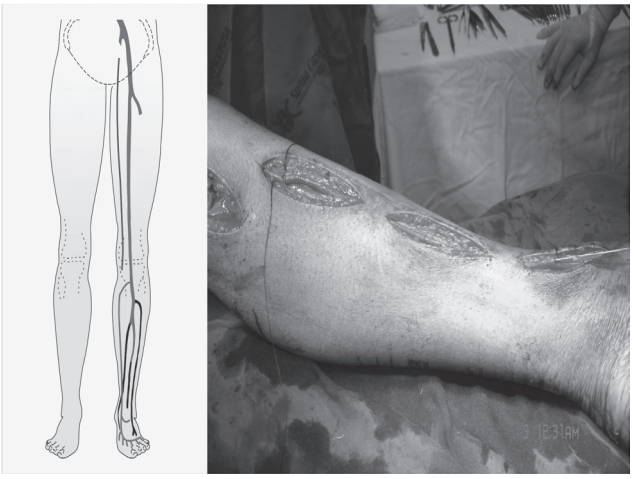

Figure 2 – Arterial flow into the venous system progresses through the vein, whose valves are destroyed by the valvulotome introduced through collateral veins untill the medial malleolus.

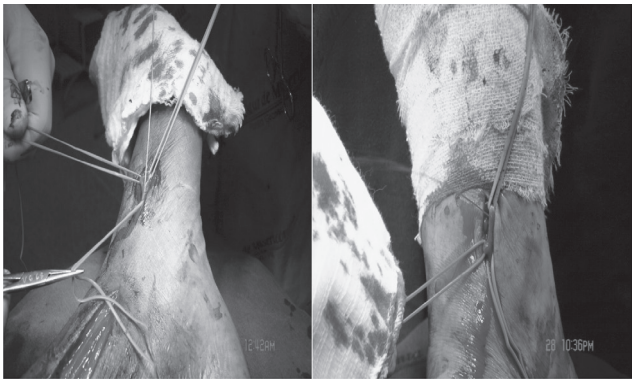

Figure 3 – Phlebotomy in the dorsal venous arch at the first interdigital space level, completing the valvotomy and enabling arterial blood flow into the foot dorsum.

were ligated from the arterial anastomosis untill the anterior perforating vein of the malleolus (Figure 4).

Eighteen patients with critical ischemia without arterial run-off, out of whom 11 had AO, 6 had TO and 1 had late presentation of popliteal artery aneurysm with distal thrombosis, were submitted to the method. Among the 11 patients with AO, six had *diabetes mellitus* and, out of these, two had renal failure and depended on hemodialysis.

Results

Among the 18 arterialized patients, 10 had foot salvage (55.6%). Six patients achieved healing of minor amputations: two transmetatarsial, two finger and two phalanx amputations. Seven of them went through major amputations (38.9%): three above the knee and four below the knee. One patient with *diabetes mellitus* and chronic renal failure died (5.5%) after developing septicemia by ascending infection.

Out of the 11 patients with AO, 5 had limb salvage, 5 suffered major amputations and 1 died. Out of the six patients with TO, five had their lower extremities maintained and one went through a major amputation. The patient who presented critical ischemia due to thrombosis of popliteal artery aneurysm and distal arterial obstruction had above-knee amputation.

The average follow-up of patients whose limbs were salvaged was 695.6 days (213 to 1,006). Two patients with AO died due to comorbidities related to patent graft. Two patients, despite having their fistulas closed, had their extremities salvaged, and a third one still presented patent fistula. Among patients with TO, four had patent fistulas and one presented closed fistula.

Discussion

Good surgical outcomes are related to precise indication, arterial and venous preoperative investigation of limb at risk, and details of the surgical technique. The presence of pulse and thrill in the dorsal venous arch is mandatory, as well as the maintenance of the foot veins from the malleolar anterior perforating vein, and the integrity of the deep venous system, which functions as an "escape route" for the blood hyperflow generated by the AV fistula (Figure 5).

Root and Cruz[21] and Matolo[22] demonstrated experimentally that end-to-side fistulas enabled a good reverse blood flow and better results in comparison to the terminal ones, which lead to edema, ecchymosis, and necrosis due to venous overload.

Figure 4 – Ligation of collateral of the great saphenous vein, from the arterial anastomosis untill the malleolus anterior perforating vein, also shown by angiography.

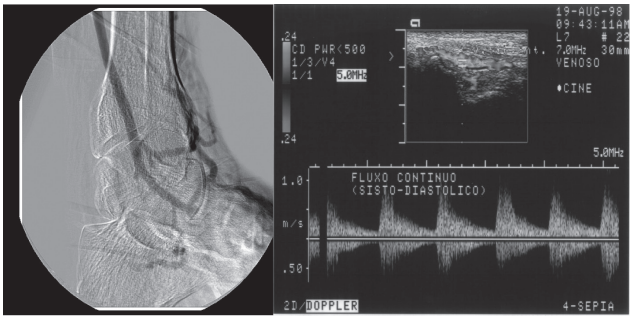

Figure 5 – Angiography showing diffusion of contrast into the deep system and duplex with systolic-diastolic flow at the level of the dorsal venous arch of the foot.

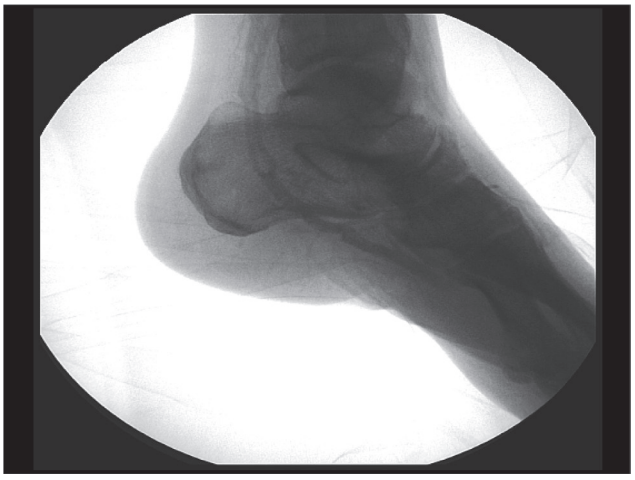

Figure 6 – Postoperative angiography showing fulfillment of the plantar arch of the foot and of the small saphenous vein.

The preoperative evaluation by means of duplex mapping, besides showing the best donor artery, may show an intact deep venous system, great saphenous vein and the foot venous arch.

The malleolar anterior perforating vein drains part of the flow into the anterior tibial veins and part into the foot proximal dorsal veins (Figure 5).

Lofgren et al.[23] demonstrated that injection of blue latex in the dorsal venous arch, between the first and the second metatarsal bones, drained into the proximal deep and superficial veins. They also noticed that over half of the perforating veins (between 6 and 12), which enable communication between the deep and superficial venous systems, lacks valves, thus allowing blood flow in both directions. The most important perforating vein is that of the first interdigital space, measuring approximately 3 mm[24]. In postoperative angiographies, added to what was reported, filling of the plantar arch and of the small saphenous vein was observed (Figure 6).

Although TO affects both veins and arteries, the great and small saphenous veins are rarely affected by the inflammatory process[25].

Maintaining the great saphenous vein *in situ* allows the "arterialization" of the foot venous arch with one anastomosis without removing the vein of its original bed, thus avoiding a tunnel for the venous graft. However, results depend more on the characteristics of the patient than on the technique itself.

In 2006, similar results were found in a survey of 56 publications in which the procedures were performed to treat critical ischemia without distal run-off by different techniques. A meta-analysis comprising seven papers gathered a total of 228 patients with 231 treated extremities and a 71% success rate with healing of lesions, minor amputations and improvement of pain at rest: 140 cases of OA and 91 cases of TO[26].

We conclude that distal revascularization of the limb with critical ischemia by foot reverse flow with *in situ* saphenous vein arterialization must be considered as an attempt to salvage the affected lower extremity presenting critical ischemia without distal arterial run-off.

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Critical analysis: CRB
Final text approval: CRB, CALU, RZG, JKH, EH and DMMC
Statistical analysis: none
Overall responsibility: CRB
Financing information: none
All authors have read and approved the final version of the paper submitted to the J Vasc Bras.