Influence of the greater saphenous vein graft quality in the early patency of infrainguinal revascularizations

Influência da qualidade do enxerto da veia safena magna na patência precoce das revascularizações infrainguinais

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Abstract

Objectives: The authors evaluate the quality of the greater saphenous veins used in lower limb revascularizations at the moment of their implantation, using a semiquantitative histopathological method, relating the vein quality with patient's sex and age, as well as the influence on early patency rates.

Method: A total of 144 veins of 144 patients were studied, 88 male and 56 female, with a mean age of 65.7 years. The vein was stained with hematoxylin-eosin. The degree of intimal hyperplasia and hypertrophy of the longitudinal and circular muscular layers of the media were analyzed. The quality of the vein was classified, by adding the grades of each layer, into good, regular and questionable quality.

Results: As to quality, 82 veins (57%) were classified as good, 49 (34%) as regular and 13 (9%) as questionable. In six months, the primary patency of good quality veins was 80.5%, that of regular quality veins was 79.6% and the patency of questionable quality veins was 84.6%.

Conclusion: No differences were seen in vein quality, either in the individual evaluation of each layer or in the global evaluation of the three layers, regarding the patient's sex and age. No difference was observed regarding the patency of the grafts.

Key words: saphenous vein, lower extremity, grafts.

Resumo

Objetivos: Os autores avaliaram a qualidade das veias safenas magnas utilizadas em revascularizações de membros inferiores no momento de seu implante, através de um método histopatológico semiquantitativo, relacionando a qualidade da veia com o sexo e a idade do paciente, assim como com a influência nas taxas de patência primária.

Método: Um total de 144 veias de 144 pacientes foram estudadas, 88 homens e 56 mulheres, com média de idade de 65,7 anos. As veias eram coloridas com hematoxilina-eosina. O grau de hiperplasia interna e hipertrofia das camadas musculares longitudinais e circulares do meio era analisado. A qualidade da veia era classificada através da adição dos graus de cada camada considerada boa, regular e questionável.

Resultados: Com relação à qualidade, 82 veias (57%) foram classificadas como tendo boa qualidade, 49 (34%) apresentaram qualidade regular e 13 (9%) qualidade questionável. Em seis meses, a patência primária das veias de boa qualidade foi de 80,5%; a patência das veias de qualidade regular foi de 79,6% e das veias de qualidade questionável foi de 84,6%.

Conclusão: Não foi encontrada diferença na qualidade das veias, tanto na avaliação individual de cada camada quanto na avaliação global das três camadas, considerando-se o sexo e a idade do paciente. Não foi observada diferença com relação à patência dos enxertos.

Palavras-chave: veia safena, membros inferiores, enxertos.

Over the past fifty years, the greater saphenous veins have been used as arterial graft. It is an easily obtained and inexpensive graft. The diameter, length and wall of greater saphenous veins are satisfactory, and also resistant to infections. However, in some circumstances, the surgeon cannot find adequate grafting conditions due to diameter alterations, total or segmental

occlusion or varicose dilatation. The decision on which vein to use as a graft is a personal choice, and this is done by visually evaluating the vein, during the procedure, and determining its quality and possibility of use, without any scientific criteria. At other times, depending on the recipient arteries, the greater saphenous vein is the only available graft option, despite its quality. An inadequate greater saphenous vein is considered a significant contributing factor for early graft failure, possibly associated with limb loss. The histopathological analysis of the greater saphenous veins used as arterial grafts aims at providing a reliable criterion to the surgeon about the quality of the graft, mainly regarding the follow-up and prognosis of revascularization.

The aims of this study are to 1) analyze the quality of the greater saphenous veins used as arterial grafts by a semiquantitative histopathological method; 2) evaluate the influence of the greater saphenous vein quality in the early patency of arterial grafts; 3) compare the patient's sex and age with the quality of the greater saphenous veins.

Method

A total of 144 greater saphenous veins used as arterial grafts in the lower limb revascularizations of 144 patients were analyzed. There were 88 males (61.1%) and 56 females (38.9%), with a mean age of 65.7 years. The mean age for males was 65.4 years, lower than the mean age for females of 67.1 years.

The inclusion criteria were the following:

– The patients were submitted to infrainguinal lower limb revascularization.

– All patients agreed to the study design.

– The surgical indications were atherosclerosis, popliteal artery aneurysm, or femoropopliteal prosthesis infection.

– The revascularization was performed with venous grafts.

– The venous graft was the greater saphenous vein.

– At least one centimeter of the distal portion of the greater saphenous vein was submitted to histopathological evaluation.

– The patients were followed for at least six months postoperatively.

At the end of a lower limb revascularization with the use of a greater saphenous vein graft, a circular segment of at least one centimeter in length, taken from the distal portion of the graft, was sent to histopathological study. The vein was stained with hematoxylin-eosin. The evaluation was based on the venous layers, according to the criteria proposed by Milroy et al.[1] The degree of intimal hyperplasia and hypertrophy of the longitudinal and circular muscular layers of the media was analyzed. Each of the three layers was classified into three degrees, according to its alterations: I – minimal, II – moderate, III – severe. The inclusion criteria for each layer are given in Table 1. A grade was given to each degree: Grade I – one point; Grade II – two points; Grade III – three points. The score of each greater saphenous vein varied from three to nine. The quality of the vein was classified by adding the grades of each layer: good quality – up to three points, regular quality – four or five points, questionable quality – six points or higher.

Table 1 -   Histopathological grading and scoring of the greater saphenous vein layers

Grade	Evaluation	%	Score
I	Mild	1-24	1
II	Moderate	25-50	2
III	Severe	51-100	3

The patients were distributed into three groups according to their age: 46 to 59 years, 60 to 69 years and 70 to 88 years, as shown in Table 2.

Table 2 -   Patient distribution according to sex and age

Age (years)	Male	Female	Total	%
46-59	29	13	42	29.2
60-69	33	13	46	31.9
70-88	26	30	56	38.8

The grades were compared with the patient's sex and age, as well as with the early patency of the grafts, which was defined as six months postoperatively.

The statistical analysis was performed by the chi-squared test. The analysis of variance was used for comparison of the means. The alpha error was established at 5% to reject the null hypothesis.

Results

The length of the distal portion of the greater saphenous vein sent to histopathological study varied from 1 to 6 cm (mean of 2.4 cm). The veins had a mean diameter of 3.81 mm varying from 2 to 7 mm.

Most of the greater saphenous veins evaluated (57%) were classified as good quality (up to three points), 34% as regular quality (four or five points) and 9% as questionable quality (six points or higher). This distribution is shown in Table 3.

Table 3 - Quality of greater saphenous vein in 144 analyses

Quality	n. of veins	%
Good	82	57
Regular	49	34
Questionable	13	9

Examples of the histopathology of the greater saphenous veins are shown in Figures 1 to 3.

There were no differences among the three groups as far as the quality of the greater saphenous veins and associated diseases, surgical indication, drainage, surgical method, and donor and recipient arteries were concerned. The most frequently associated disease was systemic arterial hypertension, followed by diabetes mellitus and heart diseases (Table 4).
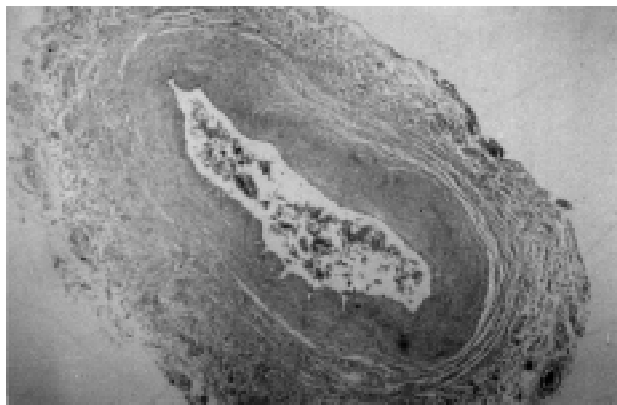

Figure 1 - Greater saphenous vein with intimal and circular muscular layers degree I and longitudinal muscular layer degree II (hematoxylin-eosin x 40).
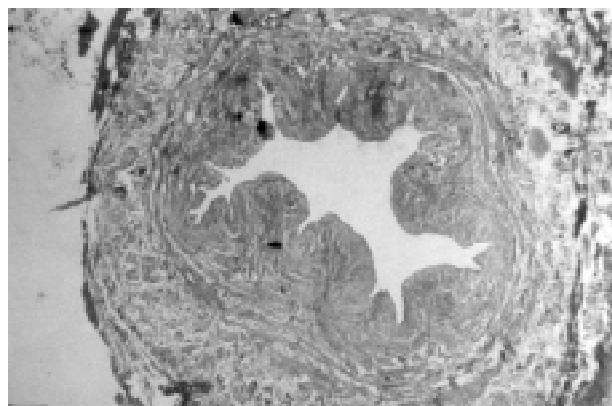

Figure 2 - Greater saphenous vein with intimal and longitudinal muscular layers degree III and circular muscular layer degree II (hematoxylin-eosin x 40).
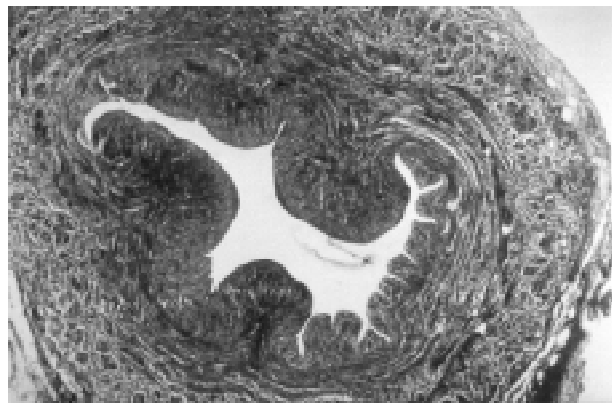

Figure 3 - Greater saphenous vein with intimal layer degree III (hematoxylin-eosin x 40).

Table 4 - Associated diseases*

Disease	n. of patients
Hypertension	92
Diabetes mellitus	70
Heart disease	54
Cerebrovascular disease	27
Chronic obstructive pulmonary disease	14
Peptic ulcer	10
Chronic renal failure	4
Abdominal aortic aneurysm	4
Diverticulitis	1
Paget's disease	1
Multiple sclerosis	1
Parkinson's disease	1

*70 patients had more than one associated disease

The indication for surgical treatment according to the clinical categories of SVS/ISCVS[2] is given in Table 5. Most of the patients were operated on due to limb loss risk (categories 4 and 5). In only three patients the surgical indication resulted from disabling intermittent claudication.

Table 5 -   Indication of surgical treatment according to the clinical categories of SVS/ISCVS

Indication	Categories	n	%
Tissue loss	5	110	76.4
Rest pain	4	25	17.3
Popliteal artery aneurysm	–	5	3.5
Intermittent claudication	3	3	2.1
Prosthesis infection	–	1	0.7

A variety of surgical methods were performed depending on the combinations between the graft and donor and recipient arteries (Table 6). The femoral artery was the donor artery in 135 cases, corresponding to 58 common femoral, 35 superficial femoral and 42 deep femoral. The popliteal artery was the donor at the remaining grafts with four proximal anastomoses above and five below the knee. The popliteal artery was the graft recipient site in 80 cases, with 21 anastomoses above and 49 below the knee. The other recipient arteries in order of frequency were: 27 peroneal, 15 anterior tibial, 14 posterior tibial, seven tibioperoneal trunk and one superficial femoral. In the 80 cases in which the popliteal artery was the recipient, three were in isolated segment. In two distal bypasses an arteriovenous fistula was associated.

Table 7 shows the runoff in each case, that is, the number of patent arteries in each limb to be revascularized. Three limbs did not have any patent artery in the leg being revascularized in an isolated segment of the popliteal artery.

Table 8 exhibits the percentages of patent distal artery. The peroneal artery presented the highest patency rate: 78.5%, representing 113 patent arteries in 144 limbs analyzed, statistically significant compared to the posterior and anterior tibial patency.

Table 6 -   Surgeries performed in 144 patients

Bypass	n. of patients
Femoropopliteal	79
Femoroperoneal	24
Femoro-posterior tibial	13
Femoro-anterior tibial	12
Femoro-tibioperoneal trunk	6
Popliteal-peroneal	3
Popliteal-anterior tibial	3
Femoro-superficial femoral	1
Popliteal-tibioperoneal trunk	1
Popliteal-posterior tibial	1
Popliteal-popliteal	1

Table 7 -   Number of patent distal arteries in 144 limbs

Patent arteries	Limbs	%
0	3	2.1
1	55	38.1
2	43	29.9
3	43	29.9

Table 8 - Patency of leg arteries in 144 limbs

Artery	Patent	%
Peroneal	113	78.5
Posterior tibial	80	55.6
Anterior tibial	77	53.5

$P < 0.01$

Table 9 shows the method of greater saphenous vein utilization in each lower limb revascularization. There was equal utilization of reversed and *in situ* methods despite the author's preference for the *in situ* utilization.

Table 9 -   Utilization of the greater saphenous vein in 144 infrainguinal revascularizations

Method	Grafts	%
In situ	68	47.2
Reversed	68	47.2
Ex situ	6	4.2
Combined	2	1.4

Table 10 exhibits the frequency of smoking according to sex, showing a predominance in males.

Table 10 - Frequency of smoking according to patient's sex

Sex	Patients	Smoking	%
Male	88	83	94.3
Female	56	32	57.1
Total	144	115	79.9

P < 0.01

The relation between vein quality and sex is shown in Table 11, with no statistically significant difference being observed.

Table 11 - Quality of greater saphenous vein according to patient's sex

	Good		Regular		Questionable	
	Veins	%	Veins	%	Veins	%
Male	48	54.6	32	36.4	8	9.0
Female	34	60.7	17	30.4	5	8.9

P > 0.05

No statistically significant difference was seen regarding vein quality and patient's age, which shows that the deterioration of the histological quality of the veins is not related to the advance of age (Table 12).

Table 12 - Quality of greater saphenous vein according to patient's age (years)

	Good		Regular		Questionable	
	Veins	%	Veins	%	Veins	%
46-59	27	64.3	11	26.2	4	9.5
60-69	25	54.3	20	43.5	1	2.2
70-88	30	53.6	18	32.1	8	14.3
Total	82	57.0	49	34.0	13	9.0

P > 0.05

Table 13 analyzes the primary patency of arterial grafts according to vein quality. In this study, we did not find any difference between the early patency of the graft and the histopathological quality of the greater saphenous vein, considering that the veins of questionable quality have had similar early patency rates compared with the veins of good and regular quality.

Table 13 - Relation between early patency of the graft and quality of the greater saphenous vein

	Patent		Occluded	
	Grafts	%	Grafts	%
Good	66	80.5	16	19.5
Regular	39	79.6	10	20.4
Questionable	11	84.6	2	15.4

P > 0.05

Discussion

The indications for lower limb revascularization can be divided into two groups: absolute and relative. There is a consensus in the literature about absolute indications; they are performed in cases of limb salvage, corresponding to tissue loss and rest pain. Concerning relative indications, divergent opinions and procedures are seen in literature, this group comprises patients with intermittent claudication and progressive claudication. In the former one, the patient has limitations only in his home environment and, in the latter, the patient presents with gradual reduction of walking distance despite clinical intervention. Both are accepted as surgical indication in the vascular surgery literature, in contrast to intermittent claudication, which limits professional activity or brings about change in lifestyle, and has some restrictions on surgical indications.[2] In this study, the surgical indication for intermittent claudication was limited to those patients with gradual deterioration of walking distance despite clinical treatment, corresponding to 2.1%. Surgical indication was not restricted by the literature in 97.9% of the cases: tissue loss, rest pain, popliteal artery aneurysm and prosthesis infection.

The associated diseases were evenly distributed as far as the patient's sex and age were concerned, especially

in diabetics who have a higher risk for graft failure due to the increase of peripheral vascular resistance.[3] However, the revascularization outcome in diabetic patients can be the same as in non-diabetic patients, even in grade 5 of SVS/ISCVS classification and in distal grafts.[4] The outcome of paramalleolar grafts can be even higher in diabetics,[5] considering that the peripheral vascular resistance is not an isolated factor in the outcome of distal revascularizations.[6]

The frequency of smoking presented itself as the only difference between groups, and was higher among males. Smoking is an important risk factor for obliterative atherosclerosis,[7] and is also related to the increased development of intimal hyperplasia after vascular injury.[8] Smoking cessation improves arterial insufficiency in claudicant patients, increasing the walking distance and decreasing the progression of atherosclerotic disease after lower limb revascularization.[9]

Besides the quality of distal arteries, another important factor concerns the graft material and its availability relative to autogenous graft. In this study, the number and types of patent arteries were equally distributed among all groups. The peroneal artery was the least involved by atherosclerotic disease.

Autogenous grafts are known as the best material for lower limb revascularizations. They have been used for 50 years,[10] most of which correspond to greater saphenous vein used *in situ*, reversed or *ex situ*.

With regard to the quality of the greater saphenous vein, the veins with long or segmental occlusions are initially discarded. Those partially occluded veins are used in composite grafts. The vein diameter is also considered an exclusion criterion. Before the popularization among vascular surgeons of the *in situ* utilization of the greater saphenous vein,[11] veins with a diameter lower than 4 mm were discarded. However, with the *in situ* utilization, veins with a diameter of 2 mm or more can be used. In this study, the average diameter of the distal portion of the vein was 3.81 mm, varying from 2 to 7 mm. Dilatations are also an exclusion criterion for the use of greater saphenous vein, especially when they involve multiple segments. An isolated dilatation can be removed and the remaining segments can be anastomosed and used on the revascularization. Dilated veins can also be covered in bovine pericardium, which works as an external support.[12]

The greater saphenous vein can be classified according to a semiquantitative histopathological method.[1] The degree of intimal hyperplasia and hypertrophy of the longitudinal and circular muscular layers of the media are classified into: I – minimal, II – moderate, III – severe. A grade is given to each degree: Grade I – one point, Grade II – two points, Grade III – three points. By adding the grades given to each layer, the vein quality is classified into: good – up to three points, regular – four or five points, questionable – six points or higher. Most of the greater saphenous veins evaluated (57%) were classified as good quality, 34% as regular quality and 9% as questionable quality.

Concerning the relation between vein quality and patient's sex, no significant difference was observed probably because the clear presence of varicose veins, which are more frequently found in women. These veins have not been used (in case of focal dilatation, the greater saphenous vein has been covered with bovine pericardium), showing that women who develop arterial disease with no varicose saphenous vein due to multiple pregnancies or hormonal alterations,[13] have greater saphenous vein of similar quality to men's.

It is classically admitted that the quality of the greater saphenous vein decreases with age, however, in this study no significant difference was observed among age groups, from 46 to 88 years, which suggests further similar evaluations in younger groups in order to determine the period of life in which this decrease occurs.

In this study, the authors did not find difference between the early patency of the graft and the histopathological quality of the greater saphenous vein. The veins of questionable quality have shown similar early patency rates compared with the veins of good and regular quality, showing that the quality of the greater saphenous vein is not an isolated factor in early patency rates of arterial grafts. These results have led the authors to continue the follow-up of the patients submitted to lower limb revascularizations with veins of questionable quality in a specific protocol.

Early graft failure results from an association of multiple factors including surgical indication; (in this study 67% of the patients have already had trophic lesions, and the failure rate is higher in limb salvage patients); the quality of proximal and distal bed; and the patient's clinical status, mainly in the immediate postoperative period.

All revascularizations were performed in this series with different combinations between donor and

recipient arteries. In three cases, revascularization was done in an isolated segment of the popliteal artery and, in two cases, an arteriovenous fistula with common "ostia" was associated. An equal number of *in situ* and reversed greater saphenous vein revascularizations were performed, despite the author's preference for the *in situ* technique. However, when the reversed vein was used, the results were similar. With the introduction of angioscopic valvulotomy, the *in situ* technique will be performed in a larger number of patients. In a few cases, nonreversed greater saphenous vein was used *ex situ* due to the diameter discrepancy of the recipient artery. In this study, only two cases required the use of contralateral greater saphenous vein segment as a complementary conduit. Composite grafts with another vein, except the greater saphenous vein, were excluded.

The conclusions of this study were that most of the greater saphenous veins used as arterial grafts have acceptable quality (good or regular); there is no relation between the greater saphenous vein quality and patient's sex; the quality of the greater saphenous vein does not change with age; the histopathological quality of the greater saphenous vein is not an isolated factor for the early patency of arterial grafts.

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