Denatured Venous Homograft as an Arterial Substitute in Civilian Vascular Injuries. Thirty Months' Experience

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Objectives: Autologous saphenous vein (ASV) for arterial reconstruction, in vascular limb injuries is the graft material of choice. Denatured saphenous vein homograft (DSVH), thanks to its characteristics of readily available autologous biological prosthesis, has been proposed as alternative. We report our prospective experience with DSVH employed for arterial reconstruction in civilian limb vascular injuries.

Materials: From January 1994 to June 1996, DSVH was implanted in 16 male patients (pts.) treated for arterial civilian injuries of eight upper limbs and eight lower limbs.

Methods: In 14 cases it was performed as an interposition graft and in two cases a bypass. We performed a 30-month follow-up and a 20-month mean follow-up.

Results: Four patients had graft thrombosis at the first postoperative week and were submitted to the replacement of the graft with reappearance of distal arterial pulse; one of them had graft failure at the fifth postoperative week and because of the necrosis due to extensive soft tissue damage, he was submitted to limb amputation.

After 30-months' follow-up we obtained 75% primary patency rate and 93% secondary patency rate.

Conclusions: In the absence of suitable ASV, DSVH appears to be an interesting alternative for arterial repair in limbs in civilian vascular injuries.

Key Words: Venous homograft; Arterial trauma; Biogenic graft; Arterial reconstruction.

Introduction

Vascular trauma is a major source of morbidity and mortality. Significant limb loss occurs after injuries to peripheral vessels, with an amputation rate of 13% reported in Vietnam and 1–28% reported in civilian experience, this rate changing as a function of lesion complexity.1-3

The successful management of peripheral arterial injury requires expeditious diagnosis and treatment. Conventional wisdom dictates that autogenous vein interposition be used, when direct repair is not feasible, because of higher resistance to potential contaminations.4,5

However, there are certain conditions in which employment of autogenous veins for arterial repair is difficult or even impossible. These are: (a) patients with critical vascular injuries threatening either life, organ or limb and in whom ready arterial flow restitution is imperative; (b) small diameter of available autogenous vein; (c) extensive tissue destruction, involving autogenous veins; (d) sparing of autogenous vein capital for further uses.6

Thanks to a search for suitable alternatives, since 1980, a new vascular graft, namely a homologous saphenous vein denatured for at least 6 weeks at a temperature of 4 °C, has been available.7

This report will detail our experience, including careful follow-up and evaluation of the use of DSVH for arterial repair in limbs in civilian vascular injuries.

Materials and Methods

From January 1994 to June 1996, we admitted in our institution 43 patients with civilian vascular injuries of the limbs.

We employed DSVH for arterial reconstruction of 16 male patients. The age ranged from 16 to 79 years (mean age: 42 years). Eight patients with upper limbs injuries had six brachial lesions, one axillary lesion and one radial lesion. The remaining eight patients with lower limbs injuries had five popliteal lesions and three superficial femoral lesions.

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Regarding the criteria of inclusion, three patients had haemorrhagic shock, four patients had non-suitable capital vein and in nine patients it was imperative to re-establish arterial flow, because of the critical general and/or local clinical conditions.

One patient had an injury secondary to a shotgun wound, six patients had an injury due to a stab wound and nine patients sustained a blunt trauma.

The mean delay of ischaemia was 8 h.

Regarding the clinical severity of limb ischaemia, we classified the patients according to the “SVS’/ISCVS ad hoc Committee for standards for lower extremity”. One patient had a “viable” limb and 15 patients had “threatened viable” limbs.

Eight patients had associated venous injuries: one brachial, one common femoral and one superficial femoral were repaired by lateral venorrhaphy; one brachial and one superficial femoral were ligated; one brachial was repaired by debridement and end-to-end anastomosis; in one patient it was performed as a 10 cm DSVH interposition at the articular popliteal vein level and in one patient it was performed as a 5 cm DSVH interposition between cephalic vein and axillary vein after brachial vein ligation.

Four patients had simultaneous orthopaedic skeletal treatment: two external fixation of the thigh-bone, one external fixation of the tibia and one internal fixation of the tibia. In these patients arterial reconstruction always had priority.

Five patients had nerve lesions treated by neurorrhaphy.

Two limbs required simultaneous fasciotomies through medial and lateral incisions.

Nine patients were submitted to preoperative arteriography, that showed arterial disruption or occlusion. At the surgery we noted the following arterial findings: three thrombosis, 10 transections, five intimal lesions and three disruptions.

In 14 patients we performed an interposition graft (one axillary, five brachial, two radial, two superficial femoral and four popliteal) and in two patients a superficial femoral-popliteal by-pass, underwent surgical revision for graft thrombosis due to post-traumatic arterial intimal damage not detected by visual inspection and left inside in three cases, and an anastomotic stenosis in one case, with reappearance of distal arterial pulse. At the surgical revision of the thrombosis of the superficial femoral-popliteal below-knee bypass, we noted the occlusion of the DSVH popliteal vein interposition, performed at the same time as the arterial reconstruction, and it was treated by venous thrombectomy with flow restitution. We obtained 75% primary arterial patency rate at 30 months (Table 1).

At the fifth postoperative week we had reocclusion of the superficial femoral-popliteal bypass and popliteal vein DSVH interposition, because of gangrene following the extensive soft tissue damage, complicated by infection and haemorrhage due to leaking from proximal anastomosis. This patient was submitted to major amputation.

The secondary patency rate at 30 months was 93% (Table 2).

DSVH interposition employed in axillary vein reconstruction resulted patent at the 30 months control. Two patients with superficial femoral interposition graft had superficial wound infection and one patient with superficial femoral-popliteal below-knee bypass had deep infection of the wound, involving the vascular prosthesis, complicating the extensive soft tissue damage. The wound infection rate was 19% and graft infection rate 6%.

Results

During the first postoperative week, one patient with brachial interposition graft, two patients with popliteal interposition graft and one patient with superficial femoral-popliteal below-knee bypass, underwent surgical revision for graft thrombosis due to post-traumatic arterial intimal damage not detected by visual inspection and left inside in three cases, and an anastomotic stenosis in one case, with reappearance of distal arterial pulse. At the surgical revision of the thrombosis of the superficial femoral-popliteal below-knee bypass, we noted the occlusion of the DSVH popliteal vein interposition, performed at the same time as the arterial reconstruction, and it was treated by venous thrombectomy with flow restitution. We obtained 75% primary arterial patency rate at 30 months (Table 1).

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Table 1. Primary patency rate.

<table>
<thead>
<tr>
<th>Interval (months)</th>
<th>Graft at risk</th>
<th>Failed graft</th>
<th>Withdrawn</th>
<th>Patency Interval</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>16</td>
<td>4</td>
<td>0</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>1-6</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>6-12</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>12-18</td>
<td>11</td>
<td>0</td>
<td>3</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>18-24</td>
<td>8</td>
<td>0</td>
<td>6</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>24-30</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>100%</td>
<td>75%</td>
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Table 2. Secondary patency rate.

<table>
<thead>
<tr>
<th>Interval (months)</th>
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<th>Failed graft</th>
<th>Withdrawn</th>
<th>Patency Interval</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>1-6</td>
<td>16</td>
<td>1</td>
<td>0</td>
<td>93%</td>
<td>93%</td>
</tr>
<tr>
<td>6-12</td>
<td>15</td>
<td>0</td>
<td>1</td>
<td>100%</td>
<td>93%</td>
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<tr>
<td>12-18</td>
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<td>0</td>
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<td>11</td>
<td>0</td>
<td>6</td>
<td>100%</td>
<td>93%</td>
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<tr>
<td>24-30</td>
<td>5</td>
<td>0</td>
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<td>100%</td>
<td>93%</td>
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</table>

Table 3. Postoperative complications.

<table>
<thead>
<tr>
<th>Complication</th>
<th>Count</th>
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<tbody>
<tr>
<td>Wound infection</td>
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</tr>
<tr>
<td>Homograft infection</td>
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</tr>
<tr>
<td>Aneurysm</td>
<td>0</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>5</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>Amputation</td>
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</tr>
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</table>

Fibrotic or aneurysmal degeneration of the graft was not observed during the follow-up (Table 3).

Discussion

ASV is generally considered the graft material of choice in peripheral vascular reconstructions. Conventional wisdom dictates the employment of autologous vein, moreover in peripheral ischaemia due to a trauma, because of the probability of wound contamination.

In the search for suitable alternatives, some authors evaluated the employment of synthetic vascular graft, reporting variable results as function of type of trauma, extension of soft tissue damage, anatomic area involved and calibre of damaged arteries.

An alternative source of autologous vein, such as contralateral saphenous vein or arm veins, were proposed for revascularisation of chronic limb ischaemia in the absence of adequate ipsilateral greater saphenous vein, but in some injured patients these veins are not available because they are involved in soft tissue damage, or because of the general and/or local critical conditions imposed to avoid time-consuming harvesting of the vein, or because the greater saphenous vein has a small diameter for implanting.

In these last years there was a renewed interest in arterial allograft. The employment of this graft in infrageniculate position in patients with critical limb ischaemia showed 46% primary patency rate and 50% secondary patency rate at 30 months.

Thanks to the search for suitable autologous vein alternatives, since 1980 a new vascular graft, namely a homologous vein denatured for at least 6 weeks at a temperature of 4 °C, has been available. This graft is made by segments of non-varicose saphenous vein, harvested after stripping. The best samples are collected aseptically in vials containing 2 g of Chloramphenicol per 100 ml of isotonic solution. No ABO blood group match or HL-A leucocyte typing is performed. Initially it was used for secondary access surgery.

The main characteristics of this graft material is to be biological, with related advantages in potentially contaminated tissue, and to be readily available in many sizes and lengths.

Some authors reported their experience about employment of DSVH in arterial revascularisation of chronic limb ischaemia, with varying results.

Van Reedt Dortland et al. employed DSVH in 156 femorodistal arterial reconstructions, obtaining 53% 5-year overall cumulative patency rate in patients with disabling claudication and 68.4% in patients with critical limb ischaemia.
Van Damne et al. revascularised 12 critical limb ischaemia patients, obtaining 50% patency rate at 1 year. There are no reports in literature concerning the use of DSVH in arterial reconstruction of limb injuries.

During a period of 30 months we implanted DSVH in eight patients with arterial injuries of superior limbs and eight patients with arterial injuries of inferior limbs, obtaining 75% primary patency rate at 30 months and 93% secondary patency rate (Fig. 1).

Van Reedt Dortland reported 10% aneurysm rate during 53 months’ follow-up in 176 denatured homologous vein grafts used for access in the arm, in patients with chronic haemodialysis. The same author obtained 15% cumulative aneurysm rate after 3 years and 50% cumulative aneurysm rate after 5 years, in 156 femorodistal arterial reconstructions for atherosclerotic disease.

Sciaccia et al. reported 14% aneurysm rate in 21 patients submitted to lower limb revascularisation with homologous vein graft for chronic ischaemia.

The best results obtained in our experience concerning the patency and the absence of prosthetic degeneration could be explained because the injury usually acts on a limited length of artery, and requires a short segment of graft for revascularisation (Fig. 2).

DSVH was also used in two patients with associated venous lesions. One patient with a popliteal artery lesion sustained a contemporary popliteal vein DSVH interposition that thrombosed after the first postoperative week. This patient was submitted to major amputation at the fifth postoperative week because of gangrene of the limb. The other patient had an axillary DSVH interposition, which was patent after 30 months.

Our isolated experience with DSVH in venous reconstruction does not enable us to make any conclusion, but we can observe that the characteristics of good compliance of the vein-homograft wall could be an aspect of interest in the reconstruction of the venous circulation, which is characterised by slow flow.

Wound infections are one of the most dangerous postoperative complications affecting arterial reconstructions in 1–13% of cases, as a function of graft material employed, arterial reconstruction technique and associated diseases. Wound infection rate grows from 5–56% in post-traumatic arterial injuries reconstructions because of the contamination, the extensive soft tissue damage and the associated lesions.

In our experience, three patients (18.5%) had infection of the wound. Two patients (12.5%) had superficial infection and one patient (6%) had deep infection of the wound with extension to the vascular graft, followed by haemorrhage from the proximal anastomosis. These are encouraging results for the employment of biological vascular graft material in potentially contaminated post-traumatic arterial reconstructions.

Our results, although obtained from a limited number of patients, suggest that DSVH could be considered as an alternative graft material in arterial reconstruction of arterial limb injuries when ASV is not available, or when, because of the critical general and/or local clinical conditions, there is not the time for harvesting the homologous vein, or when, because of the type and magnitude of the trauma, a biological graft material is preferred in the aim of more resistance to potential contaminations.
Larger series of patients and longer follow-up have to be gained in order to validate our results and to define preservation characteristics, immunological interactions and clinical use of this conduit.

Acknowledgement

The authors wish to thank Mrs Katia Tomei for her support in preparing the manuscript for this report.

References


Accepted 4 November 1997

Eur J Vasc Endovasc Surg Vol 15, June 1998