

Continuous Graft Perfusion: Optimizing the Quality of Saphenous Vein Grafts

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ABSTRACT

Background: Healthy unaltered vascular endothelium in graft material is a prerequisite for a successful CABG operation. Damage done to the endothelium during vein harvest is responsible for an early graft occlusion rate of 20% in the first year after operation. Minimally invasive vein harvesting is regarded to minimize the damage done to the Endothelium. We compared minimally invasive vein harvesting with conventional vein harvesting and studied the influence of a continuous perfusion of the veins with patient autologous blood on their endothelial integrity.

Methods: 80 patients were randomly split into 4 groups: Group 1: Conventional vein harvest and storage of the vein in a crystalloid solution before usage. Group 2: Endoscopic vein harvest and storage in cristalloid solution. Group 3: Conventional harvest under continuous perfusion of the vein with 100 ml blood via the heart lung machine. Group 4: Endoscopic vein harvest under continuous perfusion. Immediately prior to the first peripheral anastomosis a sample was taken from each graft and evaluated by scanning electron microscopy. The endothelial integrity was rated in 5 categories (from “completely confluent endothelium” (1) to “no endothelium” (5)).

Results: Group 1: 2.7±1.13

Group 2: 2.2±1.06

Group 3: 1.6±0.68

Group 4: 1.6±0.69

Conclusion: In regard to the endothelial integrity endoscopic vein harvesting is superior to conventional vein harvest. If the grafts are harvested while continuously perfused with blood there is no more difference between the groups. Considering the well known additional benefits such as reduction in wound healing disorders endoscopic vein harvesting appears to be the preferable technique.

INTRODUCTION

Autologous saphenous veins and autologous mammary arteries are the grafts of choice for aortocoronary bypass grafting [Loop 1986, Motwani 1998]. The structural integrity of these grafts at the time of implantation is a prerequisite for a successful operation [Verrier 1996]. It is a well known fact that the antithromogenic properties of healthy vascular endothelium of autologous grafts prevent early graft thrombosis [Zilla 1993, Lamm 2000]. Damage done to the endothelium during harvest and intraoperative storage is thought to be of prime importance for an early saphenous vein graft occlusion rate of nearly 20% within the first year after surgery [Bourassa 1991, Cox 1991]. Although endoscopic vein harvesting (EVH) is considered to minimize the damage done to the endothelium [Fitzgibbon 1996] we could not verify this in previous ultrastructural studies (presented at ISMICS 2000). Scanning electron microscopy of tissue samples from veins which were harvested endoscopically or in a traditional technique (TVH) revealed that the endothelial integrity was mainly dependant on the surgeons' experience in vein harvesting. Only after a learning curve a experienced surgeon was able to achieve better results with EVH than with TVH. In addition we noticed that macroscopically visible blood clots were occasionally detectable in veins after EVH in contrast to after traditional vein harvesting (TVH) where blood clots were not visible.

In order to improve the quality of saphenous vein grafts we performed a study to evaluate the influence of a continous perfusion of the saphenous veins with patients' own blood during vein harvesting.

MATERIALS AND METHODS

Patients:

The study was done with written informed consent of the patients. 80 patients, who required besides arterial grafts at least 1 venous graft in an aortocoronary bypass operation were randomly split into 4 groups:

Group 1: TVH and intraoperative storage of the veins in Bretschneider cardioplegic solution before usage (20 patients).

- Group 2: EVH and intraoperative storage of the veins in Bretschneider cardioplegic solution before usage (20 patients).
- Group 3: TVH under continuous perfusion of the veins with 100 – 150 ml autologous blood/min via the heart-lung-machine. No intraoperative vein storage (20 patients).
- Group 4: EVH under continuous perfusion of the veins with 100 – 150 ml autologous blood/min via the heart-lung-machine. No intraoperative vein storage (20 patients).

Operation technique

After sternotomy was performed, 10000 I.E. Heparin were administered intravenously and a double stage catheter with a luer lock adapter was inserted into the right atrium/V. cava inferior. A vessel canula with luer lock was inserted in the distal end of the long saphenous vein. A blood circuit from the heart to the distal end of the long saphenous vein was established via the luer lock adapters using a roller pump for continuous perfusion of the vein during vein harvest (Figure 1). Vein harvesting only started after the onset of the continuous perfusion to prevent any collapse of the vein during harvest. The lengths of the veins needed for bypass grafting was determined by measuring it on the beating heart using a thick suture as a bypass substitute. After measuring an adequate piece of the long saphenous vein, it was then resected and used for bypass grafting. The vessel canula at the distal vein end was reinserted thereafter in the new distal end of the long saphenous vein to enable further perfusion of the vein. In EVH small additional incisions were necessary to reinsert the canules. The veins were only resected at the time they were needed for bypass grafting.

Histologic evaluations

Immediately prior to the first central anastomosis a vein sample was taken from each graft for scanning electron microscopic evaluations of the endothelial integrity of the inner graft surface. The endothelial integrity was rated by the following score system by three examiners.

Score System

The score system for the description of the endothelial damage [Fischlein 1994] was:

1. completely confluent endothelium.
2. partially confluent endothelium.
3. loosely netted endothelium.

4. islands of endothelium.
5. no endothelium.

Statistical Analysis

Results are presented as the mean \pm the standard *deviation*. The Mann-Whitney test was used to analyze differences between groups. A *p* value of less than 0.05 was considered significant.

RESULTS

It was possible to establish the blood circuit for the continuous vein perfusion in all patients easily and to maintain the required blood flow.

Scores:

Group 1:	2.7 \pm 1.13
Group 2:	2.2 \pm 1.06
Group 3:	1.6 \pm 0.68
Group 4:	1.6 \pm 0.69

Unperfused veins demonstrated partially confluent endothelium independent of TVH or EVH (Figure 2a). Vein harvest using a continuous graft perfusion yielded a significant improvement ($p < 0.05$) of the endothelial integrity (Figure 2b). There was no difference in between TVH and EVH when continuous perfusion took place.

DISCUSSION

In regard to the endothelial integrity endoscopic vein harvesting seems to be superior to traditional vein harvesting. If the grafts are continuously perfused with patient autologous blood while harvested the quality of the respective grafts improves significantly independent of TVH or EVH. A possible explanation might be the prevention of a vein collapse due to the mechanical alterations by abandoning the risk of vein spasms. Whether or not this new technique is able to reduce the deleteriously high early graft occlusion rate of almost 20% can not be answered by our study since we did not perform control angiograms after the operation, although we would expect a reduction due to the improved preservation of the vascular endothelium of the veins.

Considering the well known additional benefits such as reduction of wound healing disorders and avoidance of cosmetically unsatisfying incisions EVH still appears to be the preferable technique [Hayward 1999].

In conclusion, a continuous perfusion of the saphenous vein during vein harvest and the subsequent avoidance of an intraoperative storage of the harvested veins helps to optimise the quality of saphenous vein grafts by reducing the damage done to the endothelium.

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Figure 1. Blood circuit for the continuous perfusion of long saphenous veins. (1) Right atrium; (2) venous double stage catheter with luer lock connector; (3) synthetic tube connecting the venous double stage catheter with the distal end of the long saphenous vein; (4) roller pump of the heart lung machine; (5) vessel canula with luer lock connector at the distal vein end; (6) long saphenous vein.

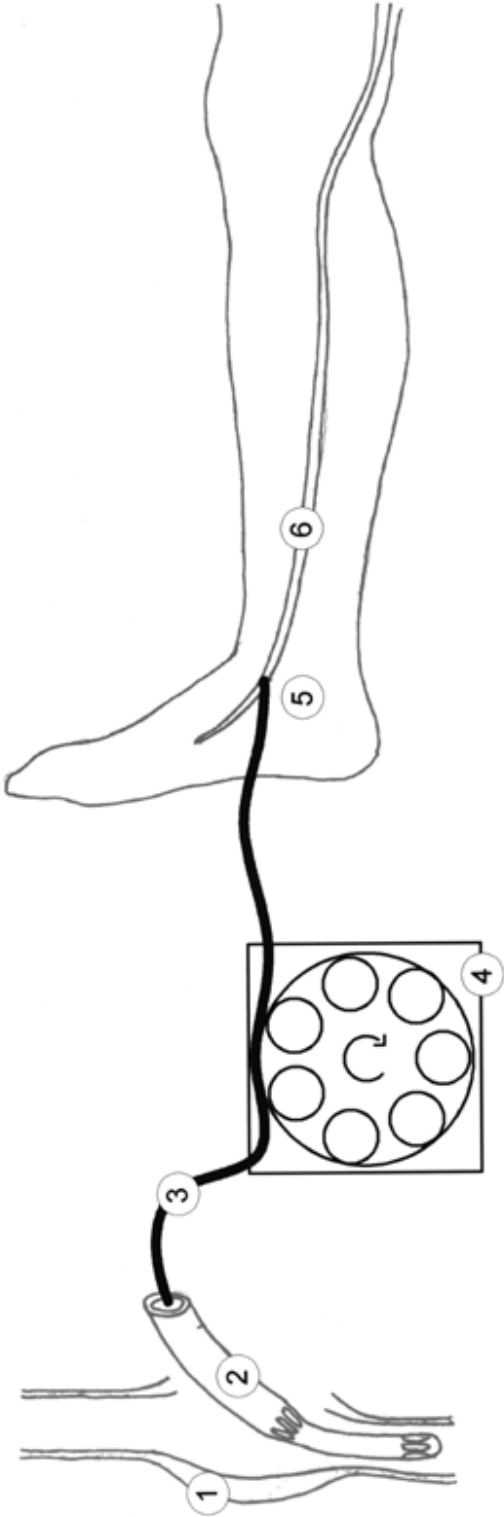


Figure 2. Scanning electron micrographs: a) Loosely netted endothelium after vein harvest without continuous perfusion (original magnification X 500); b) Completely confluent endothelium after vein harvest with continuous perfusion (original magnification X 1000).

