Transplantation of Unconserved Autologous and Cryoconserved Allogenic Vein with a Valve

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Morphofunctional properties of autologous unconserved and allogenic conserved vein implants were compared in dogs. After 14 months, 69.2% of autologous grafts and only 20% of conserved allografts remained functional. Histological examination revealed damage to all layers of the venous wall, although endothelial desquamation is the major factor of graft thrombosis. Histological manifestations of damage to allografts were more pronounced, which corresponds to the level of thrombosis. However, these changes are reversible, and if the passability of the graft is preserved during the early period after surgery, they have no effect on the graft in a remote period.

Key Words: *transplantation; cryoconservation; veins*

Autologous veins are the best material for vascular plasty and reconstruction [4]; they are usually used for arterial plasty. Sometimes autologous venous grafts are used in the treatment of chronic venous insufficiency [2,8,12,14]; however, morphofunctional properties of these venous grafts are poorly investigated.

The use of autologous vein is impossible in 15-30% cases (small diameter, thrombophlebitis, etc.) [5,15]. Therefore, allogenic vein grafts are of interest. Fresh autologous vein is immunogenic with high incidence of early thromboses [6,7,10]. Cryoconservation reduces immunogenicity [11,15], which accounts for encouraging experimental results in arterial plasty [1,9,13,16]. There is controversy over experimental and clinical data on the function of allogenic vein in the venous system.

MATERIALS AND METHODS

Two series of experiments were performed on 28 mongrel dogs (body weight 16-36 kg) of both sexes. In the first series (13 operations), a segment of jugular vein 3-4-cm long with a valve was anatomize end-to-end into the femoral vein. Before grafting, the segment was washed at room temperature with Eurocollins solution containing heparin. In the second series (15 operations), conserved allogenic jugular or femoral vein was grafted in the femoral vein. Cryoconservation was performed by the method [3]: vein segments were washed with Eurocollins solution and incubated in a cryoconservant consisting of Eurocollins, 15% dimethyl sulfoxide (DMSO), 2% albumin 1120 mg/liter, α-tocopherol, and 50 mg/liter cyclosporin. The DMSO concentration was raised at 4°C in a stepwise manner at 5% intervals. After a 45-min incubation, the vein was frozen at a rate of 1-3°C/min to -100°C and stored in liquid nitrogen and for 5 days—2 months. Before operation, the vein was thawed in a water bath and washed at 4°C in Eurocollins solution containing 5% DMSO, 600 mM mannitol, 50 mg/liter cyclosporin, and 370 mg/liter α-tocopherol with stepwise addition of the standard Eurocollins solution for 60 min until isotonicity.

RESULTS

Blood flow was preserved through 69.2% of unconserved autologous vein grafts. In all cases, throm-

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TABLE 1. The Number of Functional Autologous Unconserved and Allogenic Cryoconserved Vein Segments at Different Periods after Surgery

Observation period	Autologous grafts, %	Allogenic grafts, %
1 week	69.2	20
2 weeks	69.2	13.3
3 months	69.2	13.3
6 months	53.8	13.3
13 months	53.8	7.1

TABLE 2. Blood Flow Rate in Unconserved Vein Grafts and Cryoconserved Allogenic Vein Grafts (ml/min)

Observation period	Autologous grafts, %	Allogenic grafts, %
Immediately after surgery	74±18	88±9
After 1 month	106±16	—
3 months	104±19	—
6 months	—	86±11
13 months	115±14	—

boses occurred soon after bilateral transplantation, when autologous unconserved vein was grafted into one femoral artery and cryoconserved allogenic vein into the other. After this protocol had been replaced by unilateral transplantation, 100% grafts remained functionally normal. Presumably, the long procedure of bilateral transplantation and long postoperative sleep decreased blood flow rate through the graft, creating conditions for early thrombosis. Two cases of thrombosis were recorded 3 months after the surgery (Table 1). In other cases, when passability of the grafts was preserved within the first 2 weeks after surgery, their function remained stable throughout the entire observation period. Blood flow through the grafts was high and tended to increase in the remote period (Table 2). Retrograde phlebography performed in 7 dogs at different periods after the operation before dissecting of the graft for histological examination revealed consistency of venous valves in all cases.

In most cases after transplantation of cryoconserved grafts thrombosis of the allogenic vein developed within the first 2-6 days after the operation. Blood flow was preserved only in 3 out of 15 grafts (20%) within the first week, two grafts functioned for 6 months (one of them was dissected for histological studies), and one graft remained functional for 13 months.

Histological examination of autologous venous grafts dissected 1-2 weeks after surgery revealed focal desquamation of the endothelium, which was particularly pronounced at anastomoses, lymphomacrophagal infiltration predominantly around the sutures, and edema of the media with disintegration of the muscle bundles. Re-endothelization was observed by the end of the first months after the operation, infiltrates disappeared by the end of the third month, and the muscle bundles of the media were replaced by connective tissue. The number of *vasa vasorum* decreased after the operation and then gradually increased. Venous valves were epithelialized, slightly sclerotized, and deformed.

Five cryoconserved allogenic venous grafts were studied 2, 3, 9, 23 days, and 6 months after surgery. Massive endothelial desquamation was observed 2-3 days after surgery. Large amounts of hemosiderin were accumulated in vascular cells and extracellular space. Intramural hematomas were found in the subendothelial layer. The media was edematous with focal necroses varying in size and focal-diffuse lymphomacrophagal infiltration. The adventitial microvessels were plethoric with foci of diapedetic hemorrhages. Partial re-endothelialization and massive lymphohistiocytic infiltration of the entire vascular wall were observed after 9 days. Diffuse sclerosis occurred in the media. The number of adventitial *vasa vasorum* decreased. After 23 days, endothelial lining of the graft was completely restored, considerable accumulations of hemosiderin were seen in the intima, while the media was almost completely sclerotized. After 6 months, the endothelium and its basal membrane were preserved, the media was sclerotized and contained a small number of muscular bundles. There was no lymphohistiocytic infiltration of the vascular wall.

Thus, experimental studies have demonstrated a possibility of grafting autologous vein segments with the valve and functionality of the graft at remote periods. The development of early thromboses in this situation is probably determined by hemodynamics but not by the vascular wall damage caused by the operation. Pronounced damage to the vascular wall (endothelium and media) was observed after transplantation of cryoconserved allogenic vein segments. However, this damage is reversible and, if the passability of the graft is preserved at the early period after surgery, has no effect on remote results.

It is noteworthy that histological signs of rejection are weak in allogenic cryoconserved veins, and 2 allogenic grafts remained functional for 6 and 13 months without immunodepression. This may be due to the fact that cryoconservation reduces tissue immunogenicity [15] and the rejected donor elements are gradually replaced by the recipient tissues without any significant effect on the venous function.

Improved cryoconservation may open new prospects in the use of allogenic vein grafts.

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