Examination of the vasa vasorum of the human great saphenous vein: a scanning electron microscopy and 3D-morphometry study of microvascular corrosion casts

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"Vasa Vasorum" derives from Latin and literally means "vessels of the vessels", which describes their function of providing blood and oxygen to the vessel walls arteries and veins that, in turn, supply blood and oxygen to the rest of the body [1].

Hence the vasa vasorum is a system of small blood vessels that helps supplying large blood vessels, more precisely a network of small arterioles, venules and capillaries that supply the outer layers of large blood vessels [2,3].

The largest blood vessels in the body (e.g. the human great saphenous vein, the aorta, etc.) depend on this supporting network to maintain their health and function, therefore the vasa vasorum are an important part of the blood circulatory system [3,4].

The structure of the vasa vasorum varies first of all with the size as well as the function and location of the vessel. In the largest vessels it penetrates the tunica adventitia and the outer two third of the tunica media [5]. In smaller vessels the vasa vasorum infiltrates only the adventitia. There are no vasa vasorum in the smallest vessels, because diffusion is enough for nourishment.

The aim of this study is the examination of the vasa vasorum of the human great saphenous vein (HGSV) in normal and pathological (varicose) conditions. We try to explore the optimality principles (minimal lumen volume, minimal pumping power, minimal lumen surface, minimal endothelial shear force), which determine the design of the vasa vasorum of the human great saphenous vein using vascular corrosion casting (VCC), scanning electron microscopy (SEM) and 3D-morphometry. In order we have to calculate optimum vessel diameter and branching indexes of arterial, capillary and venous bifurcations.

Another purpose of the study is the improvement of the knowledge of venous diseases, respectively an insight into the mechanism which induces varicogenesis.

For this purpose we receive explanted segments of the HGSV, which were taken during their dissection for coronary bypass grafts or varicose vein segments, from the "Salzburger Landesklinikum" (SALK). The process of vascular corrosion casting starts with the dissection of the feeding artery from the surrounding tissue under a dissecting microscope, which is then cannulated with a glass cannula (gauge ~80µm).

Prior the injection of "Mercox-Cl-2B", the vasa vasorum network has to be rinsed with saline using an automatic infusion pump (flow rate is about 7ml/hr). After polymerisation the specimen is macerated with 7.5% potassium hydroxide for the removal of all organic material. Thereafter the cast is rinsed with distilled water for several times and frozen in distilled water. The ice-embedded cast is freeze-dried and then mounted on a stub using the "conductive bridge method" (Lametschwandtner et al. 1980). After sputtering with gold and examination under the scanning electron microscope (SEM), 3D-morphometry is performed (M3).

Arterial feeders (Fig. 2) were found to approach the HGSV from nearby arteries every 15 mm forming a rich capillary network within the adventitia and the outer two thirds of the media in normal HGSV. In HGSV with intimal hyperplasia capillary meshes were found, which extended into the inner layers of the media. Within the media, capillary meshes ran circularly (Fig. 2) [5].

The diameters of (i) arterial VV ranged from 11.6 to 36.6 µm, (ii) capillary VV from 4.7 to 11.6 µm and (iii) venous VV ranged from 11.6 to 200.3 µm [5].

The three-dimensional network of the vasa vasorum suggests, that these layers are metabolically highly active and therefore require a continuous blood supply [5].

References

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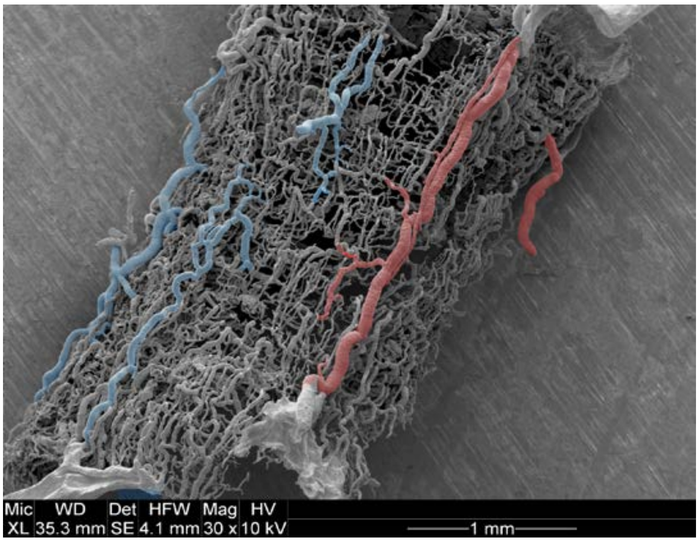

Figure 1. *Abluminal view of the vasa vasorum, which run predominately with the longitudinal axis of the vein. A part of the venous vessels are coloured blue and some arterial vessels are coloured red. Bar: 1mm*

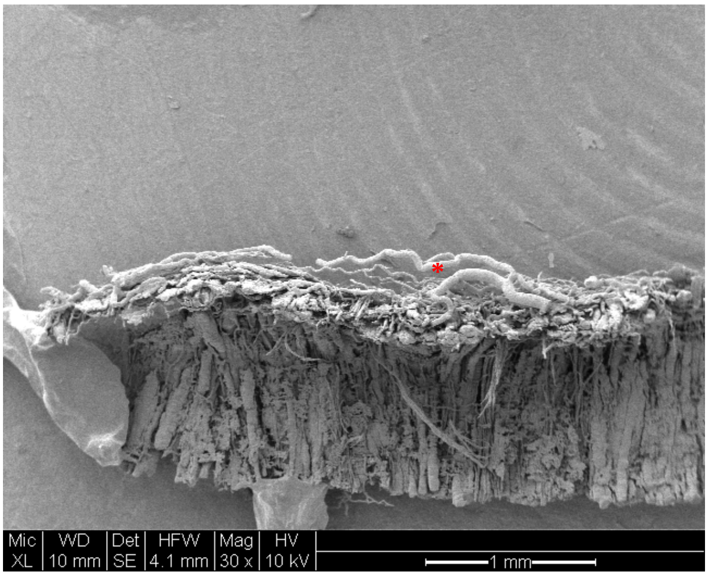

Figure 2. *Luminal and abluminal view of the vasa vasorum vascular network. The vasa vasorum mainly run along the longitudinal axis of the vessel and radially to the muscle cells. *arterial feeder. Bar: 1mm*