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Mini Review

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A SEM study on microvascular changes in a lifestyle-related disease

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Abstract

In this study, we focus on the microcirculation of whole and oral organs in a lifestyle-related disease. In the microvascular resin cast method, low-viscosity synthetic resin is injected into the blood vessels and the peripheral tissue is dissolved, revealing all of the blood vessels. A clear three-dimensional image can be obtained through the complete infusion of a synthetic resin up to the capillaries, and these can be observed using a scanning electron microscope (SEM) with deep focus. Moreover, the intravascular surface structures of endothelial cells and their nuclei and venous valves are imprinted accurately on the surface of the cast. The diameter of the cast allows the microcirculatory system to be distinguished from the arteries through the arterioles and capillaries to the venules and veins[2]. In this study, we prepared vascular casts using a rat model of diabetes and compared the three-dimensional structures of vessels in control and diabetic rats.

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Introduction

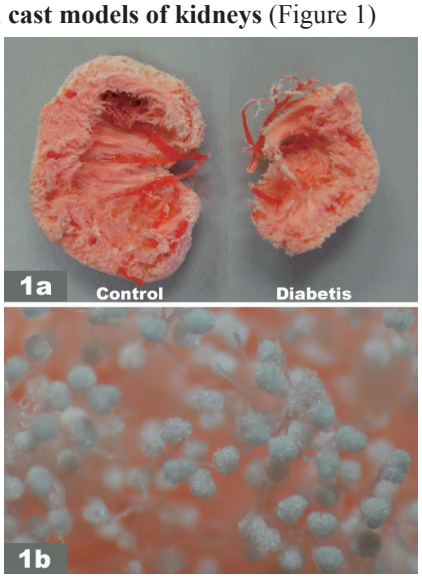
Increasing social awareness of the whole body and of oral health is an urgent task in the field of dentistry. In this study, we focus on the microcirculation of the whole body as well as of oral organs in a lifestyle-related disease model. The microvascular architecture of organs in the rat diabetes model were compared to those of control animals using a vascular resin cast method[1].

Materials and Methods

A rat model of spontaneous type 2 diabetes (Goto-Kakizaki rats: GK rats) and in a control group (Ws) were used for the experiment. Synthetic resin was injected into the ascending aorta of the experimental animals, and the surrounding soft tissue was demineralized with sodium hypochlorite to prepare a vascular resin cast model. Images obtained by scanning electron microscope (SEM) of these specimens were then assessed and compared. The organs evaluated include the glomerulus, retina, tongue, palate, gingiva, and bone marrow.

Results

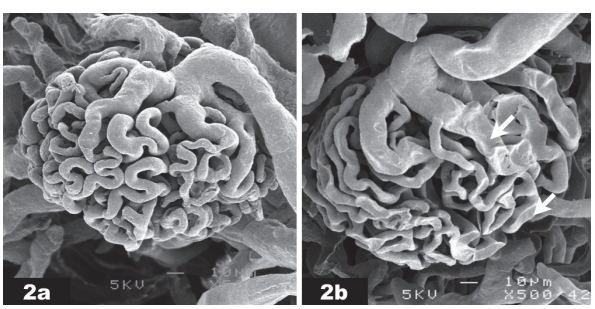
Resin cast models of kidneys (Figure 1)



Vasculature in the kidney of control (left) and diabetic (right) kidneys were observed (a). In the diabetic group with a high body weight, the blood vessels in the kidney are atrophied. Cortical renal glomeruli of control group (b) are observed as aggregates of spherical vessels. The vascular network of each part of the whole body and oral cavities can be similarly observed in detail using SEM.

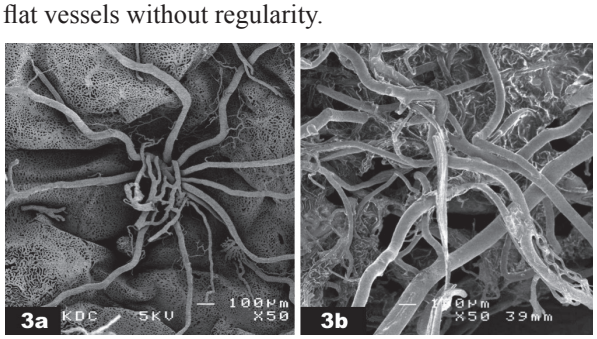
Glomerulus (Figure 2)

In the renal glomeruli, the control group (a) showed a compact spherical network of vessels. In the diabetic group (b), the vascular network is sparse and denaturation of the capillary lumen (arrow) is observed.



Retina (Figure 3)

In the retina of the control group (a), vessels are arranged radially from the central artery. In the diabetic group (b), the vessels are deformed into an expanded flat vessels without regularity.

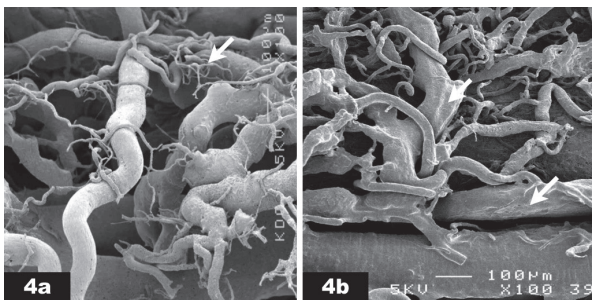


Palate (Figure 4)

The palate of the control group (a) has bilayer vascular structures. A vascular network with a large diameter is observed on the hard palate side of the lower layer, and a capillary network (arrow) is observed on the mucosal side of the upper layer.

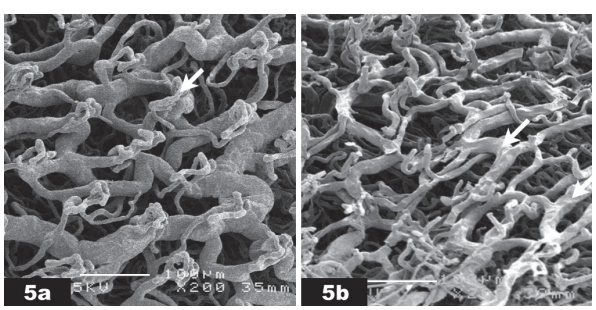
In contrast, the two-layer structure is absent in the diabetic group (b) , and is seen as a single layer.

The vessel on the palatal side causes luminal denaturation (arrow) and the capillary network is expanded.



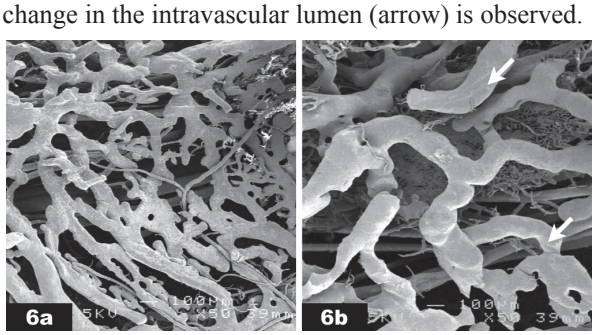
Tongue (Figure 5)

In the dorsal region of the tongue, a regular vessel loop (arrow) on the surface layer is seen in the control group (a), and a thick vascular network lines the deeper layer. In the diabetic group (b), the looping of the surface layer is deformed. Deep blood vessels are transformed into intense irregularities with luminal denaturation (arrow).



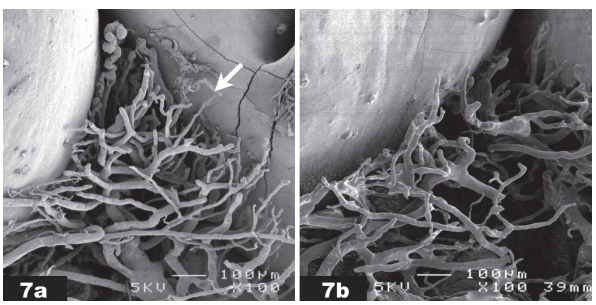
Bone Marrow (Figure 6)

In the alveolar bone marrow of the mandible in the control group (a), the vascular network is mainly composed of a flat and large diameter venous plexus. In the diabetic group (b), the vessel diameter is increased. However, the array becomes a sparse structure and a change in the intravascular lumen (arrow) is observed.



Gingiva (Figure 7)

There was very little clear change in the gingiva compared to other tissues. Marginal gingival loops (arrow) in the control group (a) along the cervical region are reduced in the diabetic group (b) and are arranged irregularly.



Discussion and Conclusion

In this study, morphological changes were observed in vessels, showing that diabetes causes large microcirculatory injury not only in the whole body, but also in organs of the oral cavity. This study also shows that these changes are markedly exacerbated due to periodontal disease.

In the future, we will conduct research that enables risk screening and risk management of lifestyle-related diseases based on the microcirculation of the oral cavity.

Acknowledgments

All animal experiments were conducted in compliance with the protocol, which was reviewed and approved by the Institutional Animal Ethics Committee of Kanagawa Dental University (Permit Number 16056). The authors declare no conflict of interest for this study.

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