

Short communication

# Lymphatic vessel system in gingival peri-implant tissues in humans

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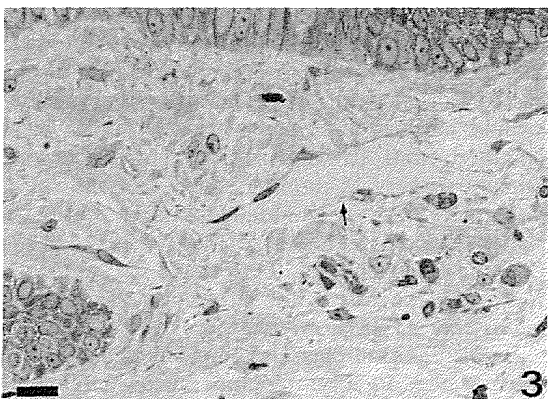
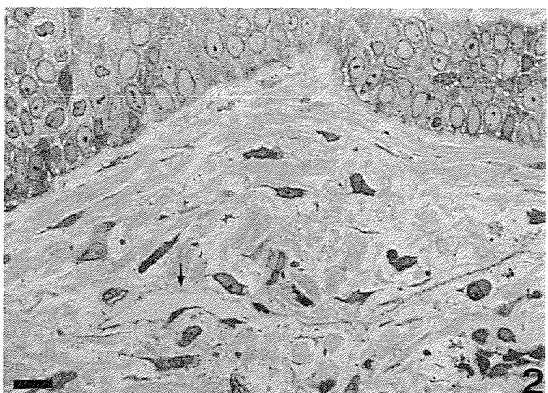
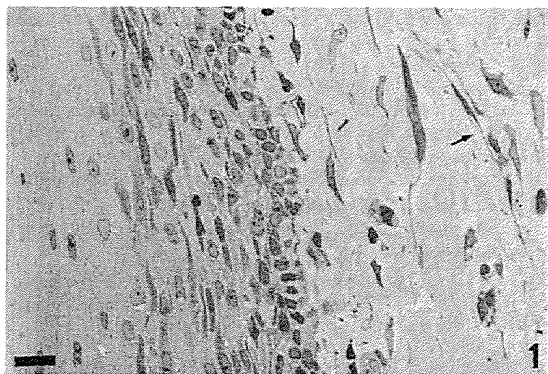
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Soft peri-implant tissue health is of primary importance in the success of implants supporting crowns and bridges. The abutment/fixture/soft tissue interface is one of the most critical points because, owing to the lack of an epithelial attachment, there is no barrier to microbial penetration towards the bone. It follows that possible marginal inflammation of the gingiva (peri-implantitis) can spread towards the apex causing bone resorption. The destruction and remodelling of the mucosal tissues following implant surgery produce extracellular matrix degradation (1). Therefore, an efficient system, able to remove the products of inflammatory or regenerative processes is essential to peri-implant soft tissue functionality. The lymphatic system plays a fundamental role in maintaining tissue integrity by removing excess fluids, macromolecules and interstitial material from the tissues. Nevertheless, to date few studies have been performed on the characteristics of lymphatic drainage in the periodontal tissues (2–4) and no studies have been conducted on the existence and characteristics of lymphatic drainage in the restored peri-implant mucosa. The aim of the present study was to investigate the existence, distribution and morphological properties of the lymphatic vessel system in the healed tissues of peri-implant gingival mucosa in humans.

The investigation was performed on fragments of human gingival peri-implant mucosa. Peri-implant soft tissue specimens, 2–3 mm wide, were obtained from the peri-implant mucosa during aesthetic gingival remodelling interventions around implant abutments. These samples were obtained from 10 subjects who had undergone implant surgery 18 months before. All the specimens were fixed in an aldehydic mixture in 0.1 M sodium cacodylate buffer (pH 7.4), postfixated in 1% OsO<sub>4</sub> in 0.2 M collidine buffer (pH 7.4) and then routinely processed for transmission electron microscope (TEM) observation.

In all the samples the gingival mucosa had transformed to peri-implant mucosa following implant treatments. The bucco-lingual sections of the peri-implant mucosae had a multilayered keratinized epithelium on the side of the oral cavity, while thinner epithelium was present in the side facing the abutment. Loose connective tissue with harboured collagen fibres and cells was interposed between the epithelial coatings. The cells were mainly fibroblasts but some inflammatory cells were also present. Deep papillae of connective tissue protruded from the lamina propria towards the oral epithelium while the border between the lamina propria and the sulcular epithelium was more regular and lacked indentations. A well-developed and uniformly arranged



Figs. 1-3. Light micrographs of collapsed (Fig. 1) and variously dilated lymphatic vessels (Figs 2, 3). Magn 400  $\times$ . Bar=20  $\mu$ m.

network of lymphatic vessels was present in the connective tissue of the lamina propria of all the samples of peri-implant mucosae. The lymphatic vessels were distinguishable from blood capillaries because of their size (3-4 times larger) and from venules because of their shape and the structure of their wall. The lymphatic vessels consisted of thin, irregularly shaped vessels with reduced lumina (Fig. 1) or vessels with more evident lumina (Fig. 2, 3) all of which were delimited by a very thin wall.

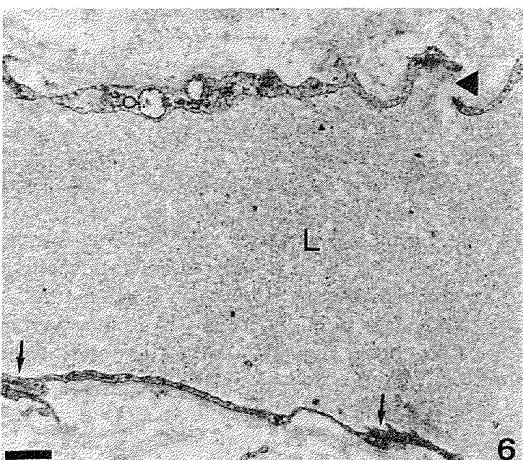
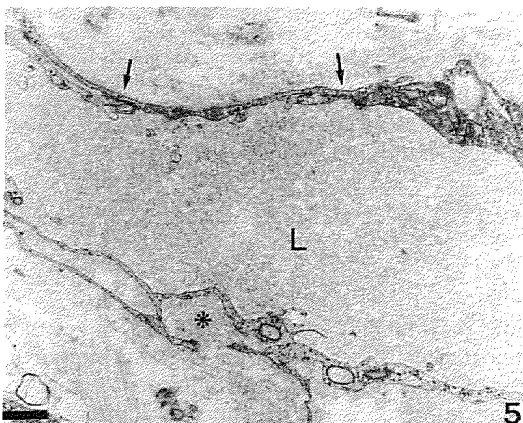


Fig. 4. Electron micrograph of a very flattened lymphatic capillary with a reduced lumen (\*) delimited by a thin and irregular endothelial wall. "Anchoring filaments" (arrows) connect the vascular wall to the collagen fibrils of the connective tissue. Magn 9700  $\times$ . Bar=1  $\mu$ m.

Figs 5-6. Electron micrographs of sections of lymphatic capillaries with evident lumina. Overlappings (arrows), intercellular channels (\*) and open junctions (arrowed) are present between contiguous endothelial cells. Magn 8400  $\times$ . Bar=1  $\mu$ m.

Lymphatic vessels originating in the connective tissue papillae were also seen.

The lymphatic vessels observed by light microscope in the peri-implant tissues had the ultrastructural characteristics of "initial" or capillary vessels (Figs 4–6). Their wall consisted of a flattened endothelium lacking pericytes and a muscular sheath, and was surrounded only by a discontinuous basement membrane and little bundles of "anchoring filaments". These filaments were connected to the collagen fibre network of the tissue (Fig. 4). Overlappings or more intricate junctions between multiple cellular protrusions generally connected the contiguous endothelial cells. On serial sections the cellular edges could be seen to form inter-endothelial channels opening towards the vessel lumen or the surrounding connective tissue matrix (Fig. 5). Inter-cellular clefts or open junctions (1–2  $\mu\text{m}$  wide) were rarely present in more dilated vessels with a distended wall (Fig. 6).

Our present study has demonstrated for the first time that a network of vessels with the morphological characteristics of lymphatic capillaries also reforms in peri-implant tissues. The lymphatic capillaries of the peri-implant mucosa are distributed in the tissue right up to the junctional epithelium as we had observed previously in healthy and inflamed gingiva (4) and as already demonstrated for the blood vessel plexus (5). Concerning the morphology of the lymphatic vessels, we observed both collapsed and distended vessels, similar to those of the healthy and moderately inflamed gingiva.

From our data we may state some first conclusions:

- In successful implants restored tissue functionality is supported by well-developed networks of both blood and lymphatic vessels.
- No substantial differences exist in localization between the lymphatic vessels in the gingiva and

those in peri-implant tissues. The degree of distension of the vessels and the presence of open junctions between contiguous endothelial cells correspond to morphological adaptations of the endothelial cells to different phases of absorption by the capillary vessels (3, 4).

Our observation that only some lymphatic capillaries present the morphological features of dilated vessels suggests that the lymphatic system is not particularly implied in absorbing activities in normally restored tissue. In other words, the mechanical disruption of the mucosa occurring at the installation of the abutments does not compromise the mucosal barrier function; and the restored epithelium facing the implant surface may maintain the permeability that characterizes the junctional epithelium of the gingiva. Therefore the migration of cells and the drainage of fluids from the connective tissue may be guaranteed by both the junctional epithelium and the lymphatic capillary system in the gingiva as in the peri-implant tissues.

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