

The Importance of Vascular System in Long Bone is Far from Well Known

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The long bones, including the femur and tibia, are not only essential for locomotion and mechanical support, but also critical for managing calcium balance and supporting hematopoiesis. In order to be involved in these missions, vascular system in bone has evolved to a specific structure [1].

The Role of Vessel in Bone Property

The vascular system of bone includes three types of blood supply: diaphyseal, epiphyseal, and periosteal vessels. The epiphyseal blood supply is through the capillary system. The periosteal blood supply is derived from intramuscular perifibrillar capillaries and forms the specific lateral blood vessel pool: cortical capillaries and marrow sinusoid. Bone marrow sinusoid is a bundle of capillaries with a larger diameter than the others [2]. These vascular structures maintain heterogeneous oxygen tension (PO₂) distribution depending on cell type and position in bone. Osteocytes and chondrocytes are exposed to lower PO₂ than mature osteoblasts and osteoclasts. Chronic anaemic conditions have been associated with osteoporosis [3]. This lateral vessel pool is very useful to assess tibia stress fractures [4]. The prominence of vessels in bone marrow as shown with MRI is associated with osteoporosis [5]. Because of the importance of the vascular system in bone, it has been imaged in animals with tomographic or histologic techniques on 2D. Fei et al. [6] have successfully made 3D-images of vessels in bone using micro computerized and synchrotron tomography. They combined advanced tomographic techniques with Goldner trichrome staining to show state-of-the-art vascular images in bone [6].

The Role of Vessel in Hematopoiesis

Long bone is an important site for hematopoiesis. The vascular system organizes a bundle of sinusoids around metaphysis, which are used as a hematopoietic niche [1]. This niche maintains the essential microenvironment for marrow-derived hematopoietic stem cells (HSCs) [7]. Moreover, the sinusoidal capillaries, the cells in bone (osteoblast and osteoclast) and bone matrix have been shown to regulate HSCs by generating many cytokines [8-12]. In contrast, HSCs are capable of regulating bone formation by themselves [13].

The Role of Vessel in Tumor Metastasis on Bone

The skeleton is a site for metastasis of many tumors (prostate, lung, breast, etc.) [14]. The sinusoidal capillaries don't have tight junction among endothelial cells. This is the perfect site for tumor invasion [15]. Moreover, the local hypervascularization is another essential condition for bone metastases. The morphology of bone vasculature has been studied with different tomographic technologies in breast cancer metastasis in rats [16]. The angiogenesis in metastasis is mediated by factor for angiogenesis: VEGF [17]; osteogenic factor: bone morphogenetic protein [18]; c-Mer tyrosine kinase and microRNA-126 [19], leading to anti-angiogenic therapies using drugs or surgery to treat tumors [20].

Although the vasculature of bone has been studied for many decades, the vascular effect and anatomy of bone in response to mechanical stress, metabolism, and tumor metastasis are still not

known very well. More study on bone-vessel interaction is needed to better understand the mechanism of fracture, osteoporosis, and tumor metastasis.

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