Endogenous Electricity on Trabecular Surface of Intertrabecular Pore, in situ MSC Niche
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In vitro, proliferation and differentiation (PF&DF) of mesenchymal stem cells (MSC) are changed by physical cues and niche environments (PHC&NE). Fluid pressure and flow (FP&F), deformation of substrates, and electric potential (EP) are main PHC. Properties of the substrates and micro-structure of the niche also affect PF&DF. It can be considered that human cancellous intertrabecular pore (PIT) is an in vivo niche. Trabecular, the element of PIT, is a porous material composed of the piezoelectric-matrix and lacunocanaliculae (PLC) filled with the bone fluid, osteocytes and processes. When a load is applied to the PIT, trabecular deformation causes PLC streaming potential (SP), which is affected by the piezoelectric-matrix potential. As a result, the PIT has EP on the trabecular. Deformation of the PIT also results in generation of FP&F in the PIT. Consequently, current in vitro MSC niches cannot mimic complex interactions of PHC&NE of the PIT. If the PIT can be used as a niche in vitro for PF&DF of MSC, the efficacy and safety for human application would be improved. To use the PIT as a niche, however, knowledge is required to understand the PLC SP and PIT FPF. In this study, the PLC SP on a trabecular was predicted using the poroelasticity, piezoelasticity, and electrokinetics. For analyses, a step loading (1 Hz) of -0.1 MPa was applied to the longitudinal trabecular. On the surface of trabecular, +0.16 and -0.15 mV of the peak SP were predicted. The results could be used to construct an in situ PIT niche.