In Situ Measurement of Transport between Subchondral Bone and Cartilage: A Potential Factor in OA Development

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Results

Similar staining pattern was observed in all perfused samples, with strong staining in uncalcified cartilage (UC), punctuated stained chondrocytes (C) in calcified cartilage (CC), and osteocytes (OC) in subchondral bone (SB). Occasionally, osteonchon-dral interface (OI) showed a wavy contour with regions almost in contact with UC (OI-C, Fig. 1). Histology showed that this pattern was closely related to tissue mineralization, and tiny pores were indentified in calcified cartilage ECM using EM (data not shown).

Discussion

The diffusion coefficient D of sodium fluorescein in the calcified cartilage of mice was comparable with that in an equine model [2]. Although the D reported here is much smaller than that in uncalcified cartilage [3], significant transport still occurred in calcified cartilage as shown by the strong staining in the perfused samples. Our results suggest that communication between cartilage and bone is highly likely in vivo. For example, sodium fluorescein penetrated the mineralized cartilage over 60 µm within 30 minutes. For larger signaling molecules such as insulin, EGF and IGF (5-7.5 kDa) [4], their diffusion expected to be 2-3-fold slower (1-2 hours). This transport rate still appears to be fast compared with times to elicit corresponding biological effects. One limitation of the study was the mathematical model with the idealized boundary and initial conditions. We are developing a dynamic simulation method based on real geometry and photobleaching profiles. Despite its limitations, our study provides direct evidence that calcified cartilage is not an impermeable transport barrier, and that bone and cartilage are one functionally and anatomically integrated unit. The cross-signaling between these two tissues may be involved in the maintenance of normal joints and the degradation of OA joints.

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