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# Fractal Dimension of Trabecular Bone Projection Texture Is Related to Three-Dimensional Microarchitecture

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## ABSTRACT

**The purpose of this work was to understand how fractal dimension of two-dimensional (2D) trabecular bone projection images could be related to three-dimensional (3D) trabecular bone properties such as porosity or connectivity. Two alteration processes were applied to trabecular bone images obtained by magnetic resonance imaging: a trabeculae dilation process and a trabeculae removal process. The trabeculae dilation process was applied from the 3D skeleton graph to the 3D initial structure with constant connectivity. The trabeculae removal process was applied from the initial structure to an altered structure having 99% of porosity, in which both porosity and connectivity were modified during this second process. Gray-level projection images of each of the altered structures were simply obtained by summation of voxels, and fractal dimension ($D_f$) was calculated. Porosity ($\phi$) and connectivity per unit volume ($C_v$) were calculated from the 3D structure. Significant relationships were found between $D_f$, $\phi$, and $C_v$. $D_f$ values increased when porosity increased (dilation and removal processes) and when connectivity decreased (only removal process). These variations were in accordance with all previous clinical studies, suggesting that fractal evaluation of trabecular bone projection has real meaning in terms of porosity and connectivity of the 3D architecture. Furthermore, there was a statistically significant linear dependence between $D_f$ and $C_v$ when $\phi$ remained constant. Porosity is directly related to bone mineral density and fractal dimension can be easily evaluated in clinical routine. These two parameters could be associated to evaluate the connectivity of the structure. (J Bone Miner Res 2000;15:691–699)**

**Key words:** trabecular bone, trabecular architecture, projection image, fractal dimension, connectivity