Longitudinal wave velocity in cortical bone of spontaneously diabetic rat

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Background, Motivation and Objective

Bone elasticity, which depends on bone mineral density (BMD) and bone quality, is one of the important factors of the bone fracture risks. Diabetic patients have higher bone fracture risks despite of the normal BMD. In this study, longitudinal wave velocities in cortical bones of healthy and spontaneously diabetic rats were experimentally investigated using a micro-Brillouin scattering technique.

Methods

Male SDT (Spontaneously Diabetic Torii, CLEA Japan) rats after 15 weeks spontaneously become hyperglycemic without obesity. Then we measured blood glucose levels of rats before or after 15 weeks. The blood glucose level of a 20-week-old SDT rat was more hyperglycemic than that of a 20-week-old normal SD (Sprague Dawley, CLEA Japan) rat. In contrast, those of 10-week-old SDT rats were similar.

The cortical thicknesses of tibias in 10-week-old rats were thinner than those of 20-week-old rats as shown in Fig. 1(a). Then, a cortical bone plate (anterior-posterior and medial-laterior directions, plates thickness 70 μ m) was fabricated from the tibia of each rat.

The micro-Brillouin scattering technique is a non-contact and non-destructive method to observe wave velocities in the GHz range. This technique enables the local measurement (spot diameter : 10μ m) of longitudinal wave velocity. We measured the longitudinal wave velocities propagating in tangential directions in the plates.

Results/Discussion

Figure 1(a) shows the wave velocity in rat cortical bones. The wave velocities near the center were higher than those near the inner and outer surfaces. The wave velocities in 10-week-old rats were lower than those of 20-week-old rats. In addition, the velocity despersions in 20-week-old rats were bigger than those of 10-week-old rats. Figure 1(b) shows the averaged wave velocities in rat cortical bones. The averaged wave velocities of young 10-week-old SDT rat (non diabetic) were low and almost the same as those of young 10-week-old SD rat. In contrast , the averaged wave velocities of the 20-week-old SDT rat were 2.8 % lower than those of the same SD rat (p<0.05). Because BMD values of both 20-week-old SD rat indicates a decrease in elasticity.

[1] H. Fujii, et al., Bone, 42, p.372, 2008.



