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Low-level mechanical vibrations can influence bone resorption and bone formation in the growing skeleton.

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Abstract

Short durations of extremely small magnitude, high-frequency, mechanical stimuli can promote anabolic activity in the adult skeleton. Here, it is determined if such signals can influence trabecular and cortical formative and resorptive activity in the growing skeleton, if the newly formed bone is of high quality, and if the insertion of rest periods during the loading phase would enhance the efficacy of the mechanical regimen. Eight-week-old female BALB/cByJ mice were divided into four groups, baseline control (n = 8), age-matched control (n = 10), whole-body vibration (WBV) at 45 Hz (0.3 g) for 15 min day(-1) (n = 10), and WBV that were interrupted every second by 10 of rest (WBV-R, n = 10). In vivo strain gaging of two additional mice indicated that the mechanical signal induced strain oscillations of approximately 10 microstrain on the periosteal surface of the proximal tibia. After 3 weeks of WBV, applied for 15 min each day, osteoclastic activity in the trabecular metaphysis and epiphysis of the tibia was 33% and 31% lower ($P < 0.05$) than in age-matched controls. Bone formation rates (BFR.BS(-1)) on the endocortical surface of the metaphysis were 30% greater ($P < 0.05$) in WBV than in age-matched control mice but trabecular and middiaphyseal BFR were not significantly altered. The insertion of rest periods (WBV-R) failed to potentiate the cellular effects. Three weeks of either WBV or WBV-R did not negatively influence body mass, bone length, or chemical bone matrix properties of the tibia. These data indicate that in the growing skeleton, short daily periods of extremely small, high-frequency mechanical signals can inhibit trabecular bone resorption, site specifically attenuate the declining levels of bone formation, and maintain a high level of matrix quality. If WBV prove to be efficacious in the growing human skeleton, they may be able to provide the basis for a non-pharmacological and safe means to increase peak bone mass and, ultimately, reduce the incidence of osteoporosis or stress fractures later in life.

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