Good Vibes by Rattlin’ Bones

Improving the strength and fracture resistance of post-menopausal bones is important. Regular physical activity has a maintenance effect and pharmacological agents can marginally reverse the process of bone loss. Neither is completely effective and oral agents do not improve the related loss of muscle (sarcopenia).

A new mechanical treatment has an interesting potential to increase bone mass and reduce fragility. It may even strengthen age-weakened muscles. It is low-magnitude, high-frequency, mechanical stimuli.

Past studies in animals (eg, rats, turkeys, and sheep) have demonstrated vibration-induced increased bone density and provided information on ideal ranges for effectiveness of vibration frequency and mechanical strain.


The study by Rubin et al comprised 70 women who were 3-8 years post-menopause. A platform was provided. Half of the patients’ platforms vibrated. An upward extension from the platform has handlebars and looks like an upright weigh scale. The active platforms delivered vibrations of 0.2 g at 30 Hz frequency. Each individual stood on the platform for 10 minutes every day for 1 year. Half of the women acted as controls for this randomized experiment. The vertebrae of high compliance, lighter weight women had a relative benefit of 3.35% greater bone mineral density (BMD) over the year ($P=0.009$).

Verschueren et al used a similar cohort of women (n=25) who stood on the platform 3 times a week for 24 weeks. At the same time, 22 women performed a variety of squats when on the platform. The whole body vibration was set at 5.09 g. A control group comprised 23 individuals. All women ranged in age from 50-74 years. Vibration significantly increased hip BMD ($+0.93\%, P<0.05$) and improved isometric and dynamic muscle strength ($+15\%$ and $+16\%, respectively; P<.01$). No change was noted in hip BMD of women participating in resistance training alone or in age-matched controls.

Blue Notes Editor:

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Modern metals and implant design technology have produced metal-on-metal hip replacement bearing surfaces and a strong interest in their performance. In general, they have good mechanical characteristics. However, their biological effects cause some apprehension, especially over the long term. Metal wear particles and ions from implant surfaces are transported through the body’s vascular channels in measurable amounts. They can be detected coming from nonbearing surfaces. The metallic ions of cobalt and chromium are required for normal metabolism in trace amounts. While they are necessary, in excess, over many years, are they a hazard?

K. Maezawa et al have measured changing chromium levels in 44 patients who had metal-on-metal bearing hip replacements (Acta Orthop Scand. 2004; 75:422-426). The serum chromium levels were measured at 6-month intervals for 3 years after implantation. The mean chromium levels increased gradually from 6 months (0.73 µg/L) up to 36 months, but between the second and third years, the increase was minimal. Moving from 0.73 µg/L to 1.05 µg/L between 6 and 12 months suggests the effects of “bedding-in.” Linear wear rates of 5 μm per year in metal-on-metal articulations have been reported and volumetric rates of 0.3 mm³ a year in vivo. While much lower by at least 20 times, compared with polyethylene, the metal wear particles are, on average, smaller (<0.1 μm) than those of polyethylene where the average is 0.5 μm. The number of metal wear particles is higher for a comparable volume of polyethylene. Only polyethylene particles of a certain size (0.3–<10 μm), induce the secretion of osteolytic interleukin-6, by macrophages.

Cobalt and chromium particles have been found in the lymph nodes, spleen, liver, and bone marrow as well as in the periartricular tissues of metal implants. This may increase, if the implants are loose. Hexavalent chromium, a possible implant degradation product, has been listed as a Class-I human carcinogen. But, time will tell.

Fears about long-term metal toxicity, which may not be justified, do not seem to impress surgeons, judging from the popularity of metal-on-metal bearings.

The Citrulline Connection

The cause of rheumatoid arthritis is still unknown, 40 years after the discovery of rheumatoid factor, the first clear connection to the immune system. The discovery signaled rheumatoid arthritis is a chronic autoimmune disorder. The rheumatoid arthritis factor is not specific nor does it provide complete sensitivity. It indicates, however, self-antigen targets such as collagen II (abundantly present in articular cartilage), human cartilage glycoprotein, and proteoglycan.

Considerable interest has been shown in the recent observation that a high proportion of patients with rheumatoid arthritis have IgG antibodies to citrullinated peptides. These anti-citrullines appear relatively early in rheumatoid arthritis, are highly specific for rheumatoid arthritis (98%), and can be measured by readily available assay systems.

Hill et al (J Rheumatol. 2004; 31:1471-1473) describe the research that has gone into the complex interrelationships of citrullinated peptides through the observation of these disease-specific antibodies as antiperinuclear factors. The target of the antibodies is filaggrin in its citrullinated form.

In patients with rheumatoid arthritis, these proteins inhabit the synovial tissues and could be targeted by the joint’s local immune response. It has been suggested that a genetic link may be present to the increased production of citrullinated peptides, in susceptible individuals. If immune responses to citrulline play an important role in the initiation and perpetuation of rheumatoid arthritis, treatment targeting these pathways could be developed.