Contraindications and Potential Dangers of the Use of Vibration as a Treatment for Osteoporosis and other Musculoskeletal Diseases

There is mounting scientific evidence, through both animal and clinical studies, that low-level, mechanical signals, delivered using vibration, can stimulate bone formation and perhaps curb osteoporosis. Just because some vibration may be beneficial, however, does not mean that a lot is better. Before considering vibration as an avenue of intervention for osteoporosis, it is important to consider the benefits of vibration versus the potential risks and complications of use. In short, vibration can be exceedingly dangerous, and is an etiologic factor in several pathologic conditions. Exposure to whole body vibration has been determined to be a central etiologic factor in low back pain (1), neurovestibular disorders (2) and Raynaud’s syndrome (3), and thus industries such as transportation and construction (4), as well as the military (5), are working towards minimizing occupational exposure to these potentially noxious mechanical stimuli, rather than introducing them as an intervention for musculoskeletal disease.

Before considering vibration as an avenue of intervention for osteoporosis, it is important to consider the benefits of vibration versus the potential risks and complications of use. Noxious levels of vibration are typically considered as a function of magnitude (g-force, where 1g = earth’s gravitational field, or an acceleration of 9.8 meters per second per second), frequency (Hz, or cycles per second), and duration (time of exposure). A large body of research has demonstrated a broad range of pathological responses to high frequency (5 to 100 Hz), high magnitude vibration (greater than 1g) (6), including irrefutable evidence of
such vibration magnitudes contributing to low back pain following extended exposure
(7), and serving as a key etiologic factor in circulatory disorders such as Raynaud's
syndrome (3). Ignoring such dangers, g-forces that greatly exceed 1.0 are the very
basis of devices referred to as PowerPlate, Galileo, SoloFlex, Galaxy, Nemes, and
others, and should be approached with extreme caution. Conditioned athletes,
should they knowingly understand these dangers and still wish to put their body at
risk is one thing, but to use such interventions on the elderly, osteoporotic, or
functionally impaired individuals is dubious, at best.

Considering the potential dangers of vibration, and the potential of an
intervention that may well cause the very fracture it is prescribed to prevent, it is
reasonable to ask if any forms of vibration are safe. Towards that end, there is no
evidence of any noxious effects of 15-50 Hz vibration exposure that falls below 0.2
g\text{rms}, corresponding to sinusoidal accelerations of 0.56 g-force, peak to peak. In fact,
for short duration exposures (up to one-half hour), the International Safety
Organization threshold for human tolerance of vibration, ISO 2631, establishes a
level of 0.3g\text{rms} (0.8 g\text{p-p}) as the pathogenic level for vibration in the 20-50 Hz range
(8). With g-forces that exceed this level, acute discomfort arises not only from focal
pain in muscle and joints, but from induced alterations in visual perception and
tracking. As early as 1938, Coermann (9) reported discontinuities in visual activity
between 25 and 40 Hz for whole body vibration (WBV). In addition, he noted that at
some acceleration levels, vibrations above 20 Hz temporarily diminished patellar
reflexes, a finding which has since been confirmed by Goldman (10), Seidel (2) and
Roll et al (11). Dupuis and Hartung (12) reported a physical resonance of the eyeball
at 20-21 Hz, and correspondingly, that visual perception time is affected during vibration exposure at 5-8 Hz, and again near 25 Hz. In contrast to concerns for the use of vibration that exceeds 1g, it should also be pointed out that no adverse effects were observed in any of the preliminary trial with humans which kept vibration below 0.3g\(^{(13-15)}\). Certainly, considering the demonstrated risk to so many physiologic systems, if functional disorders compromise an individual’s ability to protect themselves, it is clear that vibration that approaches 1g should be studiously avoided.

The great majority of research has focused on *attenuating* the transmissibility of whole body vibration to the skeleton, with the widely held presumption that high frequency vibrations are pathogenic to the musculoskeletal system\(^{(16-18)}\). In cases where vibration is inevitable\(^{(7)}\), exposure limits have been recommended by agencies focused on occupational hazards, such as the National Institute of Occupational Safety and Health, (NIOSH), Centers for Disease Control (CDC), and the International Organization for Standardization (ISO)\(^{(17)}\). Please note that our research has no relationship whatsoever with the technology or claims made by vibration plates used for exercise and physical training and manufactured by companies such as Galaxy, SoloFlex, Galileo, Power-Plate, NEMES, etc. The magnitudes used in those devices, *well in excess of 8.0g, are well beyond the limits recommended for human tolerance by ISO and OSHA*, are 35 times greater in amplitude than those mechanical signals that we study, are inherently dangerous, and to our knowledge, show little if any evidence that their devices are safe for bone, cartilage, muscle, tendon, ligaments or any of the major organs.
Please also note that our work has brought us to this point following several decades of searching for the mechanical signal to which bone is responsive. It is important to emphasize that although this low-level intervention is considered safe and beneficial, other frequencies and amplitudes may cause damage to bone and connective tissues, and many amplitudes of vibration are considered pathogenic to the musculoskeletal (e.g., vertebral disc, cartilage, ligament, tendon), neurovestibular, and cardiovascular systems. One should always be concerned that “too much of a good thing” may be true in mechanical stimulation, as well. Just because one aspirin is good for you, doesn't mean that you should take 50 aspirin per day.

Questions regarding safety:

What do you believe would be the potential short-term and long-term risks, if any, of using vibration to “treat” musculoskeletal conditions?

You have to remember that the principal reason scientists study vibration is because of the potential HARM it can do. Vibration is considered one of the principal pathogens in the high incidence of low-back pain in truck drivers and helicopter pilots, and is notorious for causing circulatory dysfunction in the extremities in occupations that use hand-held machinery. In other words, vibration is potentially very dangerous indeed, and should be approached with caution.
It is because of this concern that OSHA and the International Safety Org (ISO) have come out w/ specific advisories on duration thresholds for human tolerance, which is dependent on both frequency and duration. In the figure, below, from ISO-2631, it shows frequency (bottom), and acceleration (vertical), w/ the dark "hockey-sticks" indicating how much time you can safely be exposed to these signals.
I’m assuming that 0.3g at 30Hz is still much lower than the lower-vibration setting on the Power Plate, Galileo or other “fitness” devices? Is this true?

To try to answer this question, please refer the figure, below to mark where 30Hz (cycles per second) is, and where 0.3g shows up, indicating four hours of safe exposure each day. There is also placed a mark where "PowerPlate" and others are, in which the devices generate well over 10g… based on this graph, you should not subject yourself to any more than one second of such g-force on any given day! So, if your musculoskeletal system survives PowerPlate, there is some likelihood that there will be some long term damage. In answer to your question, 0.3g, the work we do, is 50x less, at least, than the powerplate-type devices.

References


