Mindful Exercise and its Effect on Bone Health

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**Abstract**

Years of research studies have shown how our skeleton is always ready to sacrifice itself for the survival needs of the whole, the greater good. Examples include: if blood calcium drops to a threatening level, the skeleton immediately breaks itself down and infuses a life-sustaining level of calcium into the bloodstream. Another example is if blood pH takes an acidic tilt, a pH less than 7, again, bone sacrifices its mineral compounds to reestablish blood pH balance. Scientists have recently discovered a new fascinating and unexpected way that bone protects the whole body; this is the role that our skeleton plays when in the face of danger, or stress. The hormones that are released in the body during a period of stress are detrimental to overall health but especially bone health. The main responsibly of our bodies is to keep us alive, to prepare us to fight or flee in the face of danger; thus, making these hormones necessary. However, limiting stress is imperative for good health.

Stress reduction comes in many forms and fashions and many people find relief from different things. Exercise has always been viewed as a great stress reduction technique and a tool to increase health and fitness, but something that has a positive correlation to general health and wellbeing is mindful exercise. Mindful exercise includes the likes of a few of the most popular exercises in the world like yoga, tai chi, and Pilates; but it also includes lesser known but no less effective exercises such as Qi Gong, Feldenkrais, and Alexander technique.

**Introduction to Osteoporosis**

Osteoporosis is defined as porous bone. It is a disease where the density and quality of bones are reduced. As bones become more porous and therefore fragile, the risk of fracture greatly increases. The loss of bone occurs silently and progressively; often times there are no symptoms until the first fracture occurs. Our bones are living tissue that change constantly. From birth through adolescence, bones are developing and becoming stronger. According to the International Osteoporosis Foundation, our bones are at their peak density in our early 20s and this is referred to as peak bone mass. As we age, some of our bone cells begin to dissolve while new bone cells form; this process is known as remodeling. People with osteoporosis experience bone loss that outpaces bone growth. These bones become porous and brittle, which leads them to being prone to fracture.

Osteoporosis is a wide reaching public health concern. According to the International Osteoporosis Foundation, worldwide, 1 in 3 women and 1 in 5 men that are aged fifty years and older are at risk of an osteoporotic fracture. The most common fractures associated with osteoporosis occur at the wrist, hip, and spine; of particular concern are spinal and hip fractures because of the immobility implications that these fractures are linked to. The likelihood of these fractures occurring increases with age in both women and men. The good news is that there are many steps that can be taken to prevent and diagnosis osteoporosis. It is now a largely treatable condition; with a combination of lifestyle changes such as improved diet and increased exercise regularity, along with appropriate medical treatment, many fractures can be avoided or minimally of a lesser severity.

**Stress and its Effects on Health/Bone Health**



Listed are the biomechanical processes that undergo during a period of stress (derived from the above chart (Berger, et al., 2019)).

* When faced with danger, the brain registers a fear response in its amygdale.
* This alarm signal gives the call for the specific activated form of osteocalcin to be sent to the blood.
* To provide for this active form of osteocalcin, the bone-forming osteoblasts increase their uptake of the neurotransmitter, glutamate; this neurotransmitter prevents inactivation of the osteocalcin.
* Active osteocalcin then is sent flooding into the blood stream.
* Active osteocalcin then “turns off” the “rest and digest” parasympathetic nervous system
* With the counter-balancing parasympathetic nervous system turned off, the “fight or flight” sympathetic nervous system is allowed to run full tilt without any brakes.
* The unrestrained “fight or flight” response fuels the body with high powered stress hormones fueling an immediate and robust response to the danger.

But what does all of this mean, and what implications do these things on have on our health, particularly our bone health?

A 2013 Times of India article, “Stress can hurt your bones too”, links the issue with stress to four main things. One being the release of cortisol, two being phosphoric acid, three being depression – which mimics the effect(s) of stress, and diet. (Holla 2013)

The Times of India stress article’s section on cortisol states that countless research has pointed to how stress negatively impacts bone mineral density. Dr. Bhonsle, a department head at KEM Hospital in India, says that stress plays a major role in in the result of osteoporosis. When bone tissue is constantly remodeled in the body, two types of cells are responsible. Osteoblasts, which help in depositing new bone tissue, and osteoclasts, which break down old bone tissue. Dr. Bhonsle says, “Your bone density is determined by the rate at which these cells work. Under stress, our adrenal glands increase the production of cortisol. Cortisol is known as the stress hormone, and as it’s released by the body in response to stress can decrease bone density by inhibiting the bone-building osteoblasts.” With decreased osteoblast activity, the body ends up with more broken down bone tissue than deposited, causing low bone density and eventually osteoporosis. Interestingly, America which is among the countries with the highest calcium intake, no doubt due to its love of cheese and ice cream, also has one of the highest rates of osteoporosis. The solution, health experts say, is not more calcium, but excreting less of it. When you face stress, you lose calcium through urination. Dr. Bhonsle adds, “More cortisol leads to a dip in calcium absorption and a spike in its excretion.” (Holla 2013)

The Times of India stress article’s section on phosphoric acid states that phosphoric acid acts as a corrosive agent and is a key cause of calcium and mineral loss from both bones and teeth. Dr. Bhonsle points out that stress causes a similar reaction and result. “Stress causes acidity which impedes optimal digestion of food. This acidity also hampers mineral metabolism which is critical for bone health. In fact, without proper absorption of these minerals, even a very nutritious diet is of no use to your bones,” he says. (Holla 2013)

The Times of India stress article’s section on depression states that studies have also found that people suffering from depression have a lower bone density, which makes their bones more brittle. When depressed, the brain boosts the secretion of noradrenalin within the bone, which is a chemical that obstructs osteoblasts. Depression, researchers say, mimics the effect of stress.

The Times of India stress article’s section on diet states that constant stress and the general unhappiness makes people seek comfort in junk or comfort foods. These foods aren’t rich in calcium, magnesium and other essential nutrients that help prevent osteoporosis. “Poor food choices translate into poor bone nutrition, and subsequently, bone health. Besides, the sporadic timing of meals and multitasking, like working, scrolling through social media, and texting while eating, seriously hinders optimal digestion. Of course, a regular intake of vitamin D, which is best from the sun, is important as it helps in the utilization of minerals in the bones. The solution to this problem is largely a lifestyle overhaul”, Dr. Bhonsle says. (Holla 2013)

**Methods of Reducing Stress – Mindful Exercise(s)**

According to Medical News Today article, “How does yoga work?”, yoga is a mind and body practice dating back thousands of years with its roots deriving from ancient India. There are various styles of yoga that combine posture, breathing techniques, and meditation. Today, the ancient practice of yoga has expanded to all corners of the globe. While it is now a popular form of both exercise and meditation, this has not always been the case. Yoga was practiced and taught long before any written account(s) of yoga were created; let alone a current driving fad being Instagram and lululemon. Over the next thousand plus years, yogis passed down the art their mentees, which resulted in many different schools of yoga being developed worldwide. This global expansion led to an increase of exposure and therefore, popularity. The Yoga Sutra is a 2,000-year-old guidebook by the Indian sage Patanjali; this makes it the earliest written record of yoga and one of the oldest texts in existence and provides the framework for all modern yoga. Content of the Yoga Sutra includes how to master the mind, control emotions, and grow spiritually. Yoga is widely known for its poses. However, they were not a key part of the original traditions because fitness was not a primary goal. Practitioners instead focused on expanding spiritual energy by using breathing methods and concentration. (Nichols 2018)

According to an article about stress management from Mayo Clinic, consider tai chi for many reasons but especially for stress reduction. Often described as meditation in motion, tai chi promotes serenity through gentle, flowing movements. Tai chi is an ancient Chinese tradition that, today, is practiced as a form of exercise. It involves a series of movements that are performed in a slow, focused manner, and accompanied by deep breathing. Each posture or position moves into the next without pause, which ensures that the body is in constant motion.

Tai chi is low impact and puts minimal stress on muscles and joints, which makes it appropriate for all ages and fitness levels. Due to its low-impact nature, it may be especially suitable for an older adult who otherwise may not exercise. When performed both correctly and regularly, tai chi can be a piece of the puzzle to improving health. The benefits of tai chi may include (Mayo Clinic staff 2018):

* Decreased stress, anxiety and depression
* Improved mood
* Improved aerobic capacity
* Increased energy and stamina
* Improved flexibility, balance and agility
* Improved muscle strength and definition
* Enhance quality of sleep
* Enhance the immune system
* Help lower blood pressure
* Improve joint pain
* Improve symptoms of congestive heart failure
* Improve overall well-being
* Reduce risk of falls in older adults

These same benefits are true of many mindful exercise practices.

**Studies**

Harvard published a research study review on a 12-minute yoga routine that involves 12 different yoga positions with the thought that this routine will improve bone density. The researchers who designed the study noted that yoga's benefits include better balance and coordination, which aids in protection against falling, which a major cause of osteoporotic fractures. However, they wanted to determine if yoga also increase bone density through the occurring force on the spine and hips. They recruited 741 people who joined the study on the internet spanning ten years, between 2005 and 2015. The participants were asked to submit DEXA scans of their hips and spines, along with other lab tests, at the beginning phase of the study. They also received video instructions for the poses, and were asked to record their yoga activity online. The logs indicated that 227 participants, 202 being women, practiced the routine at least every other day for two years. The average participant’s age was 68 when they entered the study. 83% had lower than normal bone density. The DEXA scans they submitted at the end of the study showed significant increases in bone density in the spine. Hip bone density increased, as well, but not significantly. Fortunately, none of the participants reported bone fractures or any other injury caused by doing the yoga routine. (Harvard Health Publications 2016)

Although promising, the study, published in 2015 in Topics in Geriatric Rehabilitation, does not provide conclusive evidence that yoga can reverse bone loss. The researchers acknowledged its drawbacks. Less than a third of the study's participants adhered to the yoga routine by practicing the poses at least every other day throughout the study, and only 43 participants submitted complete DEXA reports at the beginning and conclusion of the study. "It gives one a reason to be cautiously optimistic, but a more complete study should be done," says Dr. Marian Hannan, a professor of medicine at Harvard Medical School; her research includes the effects of biomechanics on physical function. Dr. Hannan also notes that the participants were also self-selected, not randomly selection. Meaning, the people who enrolled wanted to practice yoga. "Would the results be equally promising in people who were simply assigned to do yoga?" she asks. Yoga is a mindful exercise, so to get the most benefit full engagement is necessary. (Harvard Health Publications 2016)

In a randomized clinical trial studying the effects of tai chi training on cardiovascular health and muscle strength on female seniors, 31 elderly women were randomly assigned to receive either tai chi training or an educational program, three times a week for 16 weeks. 16 subjects were randomly assigned to learn 12 forms of tai chi, while the other 15 served as a control group. As for results on the cardiovascular system, average large and small artery compliance increased significantly at 26.2 % (*p* = 0.039) and 17.9% (*p* = 0.011) respectively after tai chi intervention. The control group recorded decreases in both large and small artery compliance, but they were not statistically significant. As for results on muscle strength, the concentric and eccentric knee extensors and flexors in the tai chi group showed percentage strength changes from 4.6% to 21.3%, but only the changes in eccentric knee extensor strength were statistically significant (*p* = 0.01). For the control group subjects, the percentage changes were from 1.2% to 10.5% and none were significant. These numbers show that tai chi can improve cardiovascular health and muscle strength. (Harvard Health Publications 2016)

**Health Belief Model**

The health belief model best expresses using mindful exercise as a tool in the chest to improve overall health, more specifically, bone health. The health belief model explains and predicts health related behaviors with an emphasis on the beliefs and attitudes of people. Basically, a person is far more likely to either take a preventative measure, or actively do something) if they feel they can avoid a negative condition/situation. In this situation, for example, a thin young woman comes under the impression that if she performs a mindful exercise like yoga or tai chi regularly, she will have a much reduced risk of developing osteoporosis/osteopenia.

**Recommendations**

Although more research needs to be conducted, the two clinical trials mentioned above, along with a plethora of others, encouragingly show that mindful exercises like yoga and tai chi are great stress reducers. Stress is known to be quite damaging to the body as a whole, and in this instance, the skeletal structure. Mindful exercises can be performed by people at any fitness level or age and require no equipment. Mindful exercises are well worth further exploration for their health benefits.

**Conclusions**

Osteoporosis is a wide reaching public health concern. According to the International Osteoporosis Foundation, worldwide, 1 in 3 women and 1 in 5 men that are aged fifty years and older are at risk of an osteoporotic fracture. The good news is that osteoporosis can largely be prevented by lifestyle changes. An improved diet and increased exercise regularity are two major components. Any form of exercise is better than no exercise but certain exercises are better suited for certain people than others. Mindful exercises are appropriate for nearly everyone and offer a wide array of benefits; perhaps most importantly, they reduce stress.

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