Green Tea and Bone Health: From Bench to Clinical Trial

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Osteoporosis, a degenerative bone disease, is characterized by low bone mass and microstructural deterioration of bone tissue that results in bone fragility and an increased susceptibility to fractures, especially of the hip, spine and wrist [1]. The trend of increased life expectancy is accompanied with an increase in the prevalence of osteoporosis and concomitant complications in the elderly population [1]. Bone is a dynamic organ that is constantly renewed through a process of remodeling and modeling involving bone resorption by osteoclasts and bone formation by osteoblasts [2]. Oxidative stress (excessive reactive oxygen species) is considered to be responsible for contributing to the etiology of various degenerative diseases, including osteoporosis [3-5]. Recent research has suggested that bone mineral density is positively associated with tea consumption that may optimize bone health. The bioactive components in tea may benefit bone health in terms of maintaining higher bone mineral density [6-8] and reducing fracture risk [9,10]. Specifically, green tea appeared to benefit bone health more than other kinds of tea (e.g., black, oolong). The abilities of green tea bioactive components to increase indices of bone formation (osteoblastogenesis) and to decrease indices of bone resorption (osteoclastogenesis) has been suggested by previous in-vitro studies, in terms of green tea’s impact in osteoblastic and osteoclastic activity, respectively [11]. The previous animal studies support that green tea polyphenols (extract of green tea) may benefit bone health by mitigating bone loss/preserving bone mass, by attenuating micro-architectural deterioration, or by improving bone strength due to aging, aging plus sexual hormone deficiency, chronic inflammation, and obesity [12]. In addition, we recently reported that 6-month supplementation of green tea polyphenols significantly increased serum bone-specific alkaline phosphatase (bone formation biomarker) concentration at 1 month, elevated the change of bone-specific alkaline phosphatase/tartrate-resistant acid phosphatase (bone resorption biomarker) ratio at 3months, and improved muscle strength at 6 months in postmenopausal women with low bone mass [13]. The beneficial effects of green tea and its bioactive components on bone health appear to be mediated via anti-oxidant or anti-inflammatory pathways and their signaling mechanisms along with various types of cells [11, 12]. These significant beneficial effects on bone suggest that green tea polyphenols may serve as an effective dietary supplement to mitigate bone loss in patients with low bone mass. It is worthy to point out that even though green tea and their metabolites are found to be useful in treating bone loss, there is a gap in knowledge still needed to explore in terms of how to translate animal observation to human populations [12]. All animal evidence only shows an increase in bone mineral density and bone strength without testing anti-fracture capacity, and these animal data mainly focus on long bones while the published epidemiological human data are for spine and hip. In addition, there is still limited report supporting bone mineral density increment and anti-fracture effect of green tea from longitudinal studies. In future human studies, green tea and its active ingredients should be given for long-term periods, the bioavailability should be monitored via validated biomarkers, and efficacy in terms of bone mass and micro-architecture should be evaluated through advanced imaging technology in order to ensure their possible benefits in treating osteoporosis [12].