Bone Marrow Mesenchymal Stem Cell Differentiation: Involvement in Osteoporosis with Obesity and Diabetes

Masayoshi Yamaguchi*

Department of Hematology and Medical Oncology, Emory University School of Medicine, Atlanta, GA, USA

Bone homeostasis is regulated through osteoclasts, osteoblasts and osteocyte [1-3]. Osteoblasts are differentiated from bone marrow mesenchymal stem cells and stimulate bone formation and calcification. Osteoclasts are developed from hematopoietic progenitors and promote bone resorption. Physiologic process of bone turnover through these bone cells underpins development and maintenance of the skeletal system. This process is dexterously regulated through various physiological systems including hormones, cytokines and bone marrow environments.

Bone marrow mesenchymal stem cells are multipotent stromal cells, which among other cell lineages, can differentiate into a variety of cell types including osteoblasts (bone cells), chondrocytes (cartilage cells), myoblasts (heart cells) and adipocytes (fat cells) [4,5]. This occurs through cross talk between complex signaling pathways including those derived from bone morphogenic proteins (BMPs), winglestype MMTV integration site (Wnt) proteins, hedgehogs, delta/jagged proteins, fibroblastic growth factors, insulin, insulin-like growth factors, and transcriptional regulators of adipocyte and osteoblast differentiation including peroxisome proliferators-activated receptor-gamma (PPARγ) and runt-related transcription factor 2 (Runx2) [6-9]. Differentiation of bone marrow mesenchymal stem cells may be involved in the development of osteoporosis.

Osteoporosis is induced with decrease in bone mass with aging due to decreasing osteoblastic bone formation and increasing osteoclastic bone resorption. Osteoporosis is a common metabolic disease and generally affects people at an advanced age and suffering from other chronic diseases. Osteoporosis is characterized by reduction of bone strength. The most dramatic expression of osteoporosis is represented by bone fractures. Osteoporosis is a major cause of the increase in morbidity and mortality in life. It is more common in women with a significant loss of bone after beginning of menopause. Especially, bone mass is dramatically reduced with depression the secretion of ovarian hormone (estrogen) in women [10]. The number of prescription medications, which recognized to increase the risk of osteoporosis or fractures, has grown as a result of recent studies. It is estimated that osteoporosis affects at least 200 million women worldwide, one third of women aged between 60 and 70 years and two thirds over 80 years. According to a recent World Health Organization report, osteoporosis has become a global health problem with a disease incidence and mortality rate similar to that of cardiovascular diseases, cancer and diabetes [11]. Thus, osteoporosis widely recognized as a major public health threat.

In recent years, osteoporosis has been shown to induce with obesity and diabetes [12,13]. Type 1 and type 2 diabetes have been associated with increase in fracture risk, and the population of type 2 diabetes with obesity is increased. Obesity is currently a major health problem worldwide and is growing in prevalence. Osteoporosis and obesity are now thought to be closely related and to share several features [7,8]. Osteoporotic fractures occur in overweight or obese people, and obese men may be particularly susceptible [14,15]. One of these shared features is that osteoblasts and adipocytes differentiate from a common precursor cell in the bone marrow, the mesenchymal stem cell. The pluripotency of mesenchymal stem cells is well known, and their ability to differentiate into osteoblasts and adipocytes has been described extensively [6,7]. There is an inverse relationship between differentiation of mesenchymal stem cells to osteoblasts and adipocytes. Secondary causes of osteoporosis including obesity and diabetes are associated with bone marrow adiposity which greatly produces tumor necrosis factor-a (TNF-a), an inflammatory cytokine [16]. TNF-a is known to suppress osteoblastogenesis and mineralization [17,18].

The author has been found that regucalcin stimulates adipogenesis and suppresses osteoblastogenesis in mouse bone marrow culture systems in vitro [19]. Interestingly, bone loss and hyperlipidemia have been shown to induce in regucalcin transgenic rats [20]. These findings suggest that development of osteoporosis is strongly involved in the regulation of differentiation of bone marrow mesenchymal stem cells. Moreover, biofactors, which regulate the differentiation of bone marrow mesenchymal stem cells, may have preventive effects on bone loss in obesity and diabetes. This finding may be significant to develop new drugs for the treatment of osteoporosis with obesity and diabetes.

Moreover, the authors have been found that plant component flavonoid p-hydroxyxinnamic acid (HCA) reveals an osteogenic effect and anti-osteoclastic bone resorption effect [21]. Among flavonoid xinnamic acid and its related compounds including HCA, ferulic acid, caffeic acid and 3, 4-dimethoxycinnamic acid, HCA has been found to have unique stimulatory effects on bone mineralization [21]. More recently, HCA has been shown to suppress adipogenesis and stimulates osteoblastogenesis in mouse bone marrow cell culture in vitro [22]. Interestingly, HCA has been demonstrated to prevent bone loss, hyperlipidemia and hyperglycemia in type 1 diabetic model rats in vivo [23]. Such biofactors, which stimulate the differentiation of bone marrow mesenchymal stem cells to osteoblastogenesis, may be respected as new osteogenic factors in the treatment of osteoporosis with obesity and diabetes.

Anti-resorptive agents have been used the preferred standard of clinical care for the amelioration of bone loss in osteoporosis. However, clinical compounds that stimulate bone formation are under development. Novel analogues, which are synthesized from bioactive chemicals derived from food factors, may be developed as new drugs that reveal potent-osteogenic effects for the treatment of osteolysis.
which is induced in various diseases including inflammation, obesity and diabetes. Development of osteogenic factors, which target the differentiation of bone marrow mesenchymal stem cells, may be important in biomedical osteoporosis treatment [24].

References

Submit your next manuscript and get advantages of OMICS Group submissions
Unique features:
• User friendly/feasible website-translation of your paper to 50 world's leading languages
• Audio Version of published paper
• Digital articles to share and explore
Special features:
• 250 Open Access Journals
• 20,000 editorial board members
• 21 days rapid review process
• Quality and quick editorial review and publication processing
• Indexing at PubMed (partial), Scopus, BIBCO, Index Copernicus and Google Scholar etc
• Sharing Option: Social Networking Enabled
• Authors, Reviewers and Editors rewarded with online Scientific Credits
• Better discount for your subsequent articles
Submit your manuscript at: http://www.omicsonline.org/submission/