Bone cells' branches sense stimulation, when to make new bone

July 20 2010

A long-standing question in bone biology has been answered: It is the spindly extensions of bone cells that sense mechanical stimulation and signal the release of bone-growth factors, according to research from The University of Texas Health Science Center at San Antonio.

The study, reported this week in Proceedings of the National Academy of Sciences *of the United States of America,* offers an important clue for developing therapies to treat the bone-thinning disease osteoporosis and bone loss associated with aging, said Jean Jiang, Ph.D., senior corresponding author from the Department of Biochemistry, UT Health Science Center Graduate School of Biomedical Sciences.

Sensitive extensions

"Osteocytes are the most abundant cells in bone," Dr. Jiang said. "In the field of bone biology, there was a long-standing debate as to which part of the osteocyte senses mechanical loading. In this study, we demonstrate for the first time that it is the extensions, which are called dendrites."

Regular physical exercise is highly beneficial in maintaining bone health and in prevention of bone loss and osteoporosis. Mechanical stimulation of the bone through weight bearing is critical for promoting bone remodeling, said Sirisha Burra, Ph.D., lead author from the Department of Biochemistry.

"Maintenance of bone health depends on the osteocytes' ability to sense the stimulation," Dr. Burra said. "If osteocytes lose this ability, it could possibly lead to diseases such as osteoporosis. Hence, it is important to understand this mechanism."

Mechanical impact

The Health Science Center collaborated with Southwest Research Institute in San Antonio to estimate the mechanical impact of force applied to the dendrites. Magnitudes of mechanical stress were determined.

"Understanding how bone cells sense and respond to mechanical signals within the skeleton is an inherently multidisciplinary problem," said co-author Daniel P. Nicolella, Ph.D., institute engineer in the Mechanics and Materials Section at Southwest Research Institute. "We determined the mechanical stresses applied to the osteocytes in these experiments so that they can be compared to the mechanical signals predicted to occur within the skeleton during routine physical activities."

Toll of osteoporosis

Approximately 8 million women and 2 million men have osteoporosis in the U.S. Affected bone becomes brittle and can fracture with minor falls. In severe cases, a bone can even break from a sneeze. Another 34 million Americans are estimated to have low bone mass and are at higher risk for osteoporosis. (Source: National Osteoporosis Foundation http://www.nof.org/osteoporosis/diseasefacts.htm)

Bone loss has been observed in astronauts who have spent a long time in space. Greater understanding of the process of bone remodeling could also aid in the discovery of solutions for the degenerative joint disease

osteoarthritis.

Intriguing idea

Apart from its clinical implications, the study is intriguing because it "brings in a novel thought that different parts of a single cell can have different material and sensory properties," Dr. Jiang said. "Different parts of the cell can react differently to the same stimulus. This is a very important fact to consider while studying cellular signaling and regulatory mechanisms."

Provided by University of Texas Health Science Center at San Antonio