The effects of exercise on bone

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Introduction

Not only is bone density higher in physically active people, but evidence suggests that increased in physical activity is associated with a lower rate of age-related bone loss. As we know, skeleton bone is a living tissue and requires constant turnover, accomplished through a process that repairs damage and alters bone mass in response to need. For most of the time, the bone responds to mechanical loading generated through exercise by increasing bone mass and strength. In human studies, bone development and bone mechanical properties are indicated by bone mineral density (BMD). Physical activity with weight-bearing has been shown to improve BMD.

Conversely, previous studies have reported that non-weight bearing exercise such as swimming have been shown to gain less skeleton benefit than do people who participate in weight-bearing activity.

Biomechanics/ Mechanics/ Explanation

Bone modeling and remodeling

Bone tissue is under constant reconstruction, bone has an ability to respond to mechanical forces and to gradually change its external geometry and internal (structure), a process called bone modeling. The adaptive modeling process of the bone occurs when bone is loaded by external forces that cause stresses and strains in it. Modeling drift is a mechanism of bone adaptation to stresses and strains. Formation drifts make and control new osteoblasts to add bone to some bone surface, while separate and independent resorption drifts make and control new osteoclasts to remove bone form other surface. Through this non-adjacent activity of both bone cells, their activity move bone surface to determine the shape and diameter of the bone and the strength of whole bone. Bone remodeling refers to the turnover of bone in small packets. It is a dynamic, lifelong process in which old bone is removed from the bone and new bone is added. It consists of two distinct stages-resorption and formation-that involved the activity of osteoclasts and osteoblasts. Loads on bone affected by weight bearing, muscle work, or other cause called stresses. The proportional change in bone in bone dimension is called strain. Functional strains in bone are between 500 and 3,000 microstrain. Stresses on bone must exceed the remodeling threshold strain range (50-100 microstrain) in order to activate mode remodeling. Whenever strains remain below the threshold, the process of disuse mode will take place.

Adaptive modeling and remodeling are sensitive to only dynamic loading changes, but not to static. A static load applied continuously produces an effect similar to disuse mode. Muscles (not body weight) have been shown to provide the largest loads on bone, and hence also the largest bone strains. Thus, muscle strength strongly influences bone strength and geometer. Swimming is the exercise that uses maximal muscles work, but it is considered as non- weight bearing activity. However, it still results the load on bone as bending strain. As research show, because of the applied loading produced by muscles activities in swimming may not reach the remodeling strain threshold. So the outcome appears to negatively in influence bone formation and thus bone density.

Application

As we know, the weight bearing activities can result to build the denser, strong bone. But not in non-weight bearing activities. Thus, when writing exercise prescription to clients, type of exercise should be counted to reach the ultimate goal. The best exercise for building strong bone should be weight bearing activities while non-weight bearing exercise such as swimming is beneficial to cardiovascular fitness. However, when writing the exercise prescription for specific population who is low in bone density such as osteoporosis, high impact exercises are not recommended because it might get more negative effects than positive. Then, non-weight bearing exercise should be applied to this case.

Table 1: summary of Literature

Topic	References
Bone modeling and remodeling mechanics	1,3,5,6,8,9,10,12
Effects of swimming to the bone	2
Stress and strain in bone	4,5,7
Muscle force on bone	11

Table 2: BMD by impact group

	Impact Group			
point	**High (n = 14)**	**Med (n = 11)**	**Non (n = 7)**	**Con (n = 7)**
Lumbar spine	1.38 ± 0.01*	1.30 ± 0.01	1.26 ± 0.001	1.20 ± 0.003
Femoral neck	1.26 ± 0.01†	1.14 ± 0.01	1.05 ± 0.004	1.04 ± 0.003
Ward's triangle	1.23 ± 0.01†	1.10 ± 0.002	1.04 ± 0.001	1.01 ± 0.01
Trochanter	1.04 ± 0.04†	1.02 ± 0.04†	0.86 ± 0.04	0.86 ± 0.02
TBMD	4.9 ± 0.14†	4.5 ± 0.12	4.2 ± 0.11	4.1 ± 0.09

Values are means ± SE expressed in g/cm; n, number of subjects. BMD, bone mineral density; TBMD, total BMD (sum of spine and hip measurements). * Greater than Con ($P < 0.05$); † greater than Non and Con ($P < 0.05$).

Summery

Skeleton bone is living tissue and requires constant turnover, accomplished through a process that repair damage and alters bone mass in respond to mechanical loading generated though exercise by increasing bone mass strength via the process bone modeling and remodeling. The magnitude of forces that could activate the bone bone's response should reach the bone remodeling threshold strain range (50-100 micro-strain). Muscle activities could cause the strain on the bone as bending stress. Swimming use the maximal muscle work, but it seems to have non-effect to bone as a bone building factor. Weight-bearing exercise is the best to build strong bone.conversely, non-weight bearing such as swimming is beneficial to cardiovascular fitness.

Reference

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