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Commentary

The Effects of Dehydration on Bone Health

Marc Slowk*

Department of Biomedical Research, University of Bern, Bern, Switzerland

DESCRIPTION

The biomechanical properties of bone, particularly its elastic behaviour, are important for understanding both its functional capabilities and its response to various stresses and strains. Among the factors influencing these properties, the hydration state of the bone plays an important role. Recent studies have shown that drying irreversibly affects the elastic behaviour of pelvic cortical bone, leading to significant implications for both clinical practice and biomedical research. Pelvic cortical bone is a dense, compact tissue forming the outer layer of bones in the pelvis. Its primary function is to support and distribute loads during activities such as walking, running, and lifting. The elasticity of this bone type is essential for its ability to absorb energy and resist fractures under mechanical stress.

Effects of hydration and drying on bone elasticity

Hydration significantly influences the mechanical properties of bone. Water content within the bone matrix helps maintain its flexibility and resilience. When bone is hydrated, water molecules act as plasticizers, facilitating the sliding of collagen fibrils and mineral crystals over each other. This interaction helps the bone absorb impact and distribute loads more evenly. When bone is subjected to drying, it loses its water content, leading to changes in its microstructure and mechanical behaviour. Several studies have demonstrated that drying can cause irreversible changes in the elastic properties of bone. These changes include:

Increased stiffness and brittleness: Drying removes water molecules that act as lubricants within the bone matrix. Without this lubrication, collagen fibrils and mineral crystals cannot slide past each other as easily, resulting in increased stiffness and brittleness. This makes the bone more susceptible to fractures under lower loads than when it is hydrated.

Altered microstructure: The removal of water can cause microstructural changes within the bone. These changes may include the collapse of collagen fibrils and alterations in the orientation of mineral crystals. Such microstructural alterations can permanently affect the bone's ability to deform elastically and absorb energy.

Reduced energy absorption: Hydrated bone can absorb more energy due to its elastic nature. However, when dried, the bone loses this ability, making it less capable of dissipating energy from impacts or sudden loads. This reduction in energy absorption can lead to a higher likelihood of fractures.

Implications for clinical practice

Understanding the irreversible effects of drying on pelvic cortical bone has significant implications for clinical practice. For instance, in medical scenarios where bone samples need to be preserved or stored for extended periods, maintaining hydration is important to prevent irreversible changes in mechanical properties. This is particularly important for bone banks and research laboratories. The design and development of orthopedic implants and prosthetics should consider the hydration state of bone. Implants need to mimic the mechanical properties of hydrated bone to ensure compatibility and longevity.

Forensic scientists and archaeologists must account for the effects of drying when analysing bone samples. Drying-induced changes in bone properties can impact the interpretation of trauma and the reconstruction of historical events. For researchers studying the biomechanics of bone, recognizing the irreversible impact of drying is essential for accurate experimental results. Experimental protocols should ensure bone samples remain hydrated to maintain their natural elastic properties.

CONCLUSION

The irreversible effects of drying on the elastic behaviour of pelvic cortical bone underscore the importance of hydration in maintaining bone health and mechanical function. Understanding these effects is vital for various applications, from clinical practice to biomedical research. By preserving the hydration state of bone, we can ensure its structural integrity and optimize its functional capabilities, ultimately enhancing our ability to prevent and treat bone-related conditions.

Correspondence to: Marc Slowk, Department of Biomedical Research, University of Bern, Bern, Switzerland, E-mail: marswk@yahoo.com

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