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Optical Approach to the Biomechanical Analysis of Osteoporotic Spine Fractures

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Introduction

Osteoporosis is a disease characterized by low bone mass and micro architectural deterioration of bone tissue, leading to increased risk of fragility fractures. In order to understand how osteoporosis develops, we must first understand what happens to bones during aging. With age, the amount of calcium lost through urine increases, causing calcium levels in blood to drop. When calcium levels fall too low, the body starts to take calcium out of the bones instead of putting it back in. This process causes bones to lose density and strength. Eventually, if enough damage occurs, the bones break.

Fractures represent one among the most serious consequences of osteoporosis for elderly people. In the case of elderly people who suffer from osteoporosis, fractures of the spine represent one of the main symptoms of the disease. When these fractures occur, they can cause severe pain, decreased mobility and an increase in the number of hospitalizations. These fractures are important because they can lead to further complications such as pneumonia, urinary tract infections, pressure sores and deep vein thrombosis. They are also important because they can increase the risk of future fractures. The fracture occurs when there is a lack of resistance between two adjacent vertebrae.

Description

This happens when the mechanical resistance of a vertebra is lower than the load applied to the segment to which it belongs. The fracture occurs when a person suffers a fall and hits his/her back against a hard surface. Another factor that increases the likelihood of suffering a fracture is the presence of osteoporosis in the affected individual. Osteoporosis is characterized by a loss of bone mass and deterioration of the microstructure of the bones. This leads to a reduction in the mechanical resistance of the bones, increasing the risk of fracture. The fracture occurs when an individual falls and hits his/her head against a hard surface. Flexion is one among the components that can be associated with producing spine fractures. In natural-backbone, living conditions, many fractures are developed by axial load on your spine, however, there is a component of force determined by the increase of the backbone curves.

When axial load, usually there is a plastic deforming of the vertebrae bone (that has a lesser mechanical strength on axial load compared with the posterior column) generating the deformation in angle flexion of the spine localized at the place of the fracture. The extension component of the force becomes much more important with deformity because of the fracture. In a cervical spine, there is kyphosis, meaning that, on an axially loaded spine, the behavior of the backbone could be to hyperextension, not to flex. Nevertheless, in our study, we utilized a short backbone segment and we studied the instant the fracture lines appeared on your vertebral body.

Considering lumbar curvature, as mentioned before, the spinal column can be compressed axially and the goal of our experiment was investigating this and seeing whether, if the force was applied more posteriorly, the segment would hyper elastic. In the last situation the mechanical behavior changes and even if the original behavior may be relevant (increased native curves of the spine) it is not relevant for compression fracture of the vertebrae (as is usual in Osteoporotic fractures). The purpose of this study is to analyze the biomechanics of the osteoporosis spine on pure axial loads and combined axial–hyperextension loads and understand the mechanisms producing fractures of the vertebral bodies. A study on the incidence of spine fractures is very interesting, but at the same times very difficult to conduct because of the anatomical structure of the spine as well as the major difference between in vivo and in-vitro requirements. This is the main reason why views differ from each other, from using the finite element method to the biomechanics method, on spine segments taken from humans or pigs. In the current study, we used the biomechanical method to observe the displacements and strains of the intervertebral discs, endplates and vertebral bodies.

Structural integrity of the vertebral spinal column is essential for quality of life and proper functioning of the entire body. However, degenerative changes caused due to aging trigger severe changes to the spine anatomy with irreversible changes in its response to activities of everyday living. Intervertebral disc degenerative changes are common after the age of 50 and can lead to serious health problems if left untreated. The relation between the structural integrity of the vertebrae and its ability to withstand loads is quite complex, involving vertebral bones, the cortical system, the trabecular bone system and the intervertebral discs. The intervertebral disc plays an important role in transferring compressive forces from one level to another and then to the vertebral bodies [1-5].

Conclusion

Almost every human activity involves the spine, so understanding the biomechanics of this structure is vital. At the level of each vertebra, compression forces are transferred from the intervertebral disk to the vertebral plate, then to the vertebral body. With aging, there are biochemical alterations at the level of the disc and vertebral plate, leading to loss of mechanical properties.

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