CHARACTERIZATION OF BONE TISSUE OF HUMAN FEMORAL HEAD

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Introduction

In 2010, an estimated 524 million people were aged 65 or older, it is 8 percent of the world's population. By 2050, this number is expected to nearly triple to about 1.5 billion, representing 16 percent of the world's population. The functionality of bone, including both mechanical and homeostatic functions (tissue quality) become impaired with aging related diseases. Unfortunately, understanding of how fundamental biological mechanisms change in bone tissue during metabolic bone diseases is lacking. Bone fracture risk and joint deformities in patients cannot be fully accounted for by currently available clinical methods such as Dual-energy X-ray absorptiometry. This drawback is because tissue quantity measurements (bone mineral density) alone provide little or no information on bone microarchitecture or material properties, both of which are important in bone quality. The most notable clinical skeletal disorder where bone quantity is clearly insufficient to explain increased fracture risk is osteoporosis, affecting 0.5% of the general population [2], where bone mineral density measurements show no significant association with fractures [3, 4].

Aim of this study is multiscale characterization of bone tissue of human femoral head and neck regions from osteoporotic patients using scanning Synchrotron X-ray diffraction to elucidate bone quality and its alterations during age related diseases conditions at physiologically relevant loading rates.

Methods

Bone specimens (femoral head and neck regions) will be harvested from patients (undergoing surgery for totoal hip replacements by surgeons. Control samples will be collected from the tissue bank in Sri Lanka.

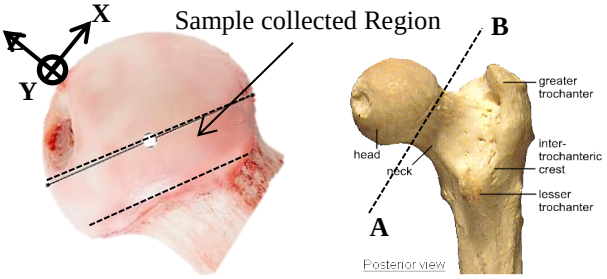

Figure 1: Femoral head and three reference directions

Bone specimens were sectioned (along AB line) from the cadaveric femora (controls: n = 6) and osteoporotic patients (n = 5) using a diamond low speed saw under constant irrigation into rectangular cross-sectioned beams with width ~ 2 mm, length 10 mm and thickness ~ 1 mm. Three bone specimens were obtained from X, Y and Z orientations of the femoral head as shown in the Figure 1. Each specimen was scanned for it mineral and collagen orientation.

Results

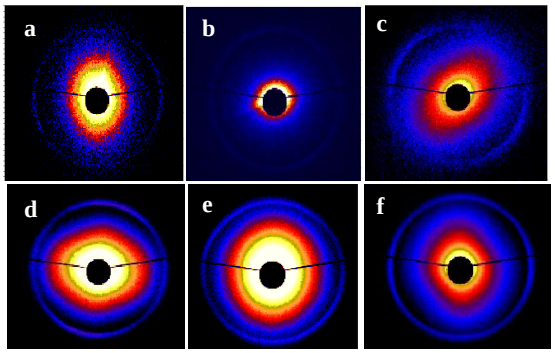

*Figure 2: SAXD images of healthy control bone (**a,b&c**) and osteoporosis fractured bone samples (**d,e&f**). **a,b & c** are respectively x,y & z directions of healthy tissue. **d,e & f** are respectively x,y & z directions of fractured bone tissue.*

According to above SAXD images, Mineral orientation of healthy tissue of femoral head are oriented around x and z axes. Collagen orientation also aligned preferred direction. Mineral and Collagen orientation of diseased tissue of femoral head are randomly oriented around three axes.

Discussion

Mineral and collagen orientation of control samples are highly orientated than diseased samples.

Mineral and collagen orientation of osteoporosis fractured bone samples are randomly orientated.

References

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