CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

S0306

Project Title

Microstructural and Mechanical Characteristics of Alligator Osteoderms: Applications in Bioceramics

Abstract

Objectives/Goals

Although ceramics are versatile and similar to human bone tissue, they are somewhat fragile compared to real osseous tissue, which can lead to some physical complications when they are used as bone replacement materials. Therefore, an alternate synthetic material, one that is both structurally sound as well as lightweight and flexible, might be more suitable for bone graft procedures. Through analysis of the mechanical characteristics of alligator osteoderms and comparison to ceramics and osseous tissue, a more efficient material for human bone grafts may be revealed.

Methods/Materials

A compression test was run for each alligator osteoderm sample. From the attained values, graphs were created, from which the Young's modulus, ultimate compressive strength, and toughness were calculated for each stress-strain curve. The microstructure of alligator osteoderm tissue was observed with optical microscopy and electron microscopy. The data was compared to values of the same properties for mammalian cancellous and cortical bone, to determine the viability of a biosynthetic material modeled after osteoderm tissue as a bone replacement.

Results

The stress-strain curves produced average values of 2.263 GPa for Young's modulus, 57.53 MPa for ultimate compressive strength, and 10.59 MJ/m3 for toughness. Although differing in some values from the original hypothesis, the osteoderm proved to be stronger than mammalian cancellous bone and more flexible than mammalian cortical bone. The microstructural characteristics of ligament bridging and porous structure may account for these differences in mechanical properties.

Conclusions/Discussion

While the alligator osteoderm tissue yielded a lower toughness than mammalian cancellous bone, it had significantly higher ultimate compressive strength and Young's modulus. These results suggest that synthetic material modeled after alligator osteoderms could potentially serve as a feasible replacement for bone grafts.

Summary Statement

This project compared the mechanical properties of alligator osteoderms to those of mammalian bone to determine the practicality of developing an effective biosynthetic material modeled after osteoderm tissue for use in bone replacements.

Help Received

Used lab equipment and tissue samples at UCSD under the supervision and guidance of Dr. Joanna McKittrick and Ms. Irene Chen; Mrs. Cheryl Stock provided valuable feedback on notebook and presentation.