Abstract Title
Design Parameters for Resorbable, 3D Printed Medical Devices

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Presenter Biography
David Dean, Ph.D. is an Associate Professor of Plastic Surgery in the College of Medicine, and a member of the Center for Regenerative Medicine and Cell-Based Therapies, at The Ohio State University in Columbus, Ohio. His Laboratory's research focuses on bone tissue engineering. He earned the PhD degree at the City University of New York (New York, NY) in 1993. His research field is bone tissue engineering and craniofacial regenerative medicine, with current emphases in: computer aided design, biomechanical modeling, additive manufacturing, bone progenitor cells, growth factors, and bioreactor technologies for the production of tissue engineered craniofacial implants.

Benefits/Take-Aways

1. Upon completion, participants will be able to explain the current state of research and utilization of resorbable polymer, ceramic, and metal materials for the additive manufacture of medical devices.

2. Upon completion, participants will be able to describe several of the challenges facing the reconstruction of bones, ligaments, tendons, fibrocartilage, and joint capsules.

3. Upon completion, participants will be aware of the importance of the design of pore geometry of resorbable polymer, ceramic, and metal implants.

Presentation Topic (select all that apply)

- ✓ Medical Materials
- ✓ Design of Resorbable Medical Devices

Content Type (select one)

- o Case study
- ✓ Expert overview
- o Industry research
- o New application
- o New technology
- o Other

Audience Experience Level

- o New - considering first purchase of equipment OR using a service bureau
- ✓ Little Experience - 2 years or less primarily with one technology
- o Some Experience - more than 2 years with possible more than one technology
- o Experienced - more than 5 years' experience and familiar with several technologies
- o Very Experienced - More than 10 years' experience and knowledge of most technologies

Significance/Importance of this presentation

Beginning in the mid 1980's additive Manufacturing (AM) was used to provide patient-specific (PS) anatomical models to guide skeletal and/or joint replacement reconstructive surgeries. In the 1990's PS surgical guides and indirect production of PS implant shapes that were recast in implantable materials were added to this repertoire. In the 2000's direct printing of inert PS polymer cranial implants became common and PS 3D printed metal medical devices were introduced. Now in the 2010's we are beginning to see 3D printing of PS implants in a wide variety of materials, especially for dental applications, but few use resorbable materials. This presentation will cover the state of current research into and the opportunities for 3D printing off-the-shelf and PS resorbable polymer, ceramic, and metal implants to be used in the clinic.

Abstract

Resorbable 3D printed, patient-specific polymer devices are beginning to make their way to the clinic. As yet there are few if any resorbable 3D printed ceramic or metal devices in the clinic. These three classes of materials face different challenges. They must show cost-benefit advantages over off-the-shelf devices, reliable resorption profiles, safe degradation byproducts, and the ability to help the body heal. Research into resorbable metals, mostly Mg alloys, has just begun and 3D printing is barely understood. A major opportunity appears to be in skeletal fixation. Research into the 3D printing of resorbable bioceramics is further along. There may be several opportunities for these devices in musculoskeletal and dental applications. Resorbable polymeric implants whether solid cured or in hydrogel form, are the furthest along. Resorbable solid cured polycaprolactone implants are already in the clinic. We will present patent-pending research into the design space of dual-initiator, resorbable polymer resin systems for 3D printing small, sharp objects to hold fast for 6-12 months while ligaments, tendons, fibrocartilage, or joint capsules heal. We will also show the relationship of different pore geometries, surface area, and polymer molecular weight to implant strength and resorption profiles.