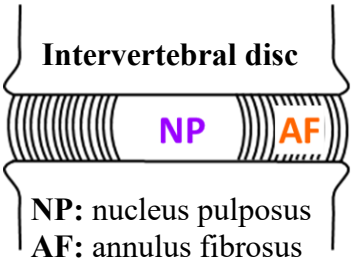
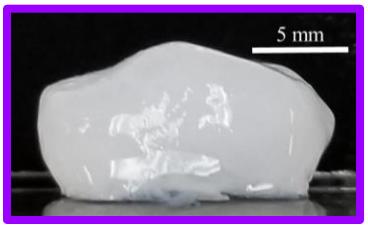
Mechanically Competent Biologic Implants for the Repair and Regeneration of Intervertebral Discs





Left, acellular bovine nucleus pulposus (*ABNP*). **Right,** annulus fibrosus repair patch (*AFRP*)

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Motivation: Annually, over 5.7 million Americans are diagnosed with intervertebral disc (IVD) disorders which include IVD degeneration (IVDD) and/or herniation leading to patient pain and disability.[1] Mechanistically, these pathologies have been shown to cause structural damage to the nucleus pulposus (NP) and annulus fibrosus (AF) regions of the IVD leading to mechanical dysfunction. To date, the major limitation of IVD repair is that no ideal biomaterials have been developed which can immediately restore mechanical competency of the IVD, while also allowing for regeneration of the damaged IVD tissue.

Product/Technology Description: The acellular bovine NP (*ABNP*) and AF repair patch (*AFRP*) are novel, decellularized xenogenic biomimetic materials derived from bovine NP and porcine pericardium, respectively. The ABNP maintains physiological levels of glycosaminoglycans and type II collagen. The AFRP's structure has been designed to mimic the multi-laminate angle-ply architecture and mechanical properties of the human AF. When used together to repair the injured IVD, these materials have demonstrated the ability to restore axial and torsional IVD kinematics. The advantages of our biomaterials compared to competitors include: 1) similar mechanical properties to native human IVD tissues, 2) the ability to generate and withstand intradiscal pressures, respectively, 3) the ability to support cell survival and proliferation, and 4) ability to be manufactured using scalable batch processing and simple assembly techniques.

Market Opportunity: The total global market for spinal orthopedic devices was valued at $7.3 billion in 2014 (growth rate of 6.4% from 2012-2014) and is expected to reach $10.7 billion in 2019.[2] Non-fusion spinal technologies comprise approximately 10% of this market. More specifically, our products will infiltrate the segment shared by minimally invasive discectomy devices valued at $1 Billion.[3] In 2009, the total number of lumbar discectomies performed in the United States was approximately 136,482.[4] Based on this clinical data and reimbursement rates associated with discectomy (derived from ICD-10-CM/PCS OSB24ZZ), we conservatively value the total available market to be approximately $500MM.

Stage of Development: The ABNP and AFRP have undergone individual preclinical verification testing for mechanical strength (dynamic mechanical analyses and uniaxial/biaxial tensile testing), durability, and cytotoxicity to address device safety, efficacy, function, and usability. Combined, the ABNP and AFRP biomaterials demonstrated mechanical restoration of damaged functional spinal kinematics including the restoration of creep and axial compressive loading parameters. Additionally, evaluation of these biomaterials in a large animal model of IVDD is currently underway.

Intellectual Property: US and PCT patent applications for both technologies: ***ABNP*:** "Decellularized biomaterial and method for formation." Filed: 09.08/2016- Application No. PCT/US2016/050689. International Publication Number: WO2017/044570 A1. ***AFRP***: "Multi-Layered Biomimetic Material and Method of Formation." Filed 09/08/2016- Application No. PCT/US2016/050693. International Publication Number: WO2017/044573 A1. USSN: 15/758,528. Filed: 08-Mar-2018.

Future Development: On-going studies are being conducted to evaluate the capacity of the implants to support regeneration in both *in vivo* and *ex vivo* models. For future assessments, we are looking for partnerships to assist in the funding of a larger animal study to evaluate the efficacy of our implants.

References: 1) Praemer *Am Acad Orthop*. 1999. 2) MountainTop Medical. *Kalorama Information Market Intelligence* 2015. 3) Medtech Insight 2013. 4) Yoshihara *Arch Orthop Trauma Surg*. 2013.