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Uncovering the fundamental behavior of annulus fibrosus using composite mechanics

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In the United States, the National Institute of Health estimated the economic impact of lower back pain to range between $19 and $71-billion per annum, where such pain has been associated with the degeneration of intervertebral discs. At advanced stages of degeneration, surgical intervention is required to alleviate the pain and allow patients to regain functionality for some of their daily activities. The focus of this research is to uncover the fundamental physical significance of the anatomical structure of the natural annulus fibrosus and its impact on the mechanical behavior of the annulus to resist common physiological loads. The approach was to focus the research on three consecutive phases. First, mechanics of engineering composite materials were used to predict the deformation resistance properties and failure behavior based on data available in the literature. Second, a new E-glass/PDMS composite laminate was manufactured using wet-layup processes, where the fiber volume fraction was set to 50% with the ability to be tailored based on the desired properties. Finally, digital image correlation was integrated in a new experimental setup that applies uniform pressure on the internal surface of an E-glass/PDMS surrogate annulus. It was found that the predications using the constitutive relationship of orthotropic materials show good agreement with experimentally measured stiffness and failure strains. The newly proposed E-glass/PDMS material was also found to match the behavior of the native annulus, while being mildly anisotropic. Also, it provided the global properties of the biological structure.

Biography

George Youssef has received his PhD in Mechanical engineering from University of California Los Angeles in 2010. Before joining SDSU, he was a faculty member at California State University, Northridge. His research is in the area of experimental mechanics of nontraditional materials, which include polymers, composites and smart materials. He is currently leading the research on the application of composite materials in bioengineering, integration of smart materials in roughness control and effect of environmental conditions on mechanical performance of protective polymeric coatings.

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