Simulation Aids Researchers Studying Spinal Disc Implants

DePuy Spine, Inc.

Orthopedic Implants

U.S.A.

www.depuyspine.com

ANSYS®

ANSYS® Structural™

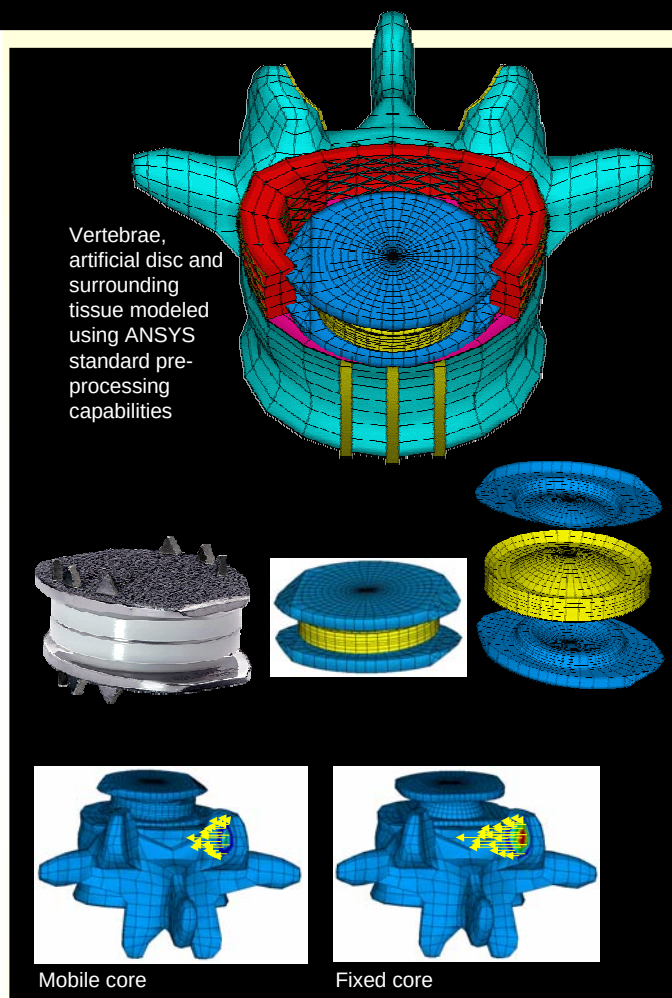
Overview

DePuy Spine Inc., one of the fastest growing companies within the medical device and diagnostic sector of Johnson & Johnson, is a leading supplier of orthopedic spinal implants to treat patients with spinal conditions resulting from degenerative diseases, deformities, trauma and sports-related injuries. One of the company's leading products is the CHARITÉ™ artificial disc. The device recently was approved by the U.S. Food and Drug Administration (FDA) and is the first device introduced in the U.S. as an alternative to spinal fusion surgery for treatment of lower back pain caused by degenerative disc disease. Until recently, surgical interventions consisted of limiting the range of motion of afflicted spinal segments. The CHARITÉ is designed to eliminate pain and maintain motion of the operative segment. The device incorporates a mobile core design while most competitive artificial discs offer a fixed core that may not restore full range of spinal motion and consequently may transfer additional stress to other areas of the spine, at which point secondary problems may develop. Major drawbacks, such as larger stresses and unnatural motion paths, are even more pronounced with traditional spinal fusion surgery in which adjacent vertebrae are rigidly joined to totally immobilize a portion of the spine.

Testimonial

"ANSYS software is an effective tool in simulating the function of the spine. Contact elements are extremely useful in modeling the complex configuration of components that touch one another. Nonlinear capabilities of the software are critical in accurately representing the material properties and behavior of the artificial disc and surrounding cartilage, ligaments and muscle tissue. Such powerful finite element modeling and analysis technologies are essential in studying impact, stresses and loading in various parts of the spine. Simply put, our work could not have been done as quickly and accurately any other way."

Dr. Missoum Moumene
Senior Principal Engineer
Research & Development
DePuy Spine Inc.



Mobile core

Fixed core

Challenge

The CHARITÉ is a three-piece articulating device consisting of a polyethylene core sliding between two cobalt chromium alloy endplates that attach to the vertebrae with metal teeth above and below the damaged disc space. As is generally done with medical breakthroughs, researchers keep striving to understand and improve the behavior of total disc replacement implants. Of particular interest is understanding the effect of implant placement within the disc space on the loading of the facets, the protruding portions of the vertebrae clinically known to be generators of pain when supraphysiologically loaded. Traditionally, such studies are performed with cadaveric testing instrumented with strain gauges and pressure sensors. However, this method is time-consuming, expensive and often inconclusive.

Solution

Researchers at DePuy Spine used ANSYS Structural to model and analyze how well the CHARITÉ artificial disc helps restore motion and how it is affected by its placement relative to the center line of the disc nucleus. They obtained contoured geometry of the vertebrae from computer tomography (CT) scans of actual bone structure. All parts of the CHARITÉ and surrounding tissue were modeled using ANSYS standard pre-processing capabilities and analyzed with ANSYS Classic Structural. Work was done on a standard Intel-based IBM M Pro desktop workstation. The ability of ANSYS to represent the nonlinear material properties was critical in this study. Moreover, contact representation was aided with ANSYS surface-to-surface contact elements, which automatically detects and adjusts dissimilar meshes.

Benefits

ANSYS simulation enabled researchers to determine what constitutes an optimal placement of the artificial disc. The analysis showed that strain and loads on facets are significantly less with the mobile core CHARITÉ when compared to a fixed core competitive device for total disc replacement. In addition, the study contributed valuable insight into spine biomechanics, the details of which have not been well understood until now. This information will provide valuable knowledge for the continuing development of artificial disc and related technologies. Working with some of the world's most respected spine surgeons, researchers at DePuy Spine already are using the results of this study and other simulation-based work to fine-tune procedures and techniques for an optimum positioning of the device.