MSC Software

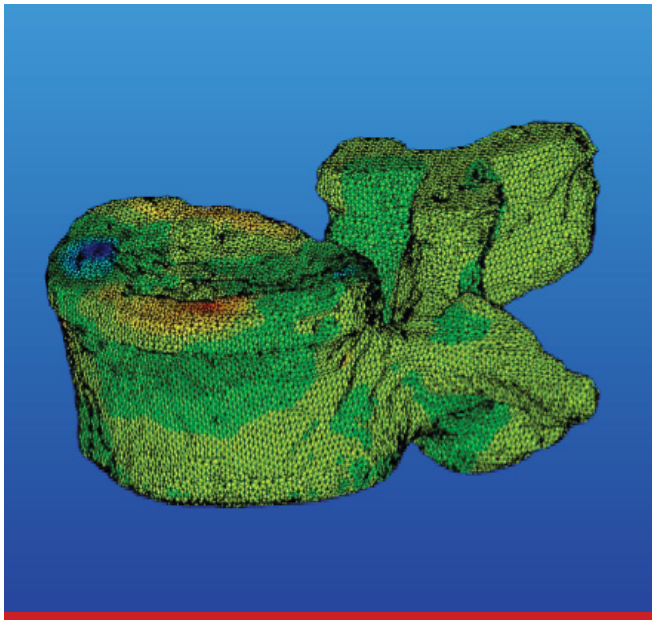
Case Study: **Infosys**

MSC Nastran Provides More Accurate Solution to Assess Bone Fracture Risk

Overview

Humans lose bone mass with age because their bones lose calcium and other minerals and become lighter, less dense and more porous. As this process continues, our bones become weaker, increasing the risk of bone fracture. A patient is said to have osteoporosis when bone mineral density (BMD), the concentration of minerals in a unit volume of bone, falls below a threshold value.

Currently, doctors estimate bone fracture risk using measurement of BMD combined with various methods such as physical examination of CT scans or X-rays and other physiological parameters such as gender, age, weight, etc. These diagnostic methods are primarily qualitative and don't take into account various mechanical factors of vertebrae such as shape, cortical bone thickness, density distribution of cortical bone -- the outer region of the vertebrae, density distribution of cancellous bone -- the inner region of the vertebrae, material properties of bone tissue, etc.



Stress Plot of Vertebrae using Patran and MSC Nastran

“With this new solution from Infosys, doctors can precisely determine the pathophysiology of the pain due to osteoporosis in individual cases. This will help us select the appropriate patient specific treatment”

Dr. Ketan Gaikwad, Radiologist

Challenge

Treatment for osteoporosis is complex, laborious, expensive and exposes the patient to the risk of side effects. The imprecision of current methods of diagnosing risk for bone fracture mean that there are probably many patients who are subjected to such treatments when their risk of bone fracture is quite low. Medical professionals need more accurate methods of determining the risk of bone fracture which should take into account individual patient characteristics in order to assess potential rewards and risks of various possible treatments. The Infosys team consisting of Dattatraya Parle, Principle Consultant - Advanced Engineering Group, and Anirudha Ambulgekar, Engineering Analyst worked with Dr. Ketan Gaikwad, Radiologist based in Mumbai, India, with the goal of utilizing computational techniques to model the actual biomechanical changes taking place in the bone structure of the vertebrae to quantify the risk of bone fracture. The objective of this project is also to utilize some of the best practices of mechanical engineering to solve problems in biomedical engineering.

Solution/Validation

The Infosys team developed a solution using computer-aided design (CAD) and finite element analysis (FEA) tools to study the mechanics of vertebrae while taking into account various factors such as the shape, density distribution of cortical/cancellous bone and other material properties of bone tissue and porosity. The innovative solution developed by Infosys applies the proven principles of mechanical engineering to understand the biomechanics of the human vertebrae and reduce the scope of errors in estimating fracture risks. The solution helps practitioners to study bones in a detailed and non-invasive manner, and quantitatively analyze the fracture risk of vertebrae.

The Infosys team utilized 50 computed tomography (CT) scan images of an older osteoporotic patient’s vertebrae. The CT scan images were used to generate a patient specific 3D CAD model containing the exact shape and size of the porosity in the vertebra of a patient. The CAD model was calibrated to actual dimensions

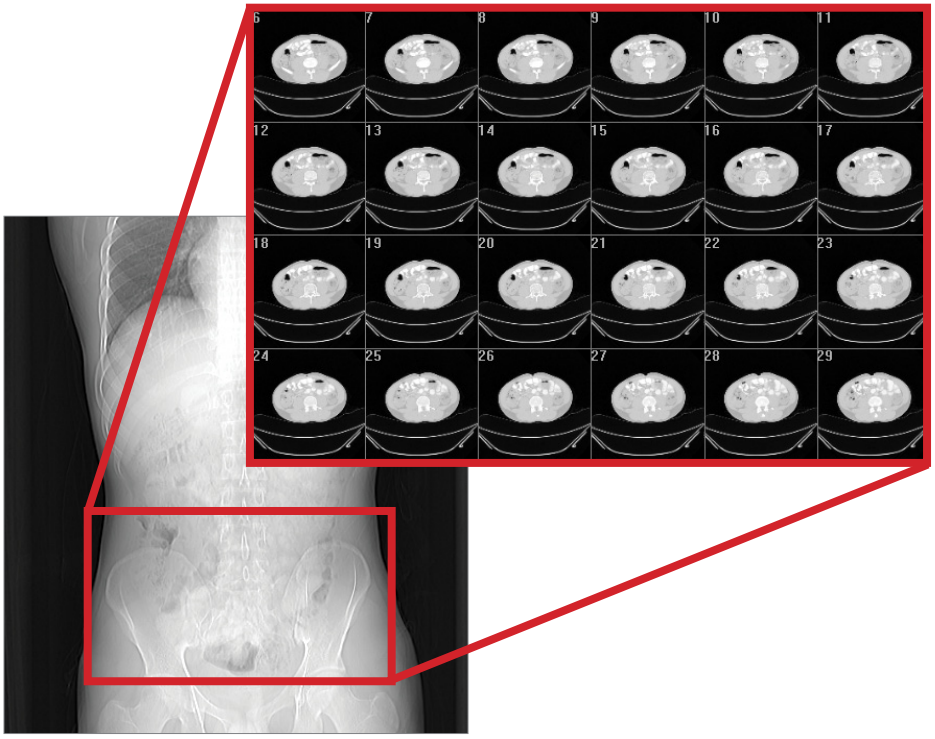
Key Highlights:

Product: Patran, MSC Nastran

Industry: Medical Device

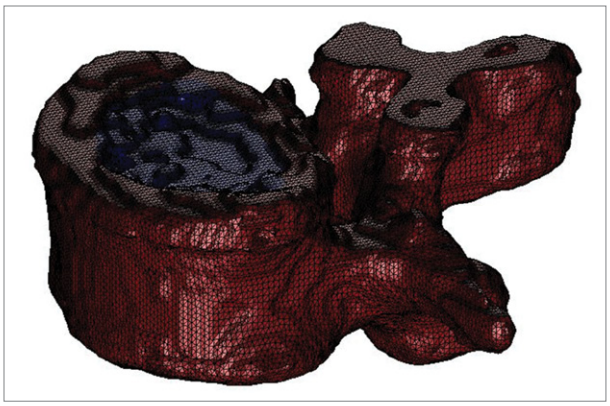
Benefits:

- Using MSC Nastran to study the mechanics of vertebrae while taking into account various factors such as the shape, density distribution of cortical/cancellous bone and other material properties of bone tissue and porosity.
- The solution helps practitioners to study bones in a detailed and non-invasive manner, and quantitatively analyze the fracture risk of vertebrae
- Stresses computed through the simulation provide more accurate assessment than traditional BMD measurements in the determination of fracture risk

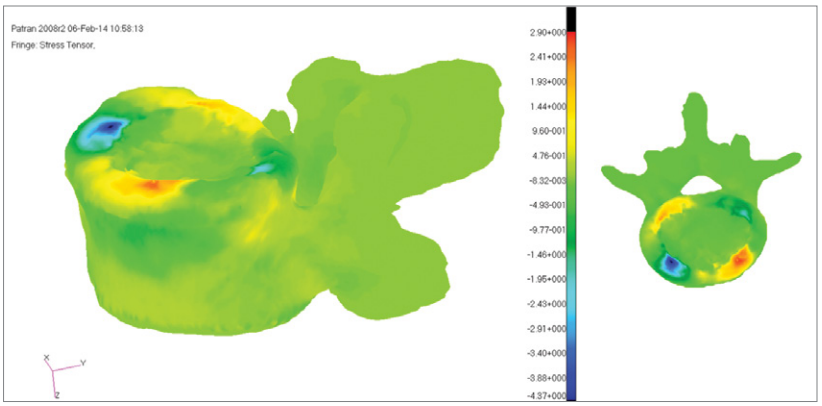


24 of the 50 CT scan images used to create CAD model

CAD model is calibrated to actual dimensions before exporting model to Patran



Meshed model of vertebrae in Patran

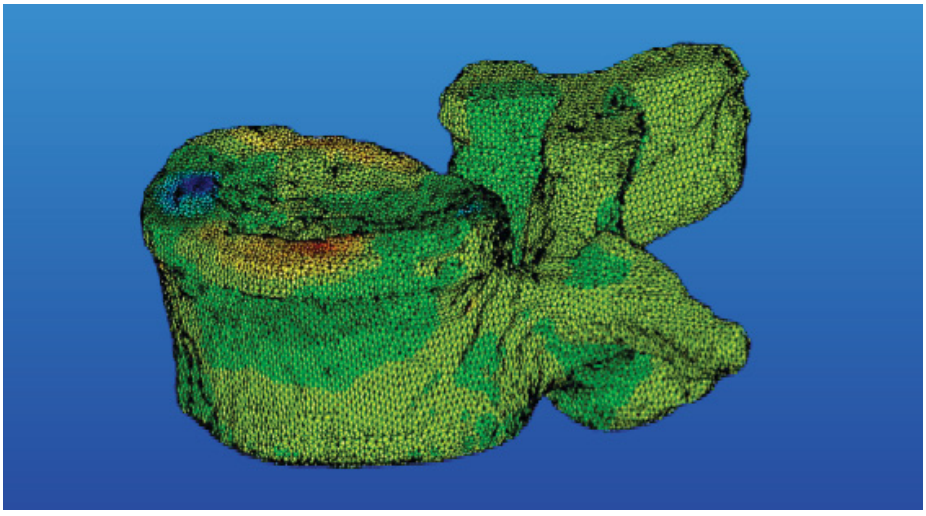


Compressive stress pattern developed in vertebrae

before using it for further analysis of fracture risk within the FEA framework.

Infosys selected MSC Nastran for this problem as it is one of the most widely used FEA solvers and has been certified by the FAA and other regulatory agencies. In this project, the accuracy of the FEA tool is important because, once this method is more fully developed; critical medical decisions may be based on the FEA results. Results must be produced quickly enough to make diagnostic decisions and there is no time to spend evaluating the accuracy of FEA software. Based on experience and reputation, Infosys engineers have confidence in MSC Nastran results.

Infosys engineers created the FEA model by considering the actual shape and size of the osteoporotic patient's vertebra in the 3D model. The FE model was created using CTETRA elements in MSC Patran. Mesh quality parameters were maintained in order to improve accuracy. Two types of material properties were obtained from physical test results available in literature for the cortical and cancellous bone. The study used 1000 N compressive force on the lumbar spine while sitting erect which is a typical value found in the literature although it is somewhat on the conservative side. However, loading depends strongly on the posture of the body. The bottom of the vertebrae is fixed. Compressive stresses induced in vertebra were used to compute patient specific fracture risk factor considering porosity shape, size and material properties.



Stress Plot - Element Edges

Results

This innovative solution to osteoporosis developed by Infosys uses computer-assisted design and FEA for the evaluation of fracture risk of the vertebrae quantitatively. Stresses computed through the simulation provide more accurate assessment than traditional BMD measurements in the determination of fracture risk. It applies best practices in mechanical engineering to understand the biomechanics of vertebrae.

"With this new solution from Infosys, doctors can precisely determine the pathophysiology of the pain due to osteoporosis in individual cases. This will help us select the appropriate patient specific treatment", said Dr. Ketan Gaikwad.

About Infosys

Infosys is a global leader in consulting, technology, and outsourcing solutions. As a proven partner focused on building tomorrow's enterprise, Infosys enables clients in more than 30 countries to outperform the competition and stay ahead of the innovation curve. With US$8.25bn in FY14 revenues and 160,000+ employees, Infosys provides enterprises with strategic insights on what lies ahead. The company helps enterprises transform and thrive in a changing world through strategic consulting, operational leadership, and the co-creation of breakthrough solutions, including those in mobility, sustainability, big data, and cloud computing.

For more information on MSC Nastran and for additional Case Studies, please visit **nastran.mscsoftware.com**

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