Simulation Modeling of Medical Devices

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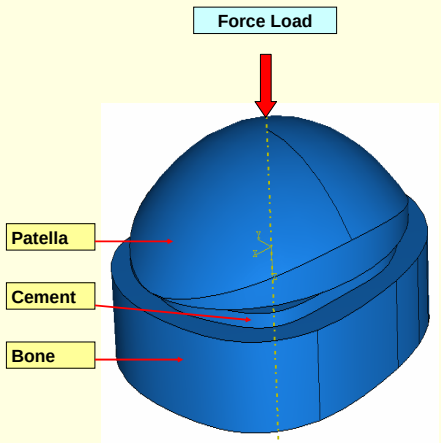
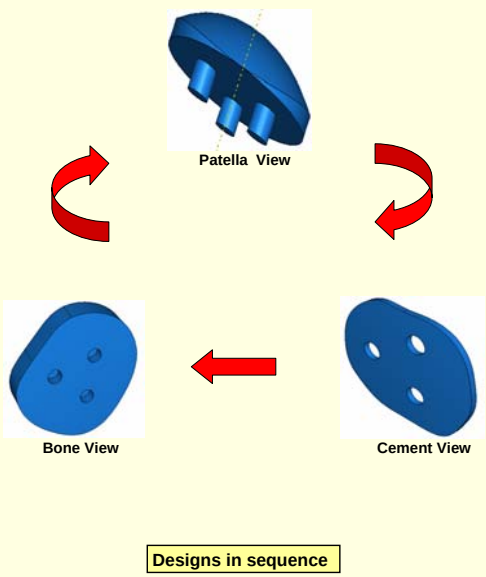
Abstract

The patella is one of the most complex joints of the human body, from both structural and kinematic points of view. It is composed of two different joints; the femoro-tibial joint between the distal part of the femur (thigh bone) and the proximal part of the tibia (shin bone) and the patello-femoral joint, consisting of the patella, which articulates with femoral surface. Total Knee Arthroplasty (TKA) is required in severe cases to restore the joint in many patients each year. During surgery, a plastic patella is implanted to augment the original patella. The original patella is flipped over, shaved flat, and drilled with three holes into which the three pegs of the plastic patella are fit. Bone cement is then placed between the plastic patella and the natural patella to stabilize the implant. The implant was designed using ABAQUS™, a Computer Aided Engineering (CAE) software used for creating geometry models, performing finite element stress analysis, and viewing results. It gave a simple understanding of how basic techniques can be applied to a system to create a successful design.

Experimental Design

- **Software**
  - ABAQUS™
- **Design Criteria**
  - Plastic Patella (1” radius dome shape – 0.38” thick)
  - Posts (0.1732“ diam - 0.19“ thick)
  - Patella bone (1” radius – 0.3125” thick)
  - Bone cement (1” radius – 0.04” thick)
- **Assembly Method**
  - Half the side profile of Plastic Patella created (rotated 360° for dome shape)
  - An elliptical cut made to shape Plastic Patella
  - Three posts added
  - Patella bone created with three holes (0.09” radius)
  - Bone cement created with three holes (0.09” radius)





Designs in sequence

Conclusions

ABAQUS™ simulations provided a simple, consistent interface for creating, submitting, monitoring, and evaluating results of the Plastic Patella Geometry Model. It’s modules defined a logical aspect of the patella implant’s modeling process; such as defining the geometry, defining material properties, generating a mesh, and submitting for analysis jobs. Separate material properties of Young’s Modulus and Poisson’s Ration were applied to each of the three parts (patella, cement, bone) to assemble the composite model. Perpendicular force loads were applied to simulate the finite stress analysis, in which the job was meshed and submitted for results.

Future Goal

To gain an understanding of the stresses on the resected patella with cemented prosthesis, in order to design better patellar resurfacing prosthesis in the future

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