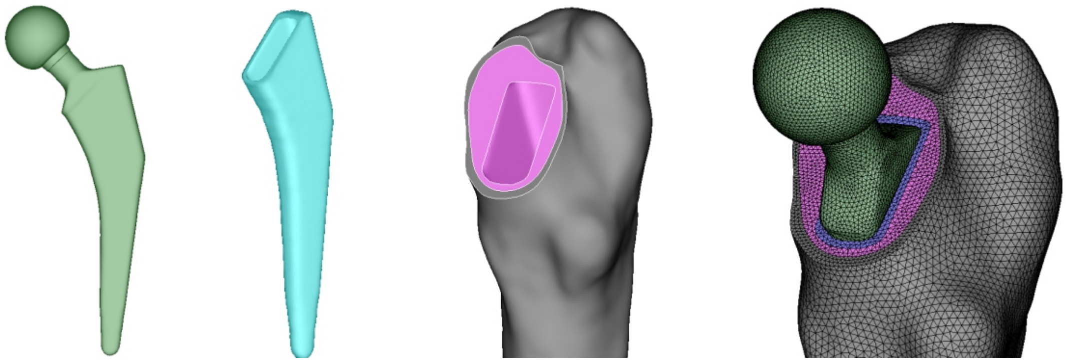
VOLMO

3D scan data to Patient Specific Implants

Patient Specific Implant design and Optimisation of implant position in cemented femur in Total Hip Replacement

Total hip replacement (THR) is one of the most common and effective surgical procedures performed worldwide with the purpose of improving the quality of life of patients suffering from hip disorders. There are two major types of artificial hip replacements : cemented and uncemented. This paper presents finite element approach to measure micromotion along the stem /cement and cement/ bone interface. A response surface model (RSM) was created and used to determine the best implant position for lowest value of micromotion.
In this study finite element model of femur was created from 3D CT scan data using ImageSim software from VOLMO LTD (UK). Surface model of femur in STL format was exported into CAE environment (TSV Pre) where femur resection , implant positioning and alignment was done. The final assembled model of bone, cement and implant was used as the base model for creating new models. The loading and boundary condition have been applied for walking condition.

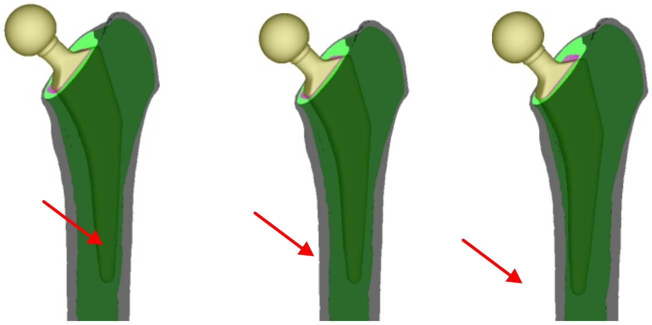


Model Generation using Script

Java scripting functionality within the tool provided a robust environment for automatically rotating the implant to a new angle, exporting STL, Volume meshing, applying load boundary condition and finally exporting volume mesh. This technique provided an efficient approach for generating new models with different implant positions in the femur bone. Around 25 models were generated in less than six hours.

Boundary and Loading Condition

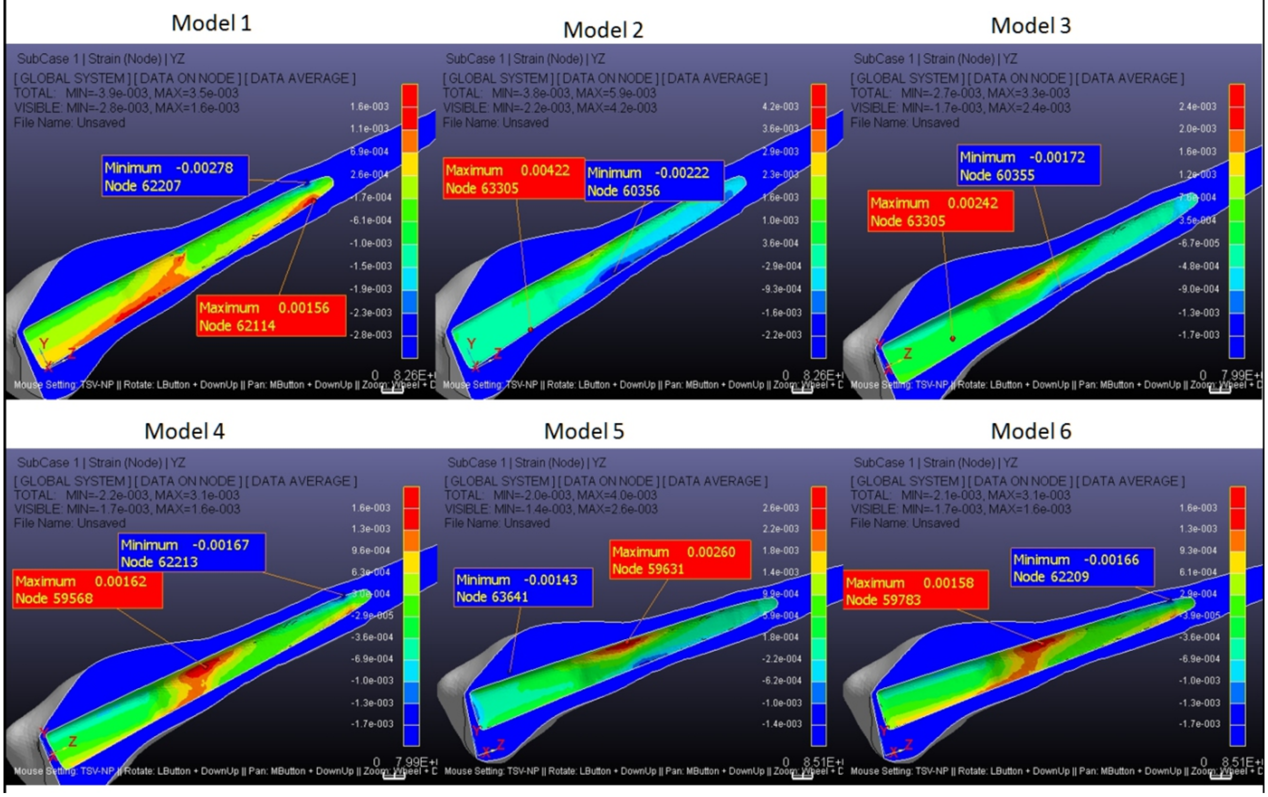
Loading and boundary condition applied are for walking, at five different locations forces have been applied including reaction and muscle force. These models were then simulated in DYNAMIS solver available internally in the environment.



Example of Models with different
Implant angle with respecte to Femur bone

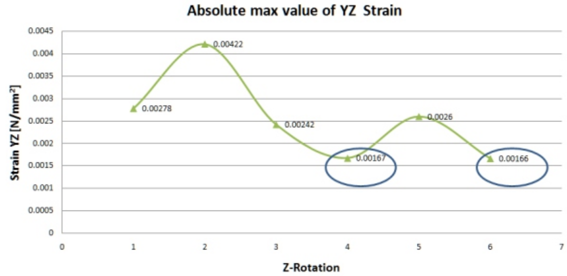
Result : Initial results obtained are shown below.

Inner Bone Structure Strain YZ result– (Rotation in Z models)



Rotation -Z	Strain Value along YZ (N/mm²)		
	maximum negative Strain	maximum positive Strain	absolute max value
1	-0.00278	0.00156	0.00278
2	-0.00222	0.00422	0.00422
3	-0.00172	0.00242	0.00242
4	-0.00167	0.00162	0.00167
5	-0.00143	0.0026	0.0026
6	-0.00166	0.00158	0.00166

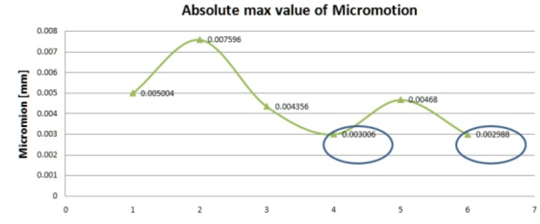
Absolute max value of YZ Strain



rotation -Z	Estimated Micromotion in millimeters using		
	maximum negative Strain YZ	maximum positive Strain YZ	absolute max value of Strain YZ
1	-0.005004	0.002808	0.005004
2	-0.003996	0.007596	0.007596
3	-0.003096	0.004356	0.004356
4	-0.003006	0.002916	0.003006
5	-0.002574	0.00468	0.00468
6	-0.002988	0.002844	0.002988

Average Mesh length : 1.8 mm

Absolute max value of Micromotion



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