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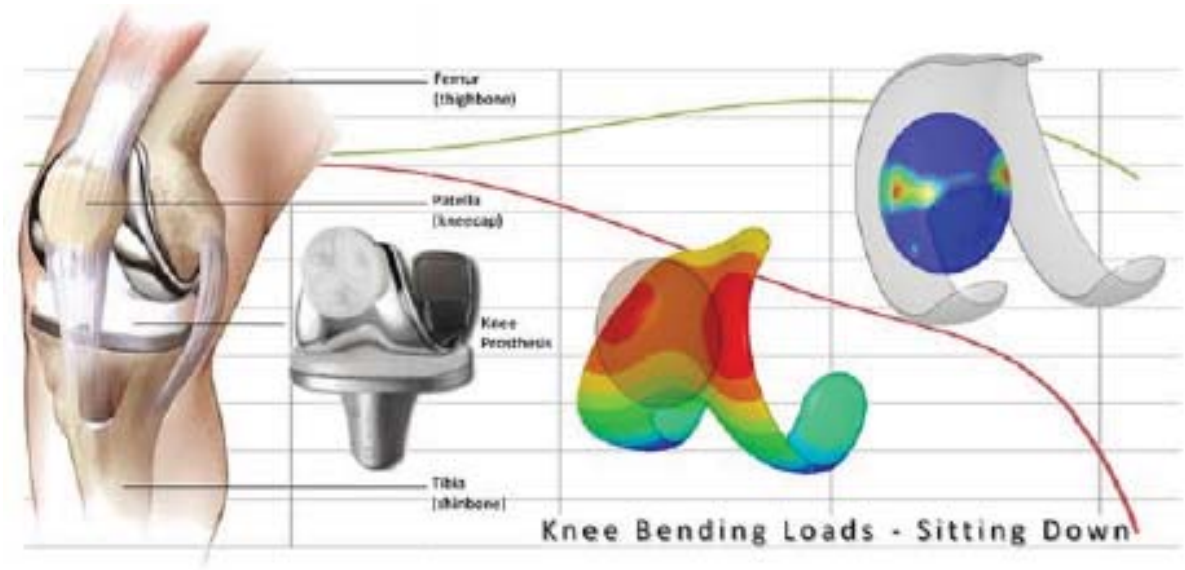
Case Study



ANSYS LS-DYNA Analysis of Total Knee-Joint Prosthesis

A hurdle in designing surgical implants, such as an artificial knee joint, is that some form of simulation, such as one performed using ANSYS LS-DYNA, is required to test the concepts, as they are not suitable for real-life prototype testing. Artificial knees are designed for longevity; however, the soft ultra-high molecular weight polyethylene (UHMWPE) that rides against the medical grade cobalt-chromium-molybdenum (CoCrMo) femoral components will slowly wear from years of knee articulation. ANSYS LS-DYNA can be used to safely simulate the effects of constant knee-cap compression and other aspects of artificial knee joints. Physical bench testing or finite element analysis (FEA) are two methods typically used to test the effects of wear on artificial human joints.

For this project, MAKO Surgical chose CAE Associates to perform a finite element analysis of the artificial knee in order to develop comparative metrics for wear in the joint. The finite element analysis was conducted with the understanding that CAE Associates would perform the initial runs and transfer the model to MAKO Surgical for further analysis. Furthermore, CAE Associates would develop the overall approach for the analysis and pass the methodology and engineering analysis techniques along to the client via a mentoring session.

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—*Guan Zhixu, MAKO Surgical*

CAE Associates utilized ANSYS LS-DYNA to perform an explicit finite element analysis of the patellar-femoral contact history in the knee during sitting down and standing up motions. ANSYS LS-DYNA provided an efficient means of simulating a wide range of motion, in time and space that resembles a physiological condition. The resulting strain levels in the patella due to its contact against the contoured posterior condyles prosthesis was tracked against the full flexion/ extension rotation angle of the femoral component.

The strain history and regions of patellar compression were used to provide a relative metric of comparison between knee prosthesis designs through a whole range of motion. Animated time history results for each concept provided additional design validation in conjunction with test data that would otherwise not easily be obtainable.

The orthopedic application of ANSYS LS-DYNA in a total knee-joint prosthesis analysis provided a means for MAKO Surgical to quantify patella strains and assist in predicting how well the implant would mimic the natural structure of the bone. Similarly, these finite element analysis techniques are also directly applicable to tibial-femoral components and would aid in classifying the reliability of those designs.

Of equal importance to the client as the results, was the ability to learn how best to perform this type of finite element analysis in-house. CAE Associates paid close attention to the transfer of engineering analysis techniques while preparing the models, so that they would be suitable for follow-on work. According to Guan Zhixu, Senior Product Development Engineer of MAKO Surgical Corp, "CAE Associates approached the engineering problem in a systematic way and prepared the models so that they could be reused to perform more analyses of similar nature in a quick and efficient manner."

Additionally, ANSYS / LS-DYNA training was developed to mentor the client on how to perform this type of analysis themselves, prompting the following comments from Guan Zhixu: "The one on one mentoring/ consulting session was professional; the material delivery was clear, well structured and thorough. Not only am I happy with the results, but also enjoyed the process. They are truly pleasant to work with."

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