Mechanical Engineering
Spring 2008 Seminar

Wednesday, March 12, 2008
1:00-2:30pm
Room 224 MEC

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"Prosthetic Knee Design: Past, Present, and Future"

The origins of "knee replacement" can be traced back to the 1800's; however, modern total knee replacement is only about 50 years old. Knee replacements can be classified into different categories such as cruciate ligament retaining, either ACL/PCL or PCL retaining (ACL is removed or missing at time of surgery), cruciate ligament substituting which is Posterior Stabilized (post and cam mechanism used to induce femoral rollback) or posterior substituting (highly conforming articular surface or hinge elements. Further ACL/PCL retaining components can either replace the entire joint or one of either the medial or lateral compartments, describe as unicompartmental. PCL retaining and posterior stabilized knees are more common as the function and status of the ACL at the time of surgery has been questioned.

Past designs achieved their main goal of reducing pain, and improving patient's quality of life, however, present and future patient needs are demanding higher performance from their replacements. The "new" quality of life is to get back to their normal or more active lifestyles. Regardless of the prosthesis, the majority of patients although satisfied with their procedure, does not feel as it is "normal" or forget that they have a prosthesis.

Present day designs have increased performance of total knee replacements with the main focus has been on improving wear performance and increasing range of motion. This has been accomplished primarily through material improvements and geometry alterations. Improvements in manufacturing technologies, materials and processing, as well as computer assisted surgery have also greatly increased the durability and longevity of total knee replacements.

Although designs have focused on improving wear performance and increasing flexion, the overall kinematics has not been the primary focus. Numerous studies have been published identifying the kinematics of the intact knee and prosthetic replacement and have shown that they are not equivalent. Several factors for this have been identified as prosthetic design, missing or dysfunctional cruciate ligaments, improper positioning of components and/or incorrect or ineffective ligament balancing.

Present research utilizing computer simulation tools, computational models, and controlled knee rigs are being used to assess past, present and future prosthetic knee designs to determine if kinematics can be altered and if this can improve the patients perception and return to active lifestyle.