INTRODUCTION: Mobile bearing prostheses are designed to maximize the contact area between the femoral component and the tibial insert, thereby reducing the peak stresses applied to the polyethylene. A mobile tibial insert can rotate and translate with the femoral component, reducing the articular constraints applied to the tibia. Therefore, muscle and ligament forces have a greater influence on the motion of the tibia. For this study, in vitro dynamic knee simulation was performed to compare patellofemoral and tibiofemoral kinematics between intact knees, knees with a fixed platform prosthesis, and knees with a mobile bearing prosthesis.

METHODS: In vitro simulation of knee squatting was performed using a Dynamic Knee Simulator [1,2]. Six knees were flexed by applying a 100 N vertical hip load and a 150 N hamstrings load, while allowing quadriiceps extension at 0.5 mm/s. The quadriceps force increased to a maximum of 200 to 500 N at 90° of knee flexion. Each knee was first tested in the intact state. The knees were retested after implanting a knee prosthesis (Foundation Knee System, Encore Orthopedics) according to the manufacturer’s guidelines. The knees were tested a third time after replacing the tibial component with a mobile component that allowed the insert to rotate and translate in the anterior-posterior (A-P) direction with respect to the base plate. The motion of the femur, tibia and patella were tracked from 20° to 90° of knee flexion using electromagnetic sensors. Statistically significant (p < 0.05) kinematic changes between the three test conditions were identified using a repeated measures ANOVA and a Student-Neuman-Keuls post-hoc test.

RESULTS: Implanting the prosthesis increased the tibial internal rotation (Fig. 1A) and medial translation (Fig. 1C). For both trends, the change in tibiofemoral kinematics, as compared to the intact knee, was greater for the mobile bearing prosthesis than for the fixed platform prosthesis. The tibial internal rotation was significantly larger for the mobile bearing prosthesis than for the intact knee from 20° to 90° of knee flexion. The tibial flexion was significantly larger for both prostheses than for the intact knee from 25° to 70° of flexion. The patellar flexion was significantly larger for both prostheses than for the intact knee from 20° to 90° of knee flexion using electromagnetic sensors. Statistically significant (p < 0.05) kinematic changes between the three test conditions were identified using a repeated measures ANOVA and a Student-Neuman-Keuls post-hoc test.

DISCUSSION: The tibial insert of the mobile bearing prosthesis was free to translate in the A-P direction and rotate with respect to the tray. The internal rotation and posterior translation of the tibia were larger for the mobile bearing prosthesis than for the fixed platform prosthesis during flexion. These variations were not statistically significant, but are related to the altered tibiofemoral articular constraints. With the tibia free to rotate with respect to the tibiofemoral articulation, tibial internal rotation increased (increased screw home motion). The posterior tibial translation also increased as the tibial insert was free to slide anteriorly on the tray during flexion, reducing femoral roll-back. These tibiofemoral kinematic trends contribute to the statistically significant variations in patellofemoral kinematics. Rotation and translation of the mobile bearing with respect to the tibia tray also creates the possibility of backside wear of the polyethylene, although this effect has not been noted on clinical follow-up [3]. The medial shift of the tibia is similar for both prostheses, and may be due to the surgical alignment of the femoral and tibial components on the knee.

Replacing the fixed bearing prosthesis with the mobile bearing prosthesis did influence the patellofemoral kinematics. The patellar flexion was significantly larger for the mobile bearing than for the fixed platform beyond 30° of flexion. The trend for increased tibial posterior translation with the mobile bearing prostheses contributed to this difference. With an increase in the tibial posterior translation, the patella tendon stretches and changes orientation, increasing the posterior component of the force acting on the inferior pole of the patella. This change increases the moment applied to the patella, increasing the patellar flexion. Although patellofemoral problems have not been noted clinically with mobile bearing prostheses [3], the increase in patellar flexion could increase the distal patellofemoral contact pressure. The patella tracked more medially during flexion for both prostheses than for the intact knee. The 6° patellar groove angle on the femoral component and the increased tibial internal rotation may have both contributed to this change. The increased anterior translation of the patella for both prostheses may have been caused by an increase in the patellar thickness after implanting the patella component. The patella sensor mounting platform made accurate measurement of the patellar thickness difficult prior to osteotomy.

In conclusion, knees tested with a mobile bearing knee followed the same general kinematic trends as knees with a fixed platform prosthesis. Possible complications resulting from small kinematic variations must be considered, however.


**Encore Orthopedics, Austin, TX.**