INTRODUCTION:
The MAKO Surgical Rio Robotic Arm utilizes pre-op CT images to plan the optimal positioning of uni-condylar and patella-femoral components in order to achieve normal kinematics for the knee joint, while preserving the cruciate ligaments. We hypothesize that the anatomic matching surfaces and the cruciate retaining design of this MAKO Restorik knee system will replicate normal knee kinematics. Also, it is important to preserve the tracking of the patella for normal knee motion and the preservation of the natural moment arms for mechanical advantage. To investigate these factors, we compared intact knee specimens versus the MAKO knee and the most common TKR designs, Posterior Stabilizing (PS) and Cruciate Retaining (CR), in order to evaluate and compare the kinematics and patella tracking.

METHODS:
Seven healthy male left knees were dissected to leave only the knee capsule, the popliteus muscle and the quadriceps tendon intact. The femur and the tibia were cut 20cm from the joint line and potted with cement into a metal housing. The knee was attached to a crouching machine (Fig 1) capable of moving the knee joint from extension to maximum flexion, validated in previous studies (Yildirim, 2009).

![Figure 1. Crouching Machine](image)

Forces applied to the quadriceps tendon allowed the knee to flex and extend physiologically, and springs attached to the posterior were substituted as the hamstrings at a rate of half the force exerted by the quadriceps as described in the literature. An accelerometer attached to the patella tracked the accelerations in 6dof to assess the smoothness of tracking of the patellar button on the femoral components. Three-dimensional visual targets attached to the bones were tracked by computer software capable of recreating the positions of the bones in any given flexion angle (RapidForm, Inus Technology, Seoul, Korea). A cruciate retaining and posterior stabilized TKR design were chosen to represent the TKRs most commonly used today. The intact knee, MAKO implanted knee, CR and PS TKR designs were tested in cruciate retaining and posterior stabilized TKR designs.

RESULTS:
The results showed that the MAKO knee kinematics resembled the normal knee kinematics throughout the knee flexion range. Average mean medial and lateral differences of the MAKO knee was at a consistently small value, compared to the varying differences for the TKR designs especially on the medial side (Fig 3).

![Figure 2. Medial and Lateral Measurement technique and presentation](image)

DISCUSSION:
Anatomic restoration of the joint surfaces and retention of the cruciate ligaments maintained normal kinematics, which is expected to be an advantage in obtaining improved clinical results. Pre-op planning in a software environment with the help of CT landmarks produced a smooth transition between the patella femoral and tibio femoral components as indicated by the lack of acceleration peaks as the knee flexed and extended. PS and CR designs cause increased accelerations on the patella possibly due to the paradoxical motion discussed in previous literature (Yildirim, 2009).

SIGNIFICANCE:
Precise insertion of modular components allows the surgeon to opt for a multi component replacement instead of the traditional TKR while preserving the ligaments necessary for the preservation of normal knee motion and smooth patella tracking. This experiment showed that the MAKO robot-assisted system achieved these goals.

REFERENCES: