INTRODUCTION:

The MAKO Surgical Rio Robotic Arm utilizes the pre-op CT images to plan positioning of the uni-condylar and patella-femoral components in order to achieve the most desirable kinematics for the knee joint, while preserving the cruciate ligaments. We hypothesize that the anatomic matching surfaces and the cruciate retaining design of the Restoris knee will best replicate normal knee kinematics. 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 (Li, 2010).

We will test the healthy cadaveric knee versus the MAKO knee and the most common TKR designs; Posterior Stabilizing (PS) and Cruciate Retaining (CR) TKRs in order to evaluate and compare the kinematic properties.

METHODS:

Six 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 (Figure 1) capable of moving the knee joint through its normal human kinematics from extension to maximum flexion, validated in previous studies (Yildirim, 2009).

![Figure 1. Crouching Machine](image1)

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 shown in the literature. An accelerometer attached to the patella tracked the accelerations in 6df to assess the conformity 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, Iusus Technology, Seoul, Korea). A cruciate retaining and posterior stabilized TKR design were chosen to represent the TKRs most commonly available in the market today. The intact knee, MAKO implanted knee, CR and PS TKR designs were tested in sequence on the same specimens. The computer software analyzed the normal distance between the bone surfaces and plotted the locations of contact which could then be quantitatively compared for each given scenario (Figure 2).

![Figure 2. Patella femoral contact at 90 degree flexion](image2)

RESULTS:

Our results showed that the MAKO knee kinematics resembled the normal knee kinematics throughout the knee flexion range. An average of 15 degrees of internal tibial rotation was observed for both the intact and MAKO knees for all samples. The TKR designs altered the kinematics of the knee where the internal rotation of the tibia was no longer observed with the increasing flexion angle, while the femoral roll back in high flexion was only replicated by the post of the PS design and not by the CR design.

![Figure 3. Representative acceleration data from the patella](image3)

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 help create a smooth transition between the patella femoral and tibio femoral components as indicated by the lack on acceleration picked up by the accelerometer as the knee extends and flexes. PS and CR designs cause increased accelerations on the patella presumably due to the paradoxical motion discussed in previous literature (Yildirim, 2009).

Precise insertion of smaller components allows the surgeon to opt for a multi component replacement instead of the traditional TKR while preserving the ligaments essential for the preservation of the normal knee motion.

ACKNOWLEDGEMENTS:

The authors would like to acknowledge Ran Schwarzkoph, MD, and Scott Hadley, MD for their contributions to the project.

WORKS CITED:
