INTRODUCTION: Patients receiving total knee arthroplasty (TKA) can expect pain relief and a return to most daily activities. Unfortunately, they also can expect that their operated knee will be functionally weaker than a normal knee [1]. The reasons for enduring functional weakness are several, and likely include preoperative muscle atrophy and loss of effective coordination, insufficient post-operative rehabilitation, loss of proprioception, and abnormal joint mechanics. Joint mechanics is the only factor directly influenced by implant design. There currently appear to be two, somewhat overlapping, schools of thought regarding TKA design and functional knee strength: one school emphasizes achieving posterior femoral translation with flexion as a means to increase the quadriceps moment arm [2,3], the other advocates more conforming articulations that emphasize joint stability and posterior cruciate ligament substitution [4]. The objective of this study was to evaluate stair-climbing dynamics in a group of patients who received a posterior cruciate retaining TKA with a spherically congruent lateral femur posterior with the femur posterior with flexion, but provides definitive anteroposterior stability up to 75° flexion. We hypothesized that intrinsically stable joints would provide functionally equivalent strength, as measured by the net external flexion moment, compared to TKA designs emphasizing tibiofemoral translation [2,3].

METHODS: Eight patients (5 male) with unilateral PCL retaining TKR (3D Knee, Encore, Austin, TX) were recruited to participate in this IRB approved study. Patient were recruited based on having unilateral TKR, good or excellent Knee Society Scores at 3 months post-op and no significant disease in the contralateral limb. Patients averaged 65±12 years of age, 85±11 kg weight, 174±5 cm height, 14±6 months post-op, with 97±5 KSS Knee scores and 97±5 KSS function scores. Patients were instrumented with 25 reflective markers and monitored during self-paced stair ascent and descent. Kinematic data were collected using a six camera motion capture system (Motion Analysis Corp.) Kinetic data were obtained bilaterally from two force platforms (AMTI) located under a two-piece, four stair staircase (rise=20 cm, run=27 cm). Parameters analyzed included knee flexion angle and knee joint flexion moment. Data for each trial were normalized to the step cycle and three trials per condition were averaged for each patient. Joint moments were computed using inverse dynamics and normalized to the patient’s body mass. Parameter differences between the implanted limb and the unimplanted limb were analyzed throughout the cycle using a two-way repeated measures ANOVA and a Tukey test for post hoc pairwise comparisons.

RESULTS: No significant differences were found in knee flexion angle between the implanted and opposite limbs during stair ascent. During stair descent, no significant differences were noted between limbs in knee flexion angle during the stance phase. Peak flexion moments for the implanted knees averaged 80% of the peak moments in the unimplanted knees for both ascending (p=0.06) and descending (p=0.05) the stairs (Table 1). During stair ascent, the implanted knees exhibited lower flexion moments during the initial 25% of the step cycle (Fig 1). During stair descent, the implanted knees had reduced moments during the latter portion of the stance phase (40-60% of step cycle, Fig 2).

DISCUSSION: Stair climbing function after TKA has been studied for the past 25 years. A comparison of results from the current study with previous studies (Table 2) shows that peak knee moments with an intrinsically stable TKA are equivalent to or greater than those reported in previous studies. Knees lacking intrinsic stability can compensate through recruitment of antagonist muscles [10], but at the cost of reduced external knee extension moments [4]. Intrinsic stability in a TKA design may be one factor that provides for efficient muscle recruitment and enhanced functional strength.


AFFILIATED INSTITUTIONS FOR CO-AUTHORS: **University of Florida, Gainesville, FL ***Imperial College School of Medicine, London ****Barry University, Miami Shores, FL