Introduction: Supracondylar fractures of the distal femur are usually the result of high energy impacts and have traditionally been one of the more difficult fractures to treat clinically. More recent developments in the use of distal locking screws for nails and locking plates have offered effective advantages over older techniques. The difficulty of these fractures only becomes greater as the patient population ages and osteoporosis becomes a factor. Proper fixation of the distal fragment of femur fractures is critical for the patient to regain a desirable result. Previous work done to investigate the differences between the various forms of fixation showed that the LISS plate was more elastic and hypothesized about the bone implant interface, but were unable to measure it directly.

This study took a novel approach by incorporating a Polhemus Fastrak to monitor real time three dimensional position and displacement of the distal fragment specifically. The sensor data from the Fastrak allowed the bone implant interface to be isolated to determine rates of plastic and elastic deformation.

Materials and Methods: Eight pairs of intact fresh frozen human femurs without evidence of prior surgery were obtained. Femoral pairs were randomized for which side would receive fixation with either a 9 hole LISS fixator with the contralateral limb receiving the 10 hole locking condylar buttress plate. The fixation was done in a manner to try and create as close to the same physical geometry of fixation in both constructs, even though the hole placement on the two plates is not identical.

After the implants were applied to the bone, an osteotomy detailed in previous studies was created. The model was selected to mimic a low energy, extra-articular O.T.A./A.O. classification Type 33A3 fracture [1]. Femoral condyles and femoral heads were then potted in Poly(methylmethacrylate). The potting molds contained a one inch diameter hemisphere. The pocket created by these spheres in the potting material corresponded to two spheres used for loading in the instron and allowed for multiaxial freedom and loading along the mechanical axis of the bone. Femurs were then placed into the instron and Fastrak sensors were applied.

Cyclical testing was performed in an Instron 5865 at a rate of 0.1 Hz for 10 cycles at load increments of 100N from 300N to 1100N. The preload and the baseline load after each cycle were both set to 100 N. There was a 30 second hold at the baseline after each set of ten loading cycles were performed. Testing was performed until the medial gap closed (a varus deformation causing the 30mm gap to close), apparent failure occurred (ie. screw tear out), or 10 cycles of loading at 1100N were achieved. Load and displacement were monitored and controlled by the Intron Bluehill software.

The distal plate and bone fragment position were measured by the Polhemus Fastrak. P values of the differences between the LISS and the Locking Condylar Plate were reported for crosshead displacement after all loading cycles as well as plastic deformation rates in the 800N loading cycle. A comparison of failure points observed during testing was evaluated with a Chi-square test. Finally, linear regression was also performed to investigate the correlation coefficient R and the coefficient of determination R² in relationships between the measured bone mineral density and the results reported.

Results: During our cyclic testing, All of the LISS specimens, except specimen six, were able to sustain higher loading and/or more cycles than the matching Locking Condylar counter parts (Chi squared p=0.034). The sixth matched pair of femurs failed at the same cycle and load. The range of failure was from the third cycle at 800N to no break throughout the testing. Only the LISS specimens, one, three, four and eight, were able to endure the entire testing procedure without failure. Table 2) Plastic Crosshead displacement (mm) after each set of 10 cycles.

Because of the failure of the implant bone constructs there was not enough significant data beyond the 800 N cycle testing to compare all samples for rates of plastic deformation as measured by the Fastrak. However in a comparison at 800N, the LISS plate on average showed 32.3% (p=0.031) the rate of plastic deformation when compared with the rates observed on the Locking Condylar plate. Testing at loading cycles lower than 800N did not show a significant difference in the plastic rate of deformation. Table 2 depicts the data collected from the load and displacement curves of the instron. Table 1) Cycle breaking points (Load (N) and Cycle number)