Introduction: The aim of this study was to quantify mid-flexion laxity in a total knee arthroplasty with an elevated joint line, as compared to a native knee and a TKA with joint line maintained. Our hypothesis was joint line elevation of 4mm would increase coronal plane laxity throughout mid-flexion in a pattern distinct from the preoperative knee or in a TKA with native joint line.

Methods: After obtaining IRB approval, six fresh-frozen cadaver legs from hip-to-toe underwent TKA with a posterior stabilized implant (APEX PS, OMNIlife Science, Inc.) using a computer navigation system equipped with a robotic cutting-guide, in this controlled laboratory cadaveric study. After the initial tibial and femoral resections were performed, the flexion and extension gaps were balanced using navigation, and a 4mm recut was made in the distal femur. The remaining femoral cuts were made, the femoral component was downsized by resecting an additional 4mm of bone off the posterior condyles, and the polyethylene was increased by 4mm to create a situation of a well-balanced knee with an elevated joint line. Real implants were used in the study to eliminate any inherent error or laxity in the trials. The navigation system was used to measure overall coronal plane laxity by measuring the mechanical alignment angle at maximum extension, 30, 45, 60 and 90 degrees of flexion, when applying a standardized varus/valgus load of 9.8 [Nm] across the knee using a 4kg spring-load located at 25cm distal to the knee joint line (Figure 1). Laxity was also measured in the native knee, as well as the native knee after a standard approach during TKA which included a medial release. Coronal plane laxity was defined as the absolute difference (in degrees) between the mean mechanical alignment angle obtained from applying a standardized varus and valgus stress at 0, 30, 45, 60 and 90 degrees. Each measurement was performed three separate times.

Separate generalized estimating equations were

Figure 1: Overall laxity in the coronal plane was significantly greater at 45° and 60° of flexion in the case of an elevated joint line when compared to the standard TKA condition.
calculated for each flexion angle to compare opening angle differences between conditions using proc genmod in the SAS System 9.2 (Cary, NC). Each of the 3 measurements were used as repeated measures for each specimen. An independent covariance structure was specified, which has been demonstrated to be robust in a wide variety of dependent covariance matrices. Due to the large number of comparisons, we calculated a false discovery rate (FDR) adjusted p-value using the non-adaptive Benjamini and Hochberg procedure. This evaluation determined that a p-value of <0.03 was considered statistically significant.

**Results:** In full extension, 30°, 45°, 60°, and 90° of flexion, the native knee showed coronal plane laxity of 2.4, 6.5, 7.0, 7.8, and 9.5°, respectively. The above soft tissue releases produced increased laxity in extension and 30° of flexion. After TKA, the mean coronal plane motion was decreased at all flexion angles and remained consistent throughout arc of motion. With 4mm of joint line elevation, coronal-plane laxity increased by a mean of 1.4° at 30° of flexion (p=.0103), 1.5° at 45° of flexion(p=.0001), and 1.3° at 60° of flexion(p=0.0018) compared to the TKA with native joint line. Conversely, there was no difference in laxity at 0° and 90° between the initial TKA and after 4mm joint line elevation.

**Discussions and Conclusions:** The computer navigated, well balanced TKA with a maintained joint line showed consistent coronal plane laxity throughout all flexion angles, while the native knee showed greater laxity at 90 degrees than in mid-flexion. Further, as suggested by retrospective clinical reports, this cadaver study confirms that joint line elevation of only 4mm results in greater coronal plane laxity in mid-flexion. These finding suggest that maintaining the joint line in TKA is necessary to avoid increased mid-flexion, coronal plane laxity.

**Acknowledgement:** Funding was obtained by Eduardo Salvati Resident Research Grant.