Introduction
Malalignment of the tibial component during total knee arthroplasty (TKA) is a leading cause for many complications and early revisions of TKA. Previous work has shown that the medial aspect of the tibial tubercle and the medial-lateral tibial axis are the most accurate indicators of the knee motion axis (KMA) (1). However, all anatomic landmarks in the vicinity of the tibial plateau have been shown to be highly variable, leading to an unacceptable incidence of internally rotated tibial components in previous clinical series. The cause of this variability has not been well studied, but is presumably due to morphology abnormalities within the proximal tibial metaphysis. In view of the deficiencies of present methods of setting the rotational orientation of tibial components, we undertook the present study to test the hypothesis that landmarks along the tibial shaft, including the anterior tibial ridge, could serve as a reliable guide for determining the motion axis of the knee intraoperatively.

Materials and Methods
Computer models of the tibia were generated by CT reconstruction of thirteen fresh-frozen lower limb specimens. The proximal tibia was resected perpendicular to the longitudinal axis of each specimen with a posterior slope of 5 degrees. The depth of the resected surface was 5mm distal to the lowest point on the subchondral surface of the medial condyle. Using data from previous kinematic studies, the KMA of each knee was then defined as the line of intersection of the resected tibial surface and the flexion-extension plane of the knee from 30° to 90° of flexion. Using a reverse engineering program, the orientation of the KMA of each knee was compared to the following:

- Ridge points selected on slices taken along the tibial shaft at 5% intervals and projected on to the resected surface of the tibia.
- The most prominent point on the tibial tubercle in the axial plane and projected on to the resected surface plane.
- A “best fit” axis defining the articular surface of the tibial plafond. These measurements were used to determine the best anatomical landmark for assessing tibial torsion and to facilitate alignment of the tibial component during TKA.

Results
The point at which the KMA crosses the tibial anterior ridge, on average, was located in the distal region of the tibial shaft at 83.9% of the distance from the tibial tubercle to the malleolus. The KMA crossed the ridge among the tested tibias are as follows: 23% crossed between 50%-80% of the distance from the tibial tubercle to the malleolus, 23% of the tibias crossed the KMA around 80%, 31% crossed the KMA around 90%, and the remaining 23% crossed the KMA near the top of the malleolus. Each individual ridge followed a similar trend, but there was never a point that a significant number of tibias had in common. Eight of the 13 tibias hovered around a 10° external deviation in the middle of the shaft from about 30% to 80% of the distance from the tibial tubercle to the malleolus. Five of the thirteen tibias were 11.9°±3° externally deviated from the KMA at 65% of the distance. Using a “best fit” axis along the tibial plafond, tibial torsion was measured to be an average of 21.1°±2.5° (range: -4.9° to 43.4°).

Figure 1. CT reconstruction of the tibia showing the resected surface and the knee motion plane. The angle shown is between a projected point on the ridge and the center of mass of the resected surface, and the KMA. The red point is the original ridge point prior to projection. The third figure shows vectors at each 5% interval between the center of mass and ridge point with respect to the KMA, illustrating the curvature of the anterior tibial ridge.

Figure 2. Average specimen degree of rotation from ridge to KMA.

Figure 3. Individual specimen degree of rotation from ridge to KMA.

Conclusion
A common point among tibias in which the knee motion axis and anterior ridge axis cross is not shown in our data. All points observed had larger standard errors compared to the foot motion axis and the tibial tubercle point, both of which are already used intraoperatively to aid tibial component placement (2). There are no other features that we observed along the anterior ridge that can serve as a reliable guide to the rotation of knee motion. Further research is needed to investigate the common trends in tibial torsion in order to better understand how to place the tibial component during TKA.

Significance
Finding common anatomical landmarks which could potentially be used in tibial component placement could reduce the incidence of failure in total knee arthroplasty.

References