INTRODUCTION

Increased posterior tibial slope has been identified as a risk factor for anterior cruciate ligament (ACL) injury [1]. Magnetic resonance imaging (MRI) is a common imaging modality for measuring lateral and medial tibial slope. Two methods have been proposed for measuring posterior tibial slope using knee coil MR images: a midpoint method [1] and a circle method [2]. A knowledge gap exists regarding how tibial slope measurements compare between these two methods, and how these tibial slope measurements compare to a method using the full tibial longitudinal axis (LA). Our null hypotheses are (1) lateral tibial slope (LTS) measurements using the midpoint method will not be affected by the length of tibia in the image; and (2) LTS measurements will not differ between the midpoint method, the circle method, and a new method using the full tibial LA.

METHODS

Thirty-two cadaveric lower extremities (22 female, 8 full tibia scans, mean (SD) age: 59(14) yrs; height: 169(11) cm; weight: 70(7) kg) were acquired and MR scanned prior to the specimen’s use in an in vitro experiment (3T Phillips Scanner; T2-weighted 3D-PE sequence; field of view: 330 mm; slice thickness: 0.7 mm). The tibial LA was measured on the sagittal plane central axis. The central axis was defined as the image where the tibial attachment of the posterior cruciate ligament was present and the intercondylar eminence was visible [2]. The tibial LA was defined using three different methods. The midpoint method involved drawing two parallel lines connecting the anterior and posterior cortices 4-5 cm apart, and connecting the midpoint of these two lines to define the tibial LA (Fig. 1A) [1]. The midpoint method was used for three measurements, with the distal line at 20 cm, 15 cm, and 10 cm from the most proximal point of the tibia. The circle method fit two circles within the proximal head of the tibia, with the superior circle fit within the anterior, proximal, and posterior cortices of the tibia and the inferior circle connecting the bottom of the superior circle with the anterior and posterior cortices (Fig. 1B) [2]. The tibial LA was then defined as a line connecting the center of both circles. Finally, the full tibial LA was defined as a line connecting the center of two circles fit within the proximal and distal tibia (Fig. 1C). LTS was measured at the femoral center of articulation on the lateral tibial plateau. LTS was defined as the angle between a line fit to the most superior-anterior and posterior portions of the lateral tibial plateau and a line perpendicular to the tibial LA. The specimens were examined using a trained blinded observer, with an intra-rater reliability of 0.92, 0.93, and 0.85 for the midpoint, circle, and full tibial LA, respectively. Paired t-tests, with a Bonferroni corrected significant p-value of 0.005, were used to compare lateral tibial slope using (a) the midpoint method using three different lengths of tibia, (b) the circle method, and (c) the full tibial LA.

RESULTS

Using the midpoint method, LTS measurements were significantly different between 20 cm and 15 cm of tibia (1.5 ± 1.4°), along with 20 cm and 10 cm of tibia (1.6 ± 1.8°) (Fig. 2). There was no significant difference between 15 cm and 10 cm of tibia (0.2 ± 2.1°) with the midpoint method. The midpoint method and circle method gave significantly different measures of LTS, regardless of the amount of tibia imaged. Eight full tibia scans showed the midpoint method using 20 cm of tibia was significantly different than the full tibial LA method, and the circle method trended towards a significant difference with the full tibial LA method (p = 0.007).

DISCUSSION

Our study provides insights into the sensitivity of LTS measurements using different measurement techniques. The midpoint method appears to be sensitive to the length of bone imaged within the knee coil. Therefore, using the most distal tibial location on a knee coil MR image to measure LTS with the midpoint method may not produce accurate results from subject to subject. ACL-injured subjects have previously shown increased LTS with the midpoint method over uninjured controls, with the mean LTS difference between injured and uninjured controls 1.43° and 1.83° for females and males, respectively [1]. However, the circle method has not been correlated with ACL injury [2]. We conclude that the midpoint method using 10 cm and 15 cm of tibia gives the closest reading of LTS obtained with the full tibial LA method. However, the circle method remains a viable method for measuring LTS from knee coil MR images when varying lengths of tibia are present.

SIGNIFICANCE

Clinical measurements of LTS should employ a standardized length of 15 cm of tibial bone length on adult MR scans obtained with a knee coil.

ACKNOWLEDGEMENTS

Mrs. Suzan Lowe, Dr. Catherine Brandon, PHS grant R01 AR054821

REFERENCES