INTRODUCTION
Anatomical placement of grafts during anterior cruciate ligament (ACL) reconstruction may lead to better control of rotational stability and help to preserve long term knee health. However, anatomical tunnel position can be difficult to validate from magnetic resonance imaging (MRI) or plain x-rays. The purpose of this study was to investigate whether the ACL inclination angle and femoral tunnel angle on clinically available 2D images can be used to evaluate anatomic positioning after single bundle (SB) ACL reconstruction.

MATERIALS AND METHODS
With IRB approval, 50 patients were identified that had SB ACL reconstructions and post-operative AP X-ray, MRI with intact ACL graft and CT scans. 50 patients that had native intact ACL on MRI were identified for a comparison group. Tunnel Position on 3D CT: The CT-scans of each patient were imported into Mimus (Materialise, Leuven, Belgium) for segmentation and then Geomagic Studio (Geomagic, Research Triangle Park, North Carolina) for 3D model development and analysis. Tunnel positions of single bundle reconstructions were analyzed on both the femur (figure 1a) and tibia (figure 1b) using anatomical coordinate systems and normalized to the AP and ML dimensions of the tibia or femur, as described by Forsythe et al [1].

RESULTS
The native ACL inclination angle average was 49.9° ± 2.8°, with a range from 43.5°7.5°. ACL inclination angle on MRI for SB reconstructions ranged from 46.4° to 79.4° and femoral tunnel angle ranged from 2.1° to 46.1°. There was a strong correlation between anterior tunnel position on the femur and an increase in ACL MRI inclination angle (p<0.001, r = 0.74) and decrease in x-ray femoral tunnel angle (p<0.001, r = 0.78), as well as a good correlation between ACL inclination angle and femoral tunnel angle (p<0.001, r = 0.63).

DISCUSSION
Forsythe et al. described the normalized femoral footprint of the native ACL to be between 0.089 and 0.364, from posterior to anterior [1]. The SB reconstructions that fell within this range had an MRI inclination angle range of 46.4° - 54.8°, which is consistent with the native MRI inclination angles measured in this study. Also, these same reconstructions had an x-ray femoral tunnel angle range of 33.9° - 46.1°. Although it is possible to have a non-anatomic SB ACL reconstruction that falls within these ranges of MRI inclination and femoral tunnel x-ray angle, these simple measurements on routine clinical imaging allow the surgeon to have a quick and easy measurement that can aid in determining whether a graft is placed anatomically.