INTRODUCTION:
Historically, tibial tunnel creation in ACL reconstruction was performed by antegrade insertion of a tibial guide pin followed by antegrade reaming from the anteromedial tibial metaphysis (distal aperture) to the tibial plateau (proximal aperture). In the last few years retrograde reaming has been introduced.1, 2 It has been theorized that the retrograde tibial tunnel drilling technique may cause less trauma to the proximal aperture.3

Our hypothesis was that the proximal and distal apertures of ACL tibial tunnels created with different reamers would be affected by the type of reamer design. The purpose of this study was to compare the potential differences between antegrade and retrograde reaming using different reamer designs and the effect on both proximal and distal tibial tunnel apertures using micro-computed tomography (micro-CT).

METHODS:
Forty skeletally mature, fresh-frozen, intact porcine tibias were used to compare the effects of five different reamer designs (three antegrade and two retrograde) on tibial tunnel proximal and distal apertures as well as intra-tunnel uniformity. There were no signs of previous musculoskeletal injury, abnormality, or disease in any of the tibias.

Bone Mineral Density Analysis
Prior to tibial tunnel drilling, bone mineral density (BMD) (measured in grams per square centimeter) was analyzed in all specimens via dual energy x-ray absorptiometry (DEXA). All 40 selected specimens had an average BMD of 1.30 g/cm² which were comparable to those reported in a young athletic population that make up the majority of patients having an ACL reconstruction (range, 1.24-1.62 g/cm²). The tibias were divided into five test groups (eight tibias per group) and one reamer model was randomly assigned to each group.

Drilling Technique
Five different 9 mm reamer models (three antegrade: A1, smooth-bore reamer; A2, acorn-head reamer; A3, flat-head reamer; and two retrograde: R1, retrograde acorn reamer; R2, single-blade retrograde reamer) were used and a new reamer was used for each tibia (Figure 1). The power source and reamer chuck utilized were consistent with current surgical equipment with a maximum rotation rate and torque of 500 RPM and 6.8 Nm and was used for all tibias.

Micro-CT Analysis
All specimens underwent micro-CT scanning and images were reconstructed and analyzed using 3D image analysis software. Proximal and distal apertures were examined for the presence of discontinuous aperture rims; this included discontinuities that enlarged the aperture (rim fracture) and those that decreased the area of the aperture (incomplete aperture). Aperture rim fractures were graded on a 0-4 scale which represented the proportion of the aperture circumference in quartiles that was fractured. The characteristics of the incomplete apertures were recorded for each particular reamer model and the number of specimens with this finding per reamer model subgroup was recorded. Due to unique characteristics of various tunnels, intra-tunnel characteristics were also observed and recorded.

RESULTS:
One proximal and seven distal aperture rim fractures were found (Figure 2). Three, zero, and four distal aperture rim fractures were found with groups A1, A2, and A3, respectively. Incomplete apertures were more commonly found at the distal aperture (n=15) than the proximal aperture (n=8).

All incomplete distal apertures occurred with the retrograde technique and all incomplete proximal apertures occurred with the antegrade technique, most commonly with reamer design A3. An added finding of tunnel curvature at the distal aspect of the tunnel was observed in five tibias with R1 and three tibias with R2 reamers. This phenomenon was not observed in any of the tibias reamed with the antegrade technique.

DISCUSSION:
ACL tibial tunnel aperture characteristics were highly dependent on reamer design. Optimal proximal aperture characteristics were produced by the retrograde reamers whereas optimal distal aperture characteristics were obtained with the antegrade reamers. In addition, a phenomenon of tunnel curvature in retrograde-type reamers was also found which may have effects on ACL graft or screw fixation. We found that ACL tibial tunnel aperture characteristics were dependent on reamer design. We recommend that care be taken to ensure that the tunnel apertures be assessed for the ability of graft passage at either end of the tunnel depending upon the reamer design utilized.

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REFERENCES: