Introduction: Anterior cruciate ligament (ACL) rupture is a common sports injury treated with ACL reconstruction. However, 10%-20% of primary ACL reconstructions have poor long-term outcomes due to residual rotational instability. Recently, native insertion and location of ACL have been emphasized in ACL reconstruction for restoring normal knee kinematics. According to a recent cadaveric study, the ACL femoral footprint was flat and ribbon-like, and the ACL tibial footprint was not round but oval or C-shaped. However, biomechanical studies on ACL reconstructions using oval tunnels are lacking. The purpose of this study was to compare knee laxity between the conventional round tunnel and oval tunnel techniques in primary ACL reconstruction in a porcine model.

Methods: Twenty porcine knees were used for evaluating laxity in terms of anterior translation and anterolateral rotation. The study determined porcine knee kinematics on the Instron instruments under simulated Lachman (89 N anterior tibial load) at 15°, 30°, and 60° of flexion and a simulated pivot shift test (89 N anterior tibial load, 10 Nm valgus, and 4 Nm internal tibial torque) at 30° of flexion. Kinematics were recorded for intact (n=10), ACL-deficient (n=10), and conventional round (n=10) or oval tunnel techniques (n=10). All measurements were repeated twice, and the average was used for comparison.

Results: Under the Lachman test, conventional round tunnel and oval tunnel both showed significantly larger anterior tibial translation (ATT) at 30° and 60° compared to the intact knee ($p<0.05$), but the smaller ATT was found compared to the ACL deficient knees ($p<0.05$). However, there were no differences in ATT between the conventional round tunnel and oval tunnel techniques ($p>0.05$). Under simulated pivot shift at 30° flexion, there was a significant difference between the conventional round tunnel and oval tunnel techniques (round vs. oval: 4.27 mm ± 0.87 vs. 3.52 mm ± 0.49, $p=0.028$).

Discussion: In this study, the stability of ACL reconstructions with oval dilators was significantly better than that with conventional round tunnels when combined with rotatory force. Due to the anatomical characteristics of oval tunnels designed to have anatomical shape and larger cross-sectional areas than corresponding conventional round tunnels, restoration of knee rotational stability would be sufficient by better coverage of ACL footprints, especially the posterolateral aspect of ACL substance (known to be associated with knee rotation).

Significance/Clinical Relevance: Both conventional round tunnel and oval tunnel techniques reduced anterior tibial translation compared to ACL-deficient knees but failed to restore normal

knee stability. However, the oval tunnel technique showed better rotational stability at 30° than the round tunnel technique. These findings suggest that oval tunnel technique would be a viable therapeutic option in primary ACL reconstruction.