INTRODUCTION:
There are three arthroscopic approaches in creating the femoral tunnel—through the tibial tunnel (tibial tunnel dependent or more commonly known as transtibial (TT) technique) or independent of the tibial tunnel (via an anteromedial (AM) portal or via two-incision technique also known as outside-in (OI) technique). With recent emphasis on anatomical tunnel placement, transtibial approach has been critically scrutinized as it is shown by some authors to produce non-anatomical tibial and femoral tunnels. A modified transtibial technique which can achieve a lower femoral tunnel on the lateral intercondylar notch compared to traditional transtibial technique could potentially restore the normal knee biomechanics. Therefore, the objective of this study was to compare the knee joint laxities between the three femoral tunnel drilling approaches namely: modified transtibial technique, anteromedial portal technique and two-incision technique. We hypothesized that there will be no significant differences in the knee joint laxities following ACL reconstruction by these three techniques.

METHODS:
This study was conducted on eight cadaveric knee specimens with a mean age of 56.4 years (46-77 years). Knee kinematics and forces of the ACL or ACL graft in each knee were evaluated by using a robotic testing system under an anterior tibial load (134-N) at 0°, 30°, 60° and 90° of flexion, and combined torques (10-N.m valgus and 5-N.m internal tibial torques) at 0°, and 30° of flexion. Each knee was testing under five different conditions 1) ACL intact knee, 2) ACL deficient knee, 3) ACL reconstructed knee by AM portal technique, 4) ACL reconstructed knee by OI technique, and 5) ACL reconstructed knee by TT technique.

RESULTS:
Under anterior tibial load, no significant difference was observed between the three reconstructions in terms of restoring anterior tibial translation (Fig 1; P > 0.05). However, none of the three ACL reconstruction techniques could completely restore the normal anterior tibial translations (Fig 1; P < 0.05). The maximum difference in anterior tibial translations between the intact knees and ACL reconstructed knees by AM portal technique, OI technique and TT technique were 2.7±1.7 mm at 90°, 2.4±1.6 mm at 60° and 3.1±2.1 mm at 60° of flexion, respectively (Fig 1).

Under combined torques, differences in anterior tibial translations between the intact knees and ACL reconstructed knees by AM portal technique and OI technique were 0.7±1.1 mm and 0.6±1.2 mm at 0° of flexion (Fig 2; p > 0.05) and 1.7±0.5 mm and 1.9±1.0 mm at 30° of flexion (Fig 2; p < .05), respectively. In contrast, statistically significant differences in anterior tibial translations between the intact knees and ACL reconstructed knees by TT technique were observed both at 0° (1.5±1.1 mm) and 30° (3.0±1.6 mm) of flexion (Fig 2; p < 0.05).

DISCUSSION:
Restoring normal knee joint laxities is the primary goal of an ACL reconstruction. This study evaluated the efficacies of three different tunnel creation techniques for ACL reconstruction in restoring normal knee laxities and ACL forces under two different loading conditions. The results of this study support the hypothesis that ACL reconstruction by modified TT, AM portal and OI techniques result in similar knee joint laxities. Further, none of these techniques were able to restore the normal knee joint laxities under the external loads applied. Similarly, ACL grafts in all techniques carried lower forces than the native ACL.

In conclusion, this study demonstrated that both tibial tunnel independent and dependent femoral tunnel placement techniques can equally restore the joint laxity and ACL force under external loading. However, none of these three techniques could completely restore the normal knee joint laxity and ACL forces.

SIGNIFICANCE:
This objective evaluation elicits the efficacy of these operative techniques in restoring normal knee kinematics and ACL forces. While the choice of an operative technique is crucial, the results of this study demonstrate that other factors are to be optimized to restore normal knee biomechanics.