INTRODUCTION
Combined injuries of the posterior cruciate ligament (PCL) and the posterolateral corner of the knee results in postero-lateral rotatory instability. The detailed anatomy and kinematics of the PCL is well described in the literature; however, the anatomy and detailed kinematics of the posterolateral corner ligaments and tendons are not well understood. This information on the posterolateral corner is important for developing a strategy for accurate anatomical reconstruction. Therefore, the purpose of this study was to quantify the detailed kinematics of the posterolateral corner of the knee ligaments and tendons.

METHODS
Five fresh frozen human cadaveric knees were investigated using a custom knee testing system that has six degrees of freedom for positioning (Fig. 1). The capsule was preserved except for that covering the posterolateral corner ligaments and tendon. Six stitches and two screws for the popliteal tendon (PLT), four stitches for the popliteofibular ligament (PFL) and two stitches and two screws for the lateral collateral ligament (LCL) were used as digitizing markers using No. 0 black silk and small metal screws (Fig. 2). To represent residual tension, 10N was applied to the quadriceps, 4N to the hamstrings and 0.8N to the popliteal muscle.

RESULTS
The PLT-PFL junction moved laterally-superiorly-anteriorly 6.4 ± 1.0 mm with tibia ER and medially-inferiorly-posteriorly 5.9 ± 1.6 mm with tibia IR (p<0.02 at 30°, Fig. 8). The PLT-PFL angle on the tendon-ligament plane and the PFL-fibula angle on the sagittal plane increased 15.0 ± 2.3°, 14.6 ± 1.4° with tibia ER and decreased 9.5 ± 3.5°, 10.7 ± 0.4° with tibia IR respectively (p<0.01 Fig. 9, p<0.02 Fig. 10). The angle between LCL and the fibula was antverted at 0° and 30°, but retroverted at 90° knee flexion; moreover, the PLT was antverted at all knee flexion angles (p<0.01 Fig. 11). The distance from the medial knee joint space to the PLT-PFL junction, PFL insertions on the fibula head were 74.1 ± 11.0 mm, 89.0 ± 6.6 mm, respectively (p<0.04 Fig. 12). The bone clearance of the fibula head between both PFL and LCL insertions was 4.1 ± 2.1 mm.

CONCLUSIONS
The findings from this study suggest that reconstruction of the PLT and PFL is necessary for postero-lateral corner reconstruction. One of the current standard techniques is fixing the PLT and PFL grafts to the posterior wall of the tibia; however, our study showed that this point is moving with tibia rotation (Fig. 8). The angle between the PLT and PFL and the angle between the PFL and fibula increase with tibia ER and decrease with tibia IR. These structures are stretched between insertions when they work together to resist tibia rotation (Fig. 9-10). LCL restrained fibular posterior translation at 0° and 30° knee flexion, and the PLT-PFL restrained fibular posterior translation at all knee flexion angles (Fig. 11). The PLT-PFL plays a more important role in restraining postero-lateral rotatory instability at high knee flexion angles than the LCL. The distance from the medial knee joint space to the PLT-PFL insertion on the fibula head is 1.2 times longer than that to the PLT-PFL junction. The longer lever arm from the axis of varus rotation would be more advantageous in resisting varus rotation; therefore, using the PFL insertion as the graft fixation point would restrict varus rotation more than the using the PLT-PFL junction as the graft fixation point (Fig. 12). These findings also showed that both insertions of the LCL and PFL are located on top of the fibula head and it is not possible to make a tunnel at the anatomical positions for the PFL reconstruction. An anatomical reconstruction for the PLT-PFL injury should be connected to the PLT insertion on the lateral femoral condyle and to the insertion of the PFL on the fibula head.

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