INTRODUCTION:
ACL reconstruction is one of the most common procedures for orthopedic surgeons, however, worrisome complications such as intercondylar roof impingement have been reported. Roof impingement in which the graft impinges on the intercondylar notch at the terminal knee extension can lead to effusions, knee extension deficits, recurrent instability, or anterior knee pain. Several studies have emphasized the risk of graft abrasion secondary to elevated pressure between the intercondylar roof and the tensioned graft, with severe roof impingement occurring with tibial tunnel placement fully anterior to the slope of the intercondylar roof [Blumensaat line (B line)]1. To avoid roof impingement, intraoperative radiographic evaluation of lateral x-rays is commonly used to determine tibial tunnel placement when ACL reconstruction is performed. However, since the ACL deficient knee has anterior instability, there is a possibility that the leg position in lateral x-rays could affect the results of lateral x-rays. Therefore, the authors have been concerned that the position in which surgeons hold the leg may affect x-ray results when lateral x-rays are taken intraoperatorily. The purpose of this study was to evaluate the effect of leg position on intraoperative lateral x-ray findings in the assessment of intercondylar roof impingement.

MATERIALS AND METHODS:
13 consecutive patients (7 men, 6 women; average age, 26.8 ± 9.6 years) with isolated ACL unilateral deficiency who underwent anatomic double bundle (DB) ACL reconstruction using hamstring tendon autographs were involved in this study. Under general anesthesia, the patients were placed in the supine position on the operating table. All evaluations were performed by a single examiner. Before surgery, lateral x-rays of the contralateral intact knee were taken while only the ankle was held (Normal group). During ACL reconstruction, after drilling the tibial guide pins, intraoperative lateral x-rays were taken to evaluate roof impingement. When the intraoperative lateral x-rays were taken, we held the leg at two different positions. First, the leg was held only by the ankle (Ankle group) as is the practice of most surgeons, and secondly, the leg was held by the ankle and thigh posterior (Thigh group) to eliminate anterior tibial translation(Fig. 1). After x-rays were taken, the roof-plateau intersection ratio2,3(Fig. 2) showing the area located anterior to the B line was measured in each group. In addition, we evaluated the numbers of guide pins which indicated roof impingement and the positions of the two guide pins for tunnel placement of the anteromedial bundle (AMB) and posterolateral bundle (PLB). The roof-plateau intersection ratio was analyzed by use of repeated-measures analysis of variance (ANOVA) with a Bonferroni post hoc correction to determine significant differences between groups. Statistical significance was defined as P < .05.

RESULTS:
The roof-plateau intersection ratio was 28.4 ± 5.1% on average in the Normal group, 30.9 ± 5.3% in the Ankle group and 25.5 ± 4.4% in the Thigh group (Fig. 2). Significant differences were observed in the roof plateau insertion ratio between the Ankle group and the Thigh group. The number of guide pins located anterior to the B line was 4 out of 13 guide pins for the AMB in the Ankle group, however, there were none in the Thigh group. The tibial pin position was 31.2 ± 4.6% for the AMB and 46.8 ± 7.0% for the PLB (Fig. 3).

DISCUSSION:
The reported advantages of anatomic ACL reconstruction have been the restoration of knee kinematics to close to normal conditions and improved postoperative knee function. Several studies have shown the failure of ACL reconstruction due to intercondylar roof impingement1. Avoiding roof impingement has been considered a key issue for improving the results of ACL reconstruction, therefore we currently use intraoperative lateral x-rays to assess the position of the tibial guide pin, which should be parallel and posterior to the Bline with the knee in full extension. Buzzi et al has suggested the roof-plateau intersection ratio in the ACL-deficient knee remained larger than in the normal knee in 10% of patients4. Louis C et al has also shown that anterior subluxation that can occur in these unstable knees may give the impression of nonanatomic tibial tunnel placement5. In addition, the results for tibial pin positions in our study (Fig. 3) showed that our tunnels were located in anatomical insertion sites that have been demonstrated in other anatomic studies6,7,8,9. Although the guide pins were placed in anatomical insertion sites, while intraoperative lateral x-rays in the Ankle group demonstrated that 4 guide pins out of 13 were located anterior to the B line, the intraoperative lateral x-ray for the Thigh group did not show those 4 pins to be located anterior to the B line. This indicates that intraoperative lateral x-rays may overestimate roof impingement when the leg is held only by the ankle. Suitable leg position for intraoperative lateral x-rays to evaluate roof impingement is still unclear, since anterior tibial translation of the Normal group was located between the Ankle group and the Thigh group. Among our future objects of research is to investigate the appropriate leg position for the evaluation of roof impingement. In conclusion, leg position affected the results of intraoperative lateral x-rays. When surgeons evaluate intraoperative radiographs to assess intercondylar roof impingement while holding only the ankle, they should be aware of possible overestimation of roof impingement.

SIGNIFICANCE:
This study demonstrated the effect of leg position in the assessment of intercondylar roof impingement in ACL reconstruction and may serve to alert surgeons to the possibility of overestimation due to anterior tibial translation.

REFERENCES:
5. Iriuchishima T, KSSA 2010; 18:1226–1231