INTRODUCTION:
Proper bone cut and soft tissue balancing are the most critical procedures in total knee arthroplasty (TKA). A gap balancing technique is commonly used in TKA to create an equal extension and flexion gap. However, obtaining a flexion gap sufficiently large for the extension gap in cruciate retaining (CR) TKA is sometimes difficult and the flexion gap in CR TKA tends to be smaller in comparison to the extension gap. To address this, several studies have proposed ways to manage the tight flexion in CR TKA, including posterior cruciate ligament (PCL) release, additional posterior tibial slope, and downsizing of femoral component. Among the multiple factors affecting the balance of the flexion and extension gap, we focused on the fact that a larger distal femoral bone cut produces a larger extension gap (in other words, a smaller flexion gap). We wanted to clarify how the amount of distal femoral bone cut affects the balance of the flexion and extension gap. The purpose of the present study was to evaluate the effect of the size of the distal femoral bone cut on the flexion gap in CR TKA using cadaveric knees.

MATERIALS AND METHODS:
Eight fresh frozen cadaveric knees without ligament injury or significant arthritis were used for this study. A gap-balancing technique was used and the extension gap was initially established by resection of the distal femoral and proximal tibial articular surfaces. When the distal femur was resected, we cut 9mm (equal to the thickness of the femoral component) plus 4mm of the distal femur which simulated overcut of the distal femur. The tibia was cut 10mm (equaling the total of the tibial component and the smallest bearing) minus 4mm (Fig.1 large bone cut group). After finishing the final femoral bone cut using bony landmark (3 degrees external rotation from the posterior condylar axis), the femoral component was attached and the flexion and extension gap reaction to 125N separation force was measured at 90 degrees knee flexion and at knee extension. Subsequently, a 4mm spacer was attached to back side of the femoral component and an additional proximal tibial resection (4mm) was made (Fig.1. Standard bone cut group (Standard group)). The measurement of the flexion and extension gap was performed as previously described. Finally, an 8mm spacer was attached to the femoral component and an additional proximal tibial resection (4mm) was performed (Fig.1. Less bone cut group (Less group)). The measurement was performed as before. Statistical analysis was performed using ANOVA and Bonferroni multiple comparisons as post hoc tests. Statistical significance was defined as P < .05.

RESULTS
The measured gap of the Large Bone Cut group was 12.3±2.3 mm at knee extension and 14.8±2.7 mm at knee flexion. In the Standard Bone Cut group, the gap was 12.0±1.9 mm at knee extension and 18.0±3.5 mm at knee flexion. In the Less Bone Cut group, the measured gap was 12.6±3.3 mm, at knee extension and 21.9±3.9 mm at knee flexion. The difference between the flexion gap and extension gap was 2.5±2.4mm in the Large Bone Cut group, 6.0±2.7mm in the Standard Bone Cut group, and 9.3±2.1mm in the Less Bone Cut group. The gap difference of the Standard Bone Cut group and the Less Bone Cut group were significantly larger compared to the Large Bone Cut group (Fig.2).

DISCUSSION
Several studies have shown that soft tissue balancing and proper bone cut are the most important procedures in TKA. Making equalized rectangular flexion and extension gaps using a gap technique leads to superior coronal stability after TKA. However, acquiring a sufficiently large flexion gap in comparison to the extension gap is not always easy, particularly in CR TKA. There have been many studies showing ways to manage the effects of the gap imbalance such as tight flexion. PCL release, additional tibial posterior slope, and downsizing of the femoral component are major procedures for addressing tight flexion. However, if a sufficiently large flexion gap can be obtained, these supplementary procedures will not be required. Our study evaluated the effect of the quantity of the distal femoral bone cut and showed that a smaller distal femoral bone resection made the flexion gap larger in comparison to a large distal femoral bone resection. Avoiding a large bone resection of the distal femur would reduce the necessity of additional procedures to make the flexion gap larger. Therefore, reducing bone resection of the distal femur may constitute an important gap technique for CR TKA. In conclusion, we found that the amount of distal femoral bone resection affected the balance of the flexion and extension gap.

SIGNIFICANCE:
This study investigated the effect of the amount of distal femoral bone resection on the balance of the flexion and extension gap. Our study may contribute to the introduction of novel gap techniques for CR TKA, in which the flexion gap tends to be smaller in comparison to the extension gap.

References:
2. Dennis, Komistek, et al., CORR 2010 468(1):102-7