Adjusting the combined anteversion to maximize range of motion in total hip arthroplasty:

Acetabular side or femoral side, which adjustment is more effective?

INTRODUCTION:
Cup and stem positioning correlates each other in total hip arthroplasty (THA), and it is believed that optimal combined anteversion (CA), which is a sum of cup and stem anteversion (AV) angle, is about 40° – 60°. However, there are few studies that have compared which adjustment is more effective, changing a cup or a femoral stem to optimizing CA and increasing ROM. In this study, we compared the ROM resulting from various CA parameters by changing AV angles of cup and stem using a THA model that permits variations in femoral AV.

METHODS:
THA model (Figure 1): A THA model with ROM in six different directions (flexion (Flex), extension, internal rotation (IR), external rotation (ER), abduction, adduction) was created by installing implants on saw bones. A femoral head size of 28 mm was used with a standard neck length.

Femoral anteversion models (Figure 2): Three variations were used, with 20° of AV (normal), 60° of AV (excessive anteversion), and 20° of retroversion (retroversion).

Cup anteversion: A standard anteversion of 10° was used. AV angle was varied between -20° and +20° in 5° increments, thus creating nine divisions.

Changeable neck (Figure 3): In each femur, using changeable neck AV angle was varied between -20° and +20° in 5° increments, thus creating nine divisions.

ROM measurement: For ROM evaluations, we recorded the following angles until any impingement (IM) was detected: (1) IR angle at 90° Flex, (2) ER angle at 0° extension, and (3) Flex angle. We also recorded the site where impingement occurred.

Statistics: Measurements were collected three times for each femoral model, with average values of each set analyzed using Student’s t-test; p < 0.05 was considered to be statistically significant.

RESULTS:
1. Normal AV (20° AV) (Figure 4):
A cup AV angle of 10° (CA 30°) resulted in a ROM with an ER of 45.7°, an IR of 35°, and a Flex of 116°. When CA was increased by 20° by increasing the angle of the stem (CA 50°), significantly decreased the angles of ER and Flex were noted by 18° and 5°, respectively, compared to increasing the angle of the cup. In contrast, the difference of the IR was only 7° between changing the angles of cup and stem.

2. Excessive AV (60° AV) (Figure 5): At a cup AV angle of 10° (CA 70°), ROM was characterized by an ER of 12°, an IR of 72°, and a Flex of 122°. When CA was decreased by 20° (CA 50°), changing the angle of stem resulted in the significantly better ROM than changing cup side by an ER of 22°, an IR of 15° and a Flex of 31°. Because improvement of ER is required in cases with excessive AV, changing stem AV is likely to be more effective at improving ROM than is altering cup AV.

3. Retroversion (20° retroversion) (Figure 6): A cup AV angle of 10° (CA -10°) resulted in a ROM characterized with an ER of 73°, an IR of 0°, and a Flex of 88.7°. When CA was increased by 20° (CA 10°) by changing the angle of cup and stem, the differences of ER, IR, and Flex between cup and stem were 22°, 2° and 7°, respectively. Changing the angles of stem was more effective, but the difference was minimum.

DISCUSSION and CONCLUSION:
We adjusted both the acetabular and femoral anteversion to determine how to best increase ROM and optimize CA. Effectiveness changed in each case. In case with normal AV, changing in cup AV was more effective to improve ER and Flex. In case with excessive AV, optimizing stem AV using the changeable neck system is more effective to improve ROM in any directions. In case with retroversion, optimizing stem AV is again more effective, but the difference was small. This information should prove useful in the adjustment of CA in various femoral AV cases.