Effects of cup position on range of motion in total hip arthroplasty with excessive femoral anteversion or retroversion

+ Matsushita, A; Nakashima, Y; Yamamoto, T; Mawatari, T; Motomura, G; Fujii, M; Iwamoto, Y,
+ Department of Orthopedic Surgery, Graduate School of Medical Sciences, Kyushu University, Japan,
a-matsu@ortho.med.kyushu-u.ac.jp

INTRODUCTION:
Angles of cup abduction and anteversion affect range of motion (ROM) in total hip arthroplasty (THA), with recommended values being 45° ± 10° and 15° ± 10°, respectively[1]. However, these angles were determined in cases with normal femoral anteversion, and there are few studies on particular cases such as those with excessive anteversion or retroversion. In this study, we examined optimal cup position by changing abduction and anteversion angles using a THA model.

METHODS:
THA model(Figure 1): A THA model with ROM in six different directions was created by installing an implant on a saw bone.
Femoral anteversion models(Figure 2): Three variations were used, with 20° of anteversion (normal), 60° of anteversion (excessive anteversion), and 20° of retroversion (retroversion).
Cup positioning: Abduction angle was varied between 25° and 65°, in 10° increments, thus creating 5 divisions. Anteversion angle was similarly approached using 10° increments between -10° and 30°. A femoral head size of 28 mm was used with a standard neck length.

ROM measurement: For ROM evaluations, we recorded the following angles until any impingement (IM) was detected: (1) the internal rotation(IR) angle at 90° of flexion, (2) the external rotation(ER) angle at 0° of extension, and (3) the flexion angle. We also recorded the site where impingement occurred.
Essential ROM: the essential ROM was defined as 30° of ER, 40° of flexion-IR, and 110° of flexion[2]. Cup positions that resulted in combinations of abduction and anteversion angles that fulfilled these parameters were examined.
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 anteversion (20°anteversion)(Figure 3)
ROM at a cup abduction and anteversion angle of 45° and 20° was as follows: 51° of ER, 45° of IR, and 126° of flexion. Angles of IR and flexion correlated positively with the cup’s abduction and anteversion angles, and the essential ROM was achieved at an anteversion angle of 20° or greater when the abduction angle reached 45°. The effect of cup position on ER was small, but the combination of large abduction and anteversion of the cup reduced the range of ER.
2. Excessive anteversion (60° anteversion)(Figure 4)
ROM at a cup abduction and anteversion angle of 45° and 20° was as follows: 12° of ER, 85° of IR, and 130° of flexion. Essential range of IR was achieved when the anteversion angle was 0° or greater and the abduction angle was at least 35°. The flexion angle achieved the essential ROM when the anteversion angle was 10° or greater. Cup positioning did not have the effect on the range of ER because the bone impingement between the ischiium and greater trochanter prior to implant IM or bone-implant IM.
3. Retroversion (20° retroversion)(Figure 5)
ROM at a cup abduction and anteversion angle of 45° and 20° was as follows: 75° of ER, 12° of IR, and 101° of flexion. The IR angle was improved by increasing abduction angle, but could not achieve the essential ROM due to anterior bony IM. The degree of flexion succeed in achieving the essential ROM when the anteversion and abduction angles were greater than 30° and 45°, respectively.

DISCUSSION and CONCLUSION:
Effects of cup positioning on ROM were examined using a THA model. In cases with normal femoral anteversion, angles of IR and flexion correlated positively with the cup’s abduction and anteversion angles, however, the combination of large abduction and anteversion of the cup reduced the range of ER.
In cases with excessive femoral anteversion, IR and flexion were increased when both abduction and anteversion angles increased and the essential ROM was easily achieved. Cup positioning could not improve the range of ER. Altering the femoral versions with such changeable neck system would be necessary to achieve the essential ROM.
In femoral retroversion, the ER and flexion angle achieved the essential ROM by changing cup position. The required angle of IR was not achieved to meet the essential ROM.

REFERENCES: