EFFECTS OF THE FEMORAL OFFSET ON THE SAFE RANGE OF MOTION IN TOTAL HIP ARTHROPLASTY

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Introduction
The dislocation is one of the most frequent complications after total hip arthroplasty (THA). Adding to the surgeon- and patient-associated factors, the prosthetic features such as the head-neck ratio and femoral offset also influence the stability of THA. To our knowledge, there are few studies quantifying the effects of femoral offset on the range of motion (ROM) in THA. The purpose of this cadaveric study is to quantify the effects of the femoral offset and the head size on the safe ROM in THA.

Methods
Implantation: The uncemented total hip prostheses were implanted through the postero-lateral approach in 11 hip joints of 8 cadavers. The anterior joint capsule and the gluteus medius muscle were preserved. The acetabular shell was positioned at an inclination of 45 degrees and the acetabular anteversion angle was fixed to approximately 40 to 50 degrees totaled with the femoral anteversion angle measured during the implantation. The flat liner without elevated rim was used in all the testing.

Femoral offset and head size: Three different femoral offset, standard (0mm), 4mm lateral and 8mm lateral were tested using the modular neck. Neck-shaft angle of the femoral stem were 135, 130 and 125 degrees, respectively. To equalize the leg length, the 4mm longer neck per 4mm offset was used. By this, only the effect of the femoral offset could be evaluated. Five different femoral head size (22, 26, 28, 32 and 36mm) were also tested in the same way. Twenty six millimeters head were used in the case of testing the femoral offset.

Measurement: The range of internal rotation and flexion of the hip joint under the conditions described below were measured using the goniometer when the marked head center crossed the edge of the liner. With 90 degrees flexion of the hip joint, the range of internal rotation with and without 20 degrees adduction was measured. In the same way, the degree of flexion (deep flexion) without any adduction and internal rotation was measured. The point of impingement, such as implant-implant impingement occurred between the greater trochanter and liner in most cases (22mm head size). In contrast, the impingement with 4 and 8mm offset occurred between the greater trochanter and anterior acetabulum interposing the anterior soft tissue in all cases.

Statistics: All the measurements were repeated three times and the average improved ROM compared to those of 22mm head size was used for the statistical comparison. Analysis was performed with Fisher t-test. Significance was defined when p-value was less than 0.05.

Results
Effect of femoral offset: Increasing the femoral offset to 4mm and 8mm laterally significantly increased the range of deep flexion by 21.1 and 26.7 degrees respectively (Fig. 2A). The range of deep flexion reached 132.5 degrees in average with the 8mm femoral offset. Increasing the femoral offset to 4mm and 8mm laterally with 0 degree adduction significantly increased the range of internal rotation by 13.7 and 21.2 degrees respectively (Fig. 2B). Significant improvements of the internal rotation were also noted with 20 degrees adduction. The impingement with the standard offset occurred between the femoral neck and liner in most cases (22mm head size). In contrast, the impingement with 4 and 8mm offset occurred between the greater trochanter and anterior acetabulum interposing the anterior soft tissue in all cases.

Head size: Increasing the head size from 22 to 36 mm with 0 degree adduction significantly increased the range of deep flexion by 11.3 degrees (Fig. 3A) and internal rotation by 10 degrees (Fig. 3B). Significant improvements of the internal rotation were also noted with 20 degree adduction. The head size larger than 28mm significantly increased ROM compared to that less than 26mm. There was no significance in the ROM between the 32mm and 36mm head size. Larger head size needed more ROM to be dislocated from the point of impingement compared to the smaller head size.

Discussion and Conclusions
Increasing the femoral offset and the head size resulted in the significant improvements of the safe ROM in THA. The effectiveness of the femoral offset was brought mainly by delaying the bone-bone impingement. Although the effect of head size was less than that of the femoral offset, the larger head size is effective not only in delaying the implant-implant impingements, but also in the more ROM from the point of impingement to the dislocation.

References

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