Three dimensional analyses of femoral torsion and femoral anterior bowing

KANAJI A1, ENOMOTO H1, NAKAMURA T2, YANAGIMOTO S3, FUNAYAMA A1, TOYAMA Y1, SUDA Y1

1Department of Orthopaedic Surgery, Keio University, Tokyo, Japan,
2DePuy Japan, Johnson & Johnson KK, Tokyo, Japan,
3Department of Orthopaedic Surgery, Tokyo Saiseikai Central Hospital, Tokyo, Japan

hikokanaji@gmail.com

Introduction: Appropriate implant alignment is essential for successful clinical outcome as well as implant longevity after total hip arthroplasty (THA), and a greater understanding of the femoral neck anteversion and anterior bowing is necessary to achieve the accurate implantation of the femoral stem in THA. The purpose of this study was to evaluate the femoral neck anteversion and femoral anterior bowing using three dimensional analyses methods.

Methods: Three-dimensional models of 60 femora were reconstructed from less-affected side of the lower-limb pre-operative CT-scan data for primary total knee (TKA) or THA by using the Mimics (Materialise NV, Leuven, Belgium). The data included 9 males and 51 females with average age of 69.2±8.9 years, 30 subjects who received TKA and 30 with THA. In this study, the trans-epicondylar axis was designated as the Y axis. The X axis was set perpendicular to the plane that was defined by the epicondyles and the center of the femoral head. The Z axis was computed as the vector cross product of the X axis and the Y axis. The cross-sectional contours of the femoral canal (cancellous/cortical border) were extracted along the Z axis. A least-square fitted ellipse was calculated for each extracted cross-sectional contour, and a least-square line was fitted to the centers of the cross-sectional ellipses. The proximal anatomical axis was calculated to the proximal half of the ellipse data.

Similarly, the distal anatomical axis was determined to the distal half of the data. Femoral bowing was calculated as an angle between the proximal and the distal axes, which was projected on sagittal plane and on coronal plane to obtain anterior bowing (AB) and lateral bowing (LB) respectively. Moreover, cross-sectional contours of the cancellous/cortical border were also extracted along the initial neck axis and a least-square fitted ellipse was determined for each cross-sectional contour. The line that connects the center of the ellipse at the base of the femoral neck and the center of the femoral head was defined as the new neck axis, and femoral torsion was measured with respect to the posterior condyle line (FNTP) and transepiconsylar axis (FNTT). In this study, we calculated the AB, LB, FNTT, and FNTP and evaluate the correlation between AB, LB, FNTT, and FNTP and evaluate the correlation between AB, LB, FNTT, and age.

Results: FNTP, FNTT, AB and LB were 19.7 ± 9.5 degrees (5.4~49.9 degrees), 13.8 ± 9.2 degrees (0.36~38.8 degrees), 9.7±5.2 degrees (5.2~14.4 degrees), and 0.7±2.6 degrees (-3.9~9.9degrees) respectively. The correlation of FNTP and AB are not statistically significant (r=0.063, p=0.741); however, the correlation of FNTT and age, and AB and age were statistically significant (FNTT and age: r=-0.37, p=0.043, AB and age: r=-0.44, p=0.014).

Discussion: As far as we know, this is the first report to show the results of three dimensional reconstructive analyses of femoral torsion and femoral anterior bowing. These results demonstrated that the aging is involved with the decrease of femoral torsion and increase of femoral anterior bowing. A recent report demonstrated that femoral anteversion is correlated with acetabular coverage, suggesting the lack of acetabular coverage due to the progression of pelvic posterior tilt and osteoporosis may be involved with the decrease of femoral torsion and increase of femoral anterior bowing.