Computer simulation of the stem anteversion using landmarks on the cut surface of the femoral neck in total hip arthroplasty

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Introduction: The intraoperative estimation of femoral stem anteversion is generally performed by assessing the stem position relative to the axis of the lower leg. However, recent research indicates that the surgeon’s estimation of the anteversion of the stem has poor precision. Furthermore, the number of minimally invasive total hip arthroplasties (THA) performed in a supine position has increased. In this position, it is more difficult to orient the cut to the condylar plane of the femur than in the lateral position. Therefore a reliable landmark on the cutting surface of the femoral neck, if it exists, would be helpful.

Using cross-sectional computed tomography (CT) images, Suh et al. [1] reported that the midcortical line, the midline between the anterior and the posterior cortical walls, is compatible with the true femoral anteversion, but we suspected that the version of the midcortical line on the cutting surface is different from that on the axial image. The three-dimensional (3D) Computed Tomography (CT)-based preoperative planning software for THA enabled us to evaluate the cut surface of the femoral neck osteotomy. When we planned the straight non-anatomic stem placement in 20° of anteversion, we noticed that the line connecting the trochanteric fossa and the middle of the medial cortex of the femoral neck (T line) was coincident with the component torsion in almost all cases except those involving secondary osteoarthritis of the hip. Therefore we hypothesized that the T-line would provide an accurate reference guide for anteversion of the femoral component in THA. We performed this study to answer two questions: (1) is the T line a useful intraoperative reference guide for reproducing the true femoral anteversion, and (2) is the midcortical line on the cut surface of the femoral neck a good intraoperative reference guide?

Materials and Methods: The institutional review board allowed a retrospective review of CT images of 33 normal femora (33 patients) in our CT database. We performed virtual THA using the non-anatomic straight stem (Bicontact® stem, AESCULAP AG, Tuttlingen, Germany) on the 3D CT-based preoperative planning software at the two different cutting heights of 10mm or 15mm above the lesser trochanter. The anteversion of the stem implanted parallel to the T line or the midcortical line was measured. The true femoral neck anteversion was measured using the single CT slice method reported by Sugano[2].

Results: The mean true femoral anteversion was 16.9°±10.7°. We found no statistically significant differences in the stem anteversion between the cutting heights of 10mm and 15mm using either reference guide lines (midcortical line: p=0.73.; T line: p=0.32). We found strong positive correlations between the anteversion of the stem and the true femoral anteversion using the T-line at each cutting height (r=0.845 and r=0.924 in 10mm and 15mm cutting height respectively). The mean differences between the anteversion of the stem parallel to the T line and the true femoral anteversion were 3.5° (95% confidence interval; 1.38° - 5.59°) and 2.7° (95% confidence interval; 1.15° - 4.15°) in 10mm and 15mm cutting height respectively. The mean anteversion of the stem parallel to the midcortical line on the cut surface were -2.0° and -1.9° in 10mm and 15mm cutting height respectively and we could not implant the stem in some cases.
**Discussion:** In the present study, the anteversion of the stem which was implanted parallel to the T line was not affected by the height of the osteotomy. The mean value was close to the true femoral anteversion, and there was a strong positive correlation with the measured anteversion at each cutting height. On the other hand, using the midcortical line as a reference guide for the anteversion of the femoral component, stems tended to retroversion and we could not implant the stem in some cases. Theoretically, the anteversion of the stem using the T line is close to the true femoral anteversion because the trochanteric fossa is in line with the femoral canal, and the center of the medial cortex of the cutting surface faces the center of the femoral head, if the cutting height is not too low.

**Conclusions:** The T line was a useful intraoperative reference guide for reproducing the true femoral anteversion and the midcortical line on the cut surface of the femoral neck was not a good intraoperative reference guide.

**References**
