A Useful Reference Guide for the Stem Anteversion During Total Hip Arthroplasty in the Dysplastic Femur

Tadashi Tsukeoka, Yoshikazu Tsuneizumi, TaeHyun Lee.
Chiba Rehabilitation Center, Chiba, Japan.

Disclosures:
T. Tsukeoka: None. Y. Tsuneizumi: None. T. Lee: None.

Introduction: Proper version of the femoral components is one of the most important factors to minimize impingement and reduces the risk of dislocation in total hip arthroplasty (THA). Recent research indicates that the surgeon’s estimation of the anteversion of the stem has poor precision. Therefore a reliable landmark on the cutting surface of the femoral neck would be helpful especially when the procedure is carried out through a minimally invasive approach in the supine position. Tsukeoka [1] proposed a new landmark, the T-line on the cut surface of the femoral neck for reproducing the native femoral anteverision during THA for normal hips. However, their results cannot be extrapolated directly to the DDH. We therefore conducted this computer simulation study to determine whether T-line is applicable for DDH.

Methods: CT scans are routinely conducted as part of our preoperative planning for THAs. All patients had a bilateral preoperative CT scan of their lower limbs. The institutional review board allowed a retrospective review of CT images. Our study investigated 28 dysplasia hips in 28 consecutive patients scheduled for THA. None of our patients had evidence of trauma, infection, tumor, or history of hip osteotomy. The mean age of all patients was 64.8 years (range 43 years to 81 years).

According to the classification of Crowe et al 16 hips were Crowe type I (<50% subluxation), 8 Crowe type II (50-75% subluxation) and 4 Crowe type III (75-100% subluxation). No hip was classified as Crowe type IV (>100% subluxation). We performed virtual THA using the non-anatomic straight stem, on the 3D CT-based preoperative planning software at the two different cutting heights of 5mm or 10mm above the lesser trochanter. The anteversion of the stem with straight neck implanted parallel to the T line was measured. The T line was defined as the line connecting the center of the trochanteric fossa and the center of the medial cortex of the femoral neck, i.e., the point at the intersection of the line passing through the midpoints of both the medial and lateral edges of the cutting surface with the medial cortex of the femoral neck (Fig.1A and 1B). The trochanteric fossa was defined as the space surrounded by the greater trochanter, the cut surface of the femoral neck and the extended line of the posterior cortex. The torsion of the stem was defined according to Kingsley and Olmasted [2] in a spatial co-ordinate system simulating placement of the femur on a flat surface. For measurements of the anteverision of the stem, the 3D model was positioned with the table plane (z-x plane) coincident with the posterior condyles and the most prominent posterior point of the greater trochanter. The anteverision of the femoral neck or stem was measured using the single CT slice method reported by Sugano [3]. The Pearson correlation coefficient was used to measure correlations among variables. A one-way repeated measures ANOVA test was used to analyze the differences among the native femoral neck anteverision and the stem anteverisions at two different cutting heights. When the one-way ANOVA was significant, differences between the native femoral neck anteverision and the stem anteverision of 5mm and 10mm were determined using Dunnett’s test. The two-way repeated measures ANOVA was also used to detect the interaction between the degree of subluxation of the hip and the angle difference between the stem anteverision and the native femoral neck anteverision.

Results: The mean true femoral neck anteverision was 28.8º±15.9º. We found strong positive correlations between the anteverision of the stem and the native femoral neck anteverision using the T-line at both cutting height of 5mm (r=0.891, p<0.001; Fig 2) and 10mm (r=0.889, p<0.001) above the lesser trochanter. Table 1 shows the difference between stem anteverision and the native femoral anteverision. Although a statistically significant difference was found between stem anteverision at the cutting height of 10mm above the lessor trochanter and the native femoral neck anteverision (p<0.05), the mean difference between them was relatively small (3.2º). There was no statistically significant interaction between the degree of subluxation of the hip and the angle difference between stem anteverision and the native femoral anteverision (Table 2, p=0.25).

Discussion: In the present study, the mean anteverision of the stem which was implanted parallel to the T line on the cut surface of the femoral neck was close to the native femoral anteverision with a narrow confidence interval and there was a strong positive correlation with the measured anteverision at both cutting height of 5mm and 10mm above the lesser trochanter. The degree of subluxation of the hip up to Crowe type III did not affect the surgeon’s ability to reproduce the native femoral anteverision (Table 2).

Our study has several limitations. First, we used only one kind of non-anatomical straight stem. The kind of stem and the implanted position could affect the change in version. The tapered wedge design with a slim anteroposterior dimension used in this study provides a wedge fit for mediolateral stability and provides freedom of rotation, whereas “fit and fill” press-fit implants that attempt to circumferentially fill the femoral cavity are inflexible. Second, the T-line was tested only by 3D
simulation, not in practical setting. As for validation of the virtual stem anteversion on preoperative planning to postoperative anteversion, Sariali [4] et al reported excellent agreement between the postoperative stem anteversion and 3D CT-based preoperative planning. Third, we had small sample size of severe dysplasia of the hip.

This T-line technique is similar to the technique reported by Karnezis [5]. Firstly, the trochanteric fossa, the insertion point for the femoral medullary canal is identified. A straight reamer directed along the long axis of the femur is used to enter the proximal femoral medullary canal. A box chisel is orientated along the T-line; a line connecting the center of the femoral canal insertion point to the center of the medial cortex (in Karnezis technique, the center of the remaining femoral head was used). The box chisel directed along the axis of the femoral canal is used to create an appropriately orientated entry area to the medullary canal (the trochanteric fossa). We recently applied this T-line technique to control the version of the stem in our primary THA and realized its usefulness as a reference guide.

In conclusion, the T line is a useful intraoperative reference guide for reproducing the native femoral anteversion in DDH patients.

**Significance:** T line was a useful intraoperative reference guide for reproducing the native femoral anteversion in DDH patients.

**Acknowledgments:**

The stem amteversion (°)

\[ y = 0.8206x + 6.3161 \]

\[ R^2 = 0.7943 \]
### The difference between the stem and the native femoral anteversion

<table>
<thead>
<tr>
<th>Osteotomy height (above the lesser trochanter)</th>
<th>Mean difference (SD)</th>
<th>95% confidence interval(°)</th>
<th>The correlation coefficient between the native femoral and stem anteversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 mm</td>
<td>1.1° (7.2°)</td>
<td>-1.3° - 3.6°</td>
<td>r=0.891 (p&lt;0.001)</td>
</tr>
<tr>
<td>10 mm</td>
<td>3.2° (7.4°)</td>
<td>0.4° - 6.0°</td>
<td>r=0.889 (p&lt;0.001)</td>
</tr>
</tbody>
</table>

**ORS 2014 Annual Meeting**

**Poster No: 0924**