Implant positioning is one of the critical factors influencing postoperative outcomes in total hip arthroplasty (THA). Several studies have reported that the postoperative antetorsion (AT) measurement for the femoral stem inserted without navigation showed wide variability. The current authors developed a simple instrument, the Gravity-guide (G-guide), for intraoperative assessment of stem AT and adjustment. They evaluated the effectiveness of the G-guide with postoperative computed tomography (CT) examination. Ninety patients (96 hips) who underwent primary THA using the G-guide for stem adjustment were evaluated. The G-guide consists of 2 parts: one attached to the lower leg and the other attached to the handle of the rasp. The G-guide was used to evaluate the AT at the time of inserting the final rasp. In addition, the AT value in the G-guide evaluation system required correction by the angle obtained in the preoperative epicondylar view. Intraoperative stem AT was defined as the sum of the intraoperative G-guide value and the correction angle. Postoperative AT was evaluated by CT examination. The discrepancy between the intra- and postoperative measurements was 4.6°±4.1°. Acceptable accuracy with discrepancy of less than 5° and 10° was achieved in 66 (69%) hips and 85 (89%) hips, respectively. The use of the G-guide could effectively reduce the variability of stem anteverision compared with manual adjustment. This study proved the effectiveness of the newly developed G-guide system in intraoperative stem AT adjustment. [Orthopedics. 2016; 39(2):e271-e275.]

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alignment. Jolles et al. reported multiple predisposing factors for dislocation after the THA procedure and showed that the dislocation rate increased when the combined anteversion value was outside the range of 40° and 60°. Based on the results of a computerized 3-dimensional model analysis, Widmer and Zurfluh proposed the formula (cup anteversion + 0.7 stem AT) as the optimal combination for positioning of both components to calculate

The Gravity-guide (G-guide) consists of 2 parts: one attached to the handle of the rasp to measure antetorsion (a), and the other part attached to the lower leg (b). This part provides information for the orientation of the final rasp (c).
In addition, the AT value in the G-guide evaluation system required correction by the angle obtained in the preoperative epicondylar view (Figure 4). The correction angle consisted of the posterior condylar surfaces and the right angle line with the perpendicular line of the lower leg axis. The intraoperative stem AT was defined as the sum of the intraoperative G-guide value and the correction angle.

Postoperative stem AT was measured on CT images. The stem AT on the lesion side was defined as the angle between the posterior condylar axis and the axis of the femoral stem at the most proximal part of the inferior neck with no head portion. The measured angle was compared with the value obtained from the intraoperative G-guide evaluation.

RESULTS
Average native femoral AT and correction angle were 22.3°±10.1° and 6.2°±2.6°, respectively. Average intraoperative stem AT was 22.7°±8.4° (the sum of the intraoperative G-guide angle [17.3°±7.5°] and the correction angle [6.2°±8.4°]), and the corresponding angle was 19.9°±8.4° on postoperative CT examination. The discrepancy between the intra- and postoperative measurements was 4.6°±4.1° (Table). Acceptable accuracy with a discrepancy of less than 5° was achieved in 66 (69%) hips, whereas a discrepancy of less than 10° was achieved in 85 (89%) hips (Figure 5).

No significant difference was demonstrated between cemented and noncemented stems.

DISCUSSION
Determination of stem anteversion is one of the critical factors influencing the outcome of THA. However, little has been written about the anteversion of the femoral stem. Dorr et al3 proposed a stem anteversion with an approximate range between 10° to 20° to achieve stem insertion without navigation. Recently, the concept of combined anteversion, the sum of acetabular anteversion and femoral AT, has been proposed as a parameter to assess the appropriateness of overall prosthetic alignment. Based on the results of the computerized 3-dimensional model analysis, Widmer and Zurfluh7 proposed the formula (cup anteversion + 0.7 stem AT) to calculate the combined anteverision value and defined the ideal value to be 37.3°.

The current authors previously evaluated the AT and combined anteverision values in patients who underwent THA using an image-free navigation for the cup with manual adjustment of the stem. The AT values measured showed wide variability (mean, 23.6°±11.2°). Consequently, the resultant combined anteverision was also inconsistent (mean, 44.4°±11.2°). It is thought that accuracy and consistency in combined anteverision adjustment cannot be accomplished with the use of a navigation system for the acetabular side alone.
Generally, the intraoperative estimation of femoral stem anteversion in THA is made by a surgeon’s visual assessment of the stem position in the proximal femur. However, intraoperative estimation of femoral anteversion has limited accuracy. The surgeon is at a disadvantage when trying to estimate the stem position because the available osseous landmarks are limited to the femoral neck and the coronal femoral axis as determined by palpating the epicondyle. Although experienced surgeons intended to achieve a range of stem anteversion between 10° to 20°, a wide range of femoral anteversion was obtained. Dorr et al10 reported that the accuracy of surgeon-estimated femoral anteversion in 109 hips with cementless stems was evaluated with 3-dimensional CT and that 47% of femoral stems showed anteversion of less than 10° and 7% showed anteversion of more than 20°. Sendtner11 also reported a high variability of stem anteversion by postoperative CT evaluation in 60 cases of THA. Stem anteversion ranged from -19° retroversion to 33° anteversion. Normal anteversion (range, 10°-15°) was present in 5 of 60 hips, and 21 of 60 hips were outside the range of 0° to 25°. Wine and McNicol12 reported that 70% of 111 hips achieved a range of anteversion between 10° to 30°. They proposed that surgeons’ intraoperative assessment of femoral stem anteversion may not be accurate.

Regarding determining stem anteversion intraoperatively, Unlu et al13 and Shon et al14 proposed that the lesser trochanter could be a guide in the surgical field for estimating femoral stem anteversion. Unlu et al13 investigated the version of the lesser trochanter relative to the posterior femoral condyle. Shon et al14 evaluated the relationship between the posterior lesser trochanter line and the femoral neck axis (version of the femur) using CT. They proposed that there is a constant relationship between the lesser trochanter and femoral neck axis and that the femoral neck version can be estimated with reasonable reliability using the lesser trochanter.

However, their methods required both preoperative CT evaluation and mathematical formulas. In addition, patients with dysplastic hips were excluded from the population of patients included in their study, and therefore it might be insufficient for clinical use. Bargar et al15 suggested that the mean prosthetic femoral anteversion is greater than the mean native femoral anteversion and that there is no correlation. Therefore, Bargar et al15 emphasized that the surgeon should not use native femoral anteversion to predict the anteversion of the femoral component. The only method that could provide precise intraoperative information about the femoral stem version would be computer-assisted navigation, which is not available to most orthopedic surgeons.

To attain consistency in stem AT without navigation, the current authors have used the G-guide in their clinical practice for intraoperative assessment and adjustment. Their results with the G-guide showed that the discrepancy between the intra- and postoperative measurements averaged 4.6°±4.1°. This value is larger than that attained by the navigation system.16 However, considering the level of accuracy that is feasible during the surgical procedure, the average discrepancy of 4.6° in this study seems to indicate acceptable clinical accuracy.

Intraoperatively, the G-guide measured stem AT by reference standard with the lower leg axis. In addition, patients with dysplastic hips were excluded from the population of patients included in their study, and therefore it might be insufficient for clinical use. Bargar et al15 suggested that the mean prosthetic femoral anteversion is greater than the mean native femoral anteversion and that there is no correlation. Therefore, Bargar et al15 emphasized that the surgeon should not use native femoral anteversion to predict the anteversion of the femoral component. The only method that could provide precise intraoperative information about the femoral stem version would be computer-assisted navigation, which is not available to most orthopedic surgeons.

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Intraoperatively, the G-guide measured stem AT by reference standard with the lower leg axis. This means the G-guide could not measure stem AT directly from the femur, and, similar to previous studies with intraoperative stem AT, the authors measured stem AT by referencing the lower leg intraoperatively. It was thought that there was a discrepancy between the G-guide measurement and the true stem
AT; therefore, a preoperative evaluation with an epicondylar view was required to correct the angle with femoral tilt. An epicondylar view was able to provide the angle between the posterior femoral condyle axis and the perpendicular line with the tibial shaft angle. Intraoperative stem AT was defined as the sum of the G-guide angle and correction angle with epicondylar view evaluation.

This study has some limitations. First, the authors were unable to evaluate the knee osteoarthritis and tibial bowing in each patient. It might be possible that these occur due to deformities of the posterior femoral condyle and changes in the femoral tilt. However, Dorr et al.9 and Murphy et al.17 have proposed a good correlation between the epicondylar line and the posterior femoral condylar axis. This epicondylar line may be as effective as the current authors’ method. Another limitation of this study is that the authors could not compare the G-guide evaluation with other measurement systems, such as navigation systems.

CONCLUSION

The use of the G-guide could effectively reduce the variability of stem anteversion compared with manual adjustment. This study proved the effectiveness of the authors’ newly developed G-guide system in intraoperative stem AT adjustment.

REFERENCES