Reconstructed CT assessment of image-free navigation assisted cup placement in total hip arthroplasty in Asian physique

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Introduction: Optimal acetabular cup position is an important determinant of short and long-term success of a total hip arthroplasty (THA). Poor cup placement has been associated with impingement[1], dislocation[2-4], accelerated polyethylene wear[3, 5], osteolysis[6], component loosening[7], and component migration[3].

Methods to determine acetabular cup component position intraoperatively historically have consisted of free hand techniques and use of mechanical guides. In the past decade, the accuracy and precision of these methods has been into question[8-11]. Furthermore acetabular cup position using these techniques, even in the hands of experienced surgeons, may results in considerable outliers.

Computer-assisted navigation (CAS) system with real-time adjustments for positional changes have introduced in an effort to more accurately position the acetabular cup components. Imageless CAS use digitally registered pelvic landmarks referenced to an optical array fixed to the pelvis to establish the anatomic anterior pelvic plane. The registered points included both anterior superior iliac spines (ASIS) and symphysis pubis. With these points registered, real-time cup inclination and anteversion can be determined by tracking the array with an optical camera

We first hypothesized the image-free navigation system would be accurate for inclination and anteversion of postoperative 3 dimension - reconstructed computed tomography scan values. We then analyzed the biometrical parameters affecting the discrepancy between navigation date and computed tomography data regarding to acetabular cup orientation.

Materials & Methods: We prospectively followed 81 hips (72 patients) who underwent primary THA by one senior author (KJ Oh) using an image-free navigation system (Orthopilot version 2.0 & 2.1; B.Braun-Aesculap, Tuttlingen, Germany) to place the acetabular component. Institution Review Board approval for computed tomography scans and informed consent for prospective review of data was obtained. Our study focused on the accuracy and precision of image-free navigation as intraoperative instrumentation and therefore clinical outcome data were not included.

The sample consisted of 38 men (44 hips) and 34 women (37 hips) with a mean age of 61 years (range, 26-88 years). Nine patients had bilateral arthroplasties, so 38 right hips and 43 left hips were included in the analysis. The mean BMI was 23.3 kg/m^2(range, 16.8 ~ 34.3 kg/m^2). Three of the 72 patients were classified as obese as measured by a BMI greater than 30 kg/m^2). Nineteen were classified as overweight (BMI, 25-30 kg/m^2).

Mathemetical formula by Dr. Murray[14]

- Inclination = arctan [tan (Operative AV) ÷ tan (Anatomic AV)]

- Anteversion = arctan [tan (Anatomic AV) x sin (Inclination)]

or = arctan [tan (Operative AV) x cos (Inclination)]

Results: The reconstructed CT data was different from the navigation information in Asian physique. The number of case in outliers was 5% (6 cases) in both safe zone of anteversion and inclination. The main correlated factor which affect the discrepancies was pelvic tilt. The calculated precision and accuracy was satisfactory result as shown in figures.

Conclusions: Intraoperative navigation data was statistically different from postoperative reconstructed CT data in Asian physique. But, the calculated accuracy and precision were reliable and the outlier was remarkably reduced compared previous reports. This study showed the potential racial difference of pelvic geometry. These pelvic geometry (pelvic tilt) might have the discrepancies of navigation information.