The precision of acetabular cup angles after CT-based navigation assisted THA for Japanese patients

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Introduction: Navigation systems have been mainly developed in Europe and U.S. in which most patients underwent THA were suffering from primary osteoarthritis (OA) of hip joint without pelvic and femoral deformities. Not a few Japanese patients with OA have pelvic and femoral deformities due to developing dysplasia or congenital dislocation of hip joints. There are few reports about clinical precision of cup placement after CT-based navigation assisted THA for such Japanese patients with secondary OA [1][2]. Over 1/4 of our patients, who need THA for their OA, have pelvic and femoral deformities. To get accurate geometrical information of deformed bones is essential to place implants in accurate positions. Therefore, we have performed CT-based navigation THA using VectorVision Hip (Brain LAB, Germany) since 2002. Our goal in this study is to analyze the precision of intra- and post-operative acetabular cup angles using postoperative pelvic CTs focusing on several factors which may affect the precision of acetabular cup angles.

Materials and Methods: We analyzed consecutive 42 joints of 39 patients (female: 38 joints, males: 4 joints, average of operative age: 56.9 years old, average of body mass index [BMI]: 22.8 kg/[m]2) who underwent CT-based navigation assisted THA since 2006 using VectorVision Hip version 2.51 (Brain LAB), in which the landmark matching registration procedure was used. Post-operative pelvic CTs were taken for all patients and the lateral inclination and anteverision angles of the acetabular cup were measured using 3-dimensional template soft (JMM, Japan) according to the anatomical pelvic plane [3]. The navigation error (error) is defined as an absolute value of [measured post-operative angle]-[measured intra-operative angle]. The real navigation error (real error) is defined as an absolute value of [measured post-operative angle]-[pre-operative planed angle]. We analyzed effects of several factors (age, BMI, gender, operator’s experience, surgical approach, and presence of pelvic and femoral deformities, previous surgeries, joint space, and osteoporosis) affecting the precision of the cup angles. Pelvic deformities were classified according to the Crowe’s classification [4]. Correlation analysis, Mann-Whitney U-test, and ANOVA were used for statistical analyses by using of StatView version 5.0 (SAS Institute, NC).

Results: The averages of navigation errors and real errors in lateral inclination angles were 3.8 degrees and 3.6 degrees, respectively. The averages of navigation errors and real errors in operative anteverision angles were 3.5 degrees and 3.6 degrees, respectively. There were no significant differences in the errors and real errors according to the age, BMI, and surgical approaches. The procedures of CT image processing are important factors affecting the post-operative precision after CT-based navigation, and presences of osteoporosis, metal implants, and disappearance of joint space are believed to have some effects on the precision. In our study, however, these factors did not affect the precision of the cup angles. The errors of lateral inclination and anteverision were smaller in the joints performed by the experienced surgeon (the experience of navigation THA was over 3 years) than those in the joints by inexperienced surgeons (their experiences were less than 3 years) (the averages of the real errors in inclination were 3.0 degrees in joints by the experienced surgeon and 4.9 degrees in joints by the inexperienced surgeons, respectively [P<0.05], and the averages of the errors in operative anteverision were 2.9 degrees in joints by the experienced surgeon and 4.8 degrees in joints by the inexperienced surgeons, respectively [P<0.05]). The cases with pelvic and femoral deformities (groups 2, 3, or 4 of Crowe’s classification) showed smaller real errors of anteverision than the joints without bone deformities (groups 1 of Crowe’s classification) (the averages of the real errors in operative anteverision were 4.4 degrees in joints without bone deformities and 2.2 degrees in joints with bone deformities, respectively [P<0.05]). The errors of lateral inclination were bigger in male than those in female (the averages of the errors in inclination were 7.1 degrees in male and 3.4 degrees in female, respectively [P<0.05]).

Discussion: The most effective factor on the precision of post-operative cup angles after CT-based navigation THA was the surgeon’s experience for the navigation THA. The reason why the errors of cases with pelvic and femoral deformities were low was that such challenging cases with bone deformities were often performed by the experienced surgeon. The reason why the errors of lateral inclination in male cases were bigger than those in female seemed to be the volume of abductor muscles. The abductor muscles of male cases hampered to keep the proper lateral inclination angle during the cup insertion under the muscle preserving minimally invasive surgery [5].

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