Fluoroscopy-CT-based navigation improved the acetabular component orientation in MIS THA comparing to CT-based navigation

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Introduction: Acetabular component orientation of total hip arthroplasty (THA) is critical for dislocation, range of motion, polyethylene wear, pelvic osteolysis, component migration. Therefore, acetabular component should be implanted in so-called the “safe range” [1]. Great error of acetabular component orientation under manual technique even with mechanical alignment guides has been reported [2]. Therefore, various navigation systems were introduced to reduce outliers of acetabular component orientation. Although it was reported that CT-based navigation systems improved the accuracy of the acetabular component orientation [3,4], it is still less accurate in regard to anteversion than inclination [5].

A noble technique, fluoroscopy-CT-based navigation system, has recently been developed. It combined the advantage of CT-based navigation system and fluoroscopy-based navigation system to improve the accuracy especially in anteversion. For registration with fluoroscopy-CT-based navigation system, surgeons touch only gross positions of bilateral anterior superior iliac spine, and do not need to touch the landmarks around acetabulum. Thus, it might be friendly to MIS THA and cases with sever bone deformity.

We undertook a prospective randomised study to compare the accuracy of acetabular component orientation in MIS THA between a conventional CT-based system and a new fluoroscopy-CT-based navigation system.

Materials and Methods: Between January 2005 and March 2006, 17 patients 17 cases were performed THA through MIS approach with less than 10cm skin incision. We implanted cementless hemispherical cups in 11 hips using CT-based navigation system (VectorVision CT Hip 3.1, BrainLAB, Feldkirchen, Germany) (CT group) and in 6 hips using fluoroscopy-CT-based navigation system (VectorVision CT Hip 3.5) (Fluoro-CT group) (Figure 1, 2).

For all the patients, volumetric post-operative CT scan was performed to measure three dimensional positioning of acetabular component. The position of the acetabular component was measured using 3-D image-processing software (Japan Medical Materials, Kyoto, Japan). The difference from target angles was compared between groups.

Results: The difference from target angles of anteversion was 2.9 ± 2.8 degrees (mean ± SD) in Fluoro-CT group, and 7.6 ± 4.6 degrees in CT group (p = 0.035). The absolute value of difference from target angles of inclination was 4.0 ± 2.0 degrees in Fluoro-CT group, and 6.0 ± 4.8 degrees in CT group (p = 0.651). Deviation from the target angle of inclination was significant smaller in Fluoro-CT group (p = 0.039) (Figure 3). Average time of fluoroscopy was 13.8 seconds in Fluoro-CT group.

Discussion: We previously reported that CT-based navigation system improved the accuracy of acetabular component orientation in MIS THA comparing to manual technique and fluoro-based navigation system [5]. However, CT-based navigation system for MIS THA had two problems. First, it was difficult to get accurate surface registration because small visible area in MIS THA prevented surface registration. Secondly, surface registration was difficult in cases with sever bone deformity around acetabulum, such as large osteophyte. For surgical approach (dislocation of hip joint), large osteophyte had to be removed before surface registration. Removal of osteophyte changed the landmarks for surface registration. These problems might lead the error of CT-based navigation system.

On the other hand, fluoroscopy-CT-based navigation system does not need surface registration around acetabulum. This feature is great advantage to MIS THA. Our study showed that fluoroscopy-CT-based navigation system significantly improved the accuracy of acetabular component orientation in MIS THA comparing to CT-based navigation systems. Fluoroscopy-CT-based navigation system would be friendlier for MIS THA than CT-based navigation system.

This study using 3-D image-processing software for post operative acetabular component orientation revealed that fluoroscopy-CT-based navigation system further improved the accuracy of acetabular component orientation in MIS THA, especially in anteversion, comparing to CT-based navigation system.