Postoperative 3D analysis of CT-based navigation assisted curved periacetabular osteotomy (CPO) using OrthoMAP 3D®

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Introduction: Curved periacetabular osteotomy (CPO) has been developed to treat patients who suffering from developing dysplasia of hip joint. The hip abductor muscles can be preserved in CPO since the acetabulum is osteotomized from the inside of the pelvis. However, it is not easy to osteotomize the acetabulum from the inside without watching the hip joint directly. Recently, we apply a CT-based navigation system, OrthoMAP 3D® (Stryker, US), for CPO. Not only we can navigate the intra-operative procedures, but we can analyze the postoperative CT data using the same software of OrthoMAP 3D® to assess the states of rotated acetabula. In this current study, we compared the pre- and post-operative vertical-center-anterior (VCA) angles, center-edge (CE) angles, and femoral head coverage ratio of the affected acetabulum in the anterior pelvic plane (AAP) coordinate using the pre- and post-operative CT images of patients underwent CPO.

Patients and Methods: We subjected 7 hips treated with conventional CPO without navigation (the conventional group: female 6 hips, male 1 hip, average age: 32.7 years old) and 10 hips treated with navigation using OrthoMAP 3D® navigation system (the navigation group: female 9 hips, male 1 hips, average age: 37.7 years old) to the current study. The navigation group was divided into the SM group (the hips navigated by the surface matching registration) (4 hips) and the 3D-3D group (the hips navigated by the 3D-3D matching registration) (6 hips). We made 3D pelvic model based on the pre- and post-operative CT images using OrthoMAP 3D®. Then, the VCA angles and the CE angles in the APP coordinate were measured. Using the axial images of the affected hip joint and an image analyzing software, Image-J (Wayne Rasband [NIH], US), we measured the femoral head coverage ratio of the affected hip joints.

Results: The pre- and post-operative VCA angles were 27.5 degrees and 47.2 degrees in the conventional group, 21.9 degrees and 55.7 degrees in the SM group, and 21.1 degrees and 50.3 degrees in the 3D-3D group, respectively. The pre- and post-operative CE angles were -1.71 degrees and 21.7 degrees in the conventional group, 7.5 degrees and 37.6 degrees in the SM group, and 4.2 degrees and 24.3 degrees in the 3D-3D group, respectively. The pre- and post-operative femoral head coverage ratios of the hip joints were 52.1 % and 81.3 % in the conventional group, 64.0 % and 93.2 % in the SM group, and 61.4 % and 84.5 % in the 3D-3D group, respectively. There were no statistical differences among the 3 groups in the pre- and post-operative VCA angles, the CE angles, and the femoral head coverage ratios.

Discussion: Using the same software of the OrthoMAP 3D®, we can achieve 3D analysis of the rotated acetabulum after CPO except for the femoral head coverage ratio. Even though we could not detect any statistical differences among the conventional, SM, and 3D-3D groups in the pre- and post-operative VCA angles, CE angles, and femoral head coverage ratios, the conventional group showed less or excess correction of the CE angles and excess correction of the VCA angles in some hips. The less correction of the acetabular coverage will lead progress of osteoarthritis. On the other hand, the excess anterior rotation...
of the acetabulum will lead impingement between the acetabular rim and the proximal femur. The Current navigation system does not provide us a real time tracking of the rotated acetabular fragments. So far, we can confirm the positions of the rotated acetabular fragments by touching the edges of the fragments using the navigation system. The results of the current study suggest that we may perform CPO more precisely using the OrthoMAP 3D® navigation system to get a proper correction of the dysplastic acetabulum.