CASE REPORT

Eccentric Rotational Acetabular Osteotomy Using Computed Navigation Guidance for Developmental Dysplasia of the Hip, Sacroiliac Fusion, and Femoroacetabular Impingement Owing to Acetabular Retroversion: A Case Report

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Background: Developmental dysplasia of the hip (DDH) is the main factor that causes secondary osteoarthritis of the hip (hip OA). Acetabular retroversion results in pincer-type femoroacetabular impingement (FAI), and this is also known to cause secondary hip OA. However, few cases of DDH with acetabular retroversion have been reported, and there is no definite opinion on the optimal treatment. We report a rare case of DDH and FAI owing to acetabular retroversion and dysostosis of the sacroiliac joint that was treated with eccentric acetabular rotational osteotomy (ERAO) using navigation guidance.

Case Presentation: A 27-year-old woman presented with DDH and acetabular retroversion with FAI and dysostosis of the sacroiliac joint on the contralateral side. We performed ERAO using computed navigation guidance and improved the coverage and retroversion of the acetabulum. The acetabular anteversion angle improved from 1° retroversion to 9° anteversion after surgery, the center edge angle improved from 18° to 43°, and the acetabular head index improved from 69% to 93%. The cam lesion of the femur was resected. The Harris Hip Score improved from 55.7 to 100 points at the final examination 2 years after surgery.

Conclusions: In this rare case of DDH and FAI, ERAO using computed navigation guidance accurately improved the coverage and retroversion of the acetabulum.

Key words: Computer-assisted; Femoroacetabular impingement; Hip dysplasia; Osteotomy; Sacroiliac joint

Introduction

Developmental dysplasia of the hip (DDH) is a primary contributor to secondary osteoarthritis of the hip (hip OA)[1]. DDH is characterized by various morphological abnormalities, including a shallow articulating cavity, an excessively oblique acetabular roof, and decreased acetabular coverage of the femoral head[2]. Eccentric acetabular rotational osteotomy (ERAO) has been developed as treatment for DDH, and good results have been reported[3]. Ganz *et al.*[4] reported that acetabular retroversion (AR) and femoroacetabular impingement (FAI)—a pincer-type FAI[5]—are causes of secondary hip OA. AR is defined by a positive cross-over sign, a posterior wall sign, and an ischial spine on anteroposterior radiographs and by a posterior acetabular sector angle on computed tomography (CT)[6, 7]. Cases of DDH with AR have been reported recently; however, there is no definitive opinion regarding the optimal treatment[8, 9]. Herein, we present a rare case of DDH and FAI owing to AR and dysostosis of the sacroiliac joint on the contralateral side that was treated with ERAO using navigation guidance.

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All procedures performed on our patient were in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Helsinki Declaration and its later amendments. This report was approved by the Ethics Committee at our institution. The patient and her family provided written informed consent for publication of her data.

Case Report

History

A 27-year-old woman had received medication and exercise treatment for right hip joint pain for 3 years. Her symptoms had gradually progressed, and she was aware of the pain while standing and during hip flexion. She showed positive

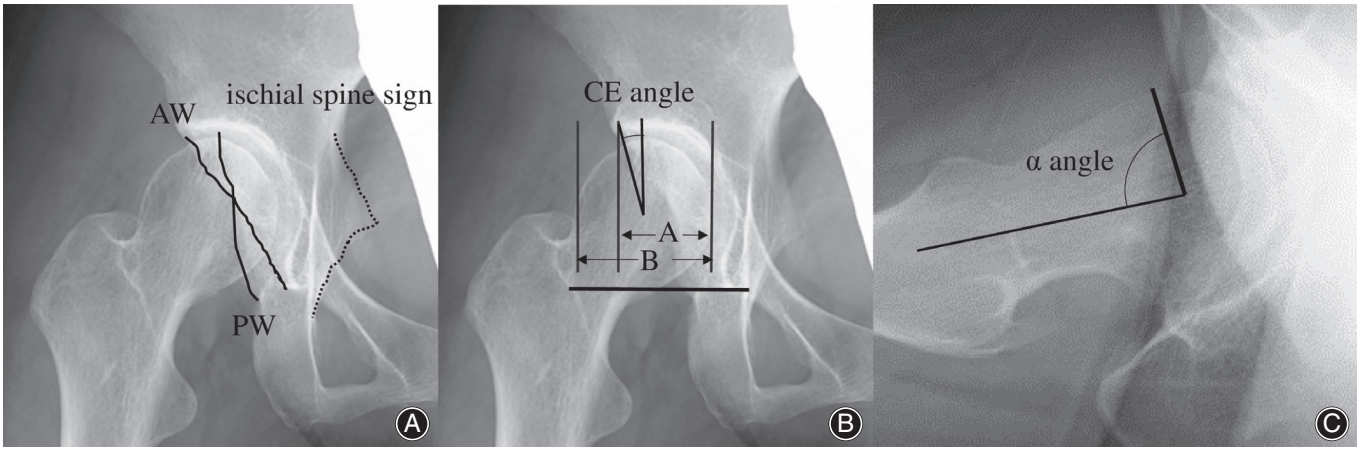

Fig 1 Preoperative radiographs. The patient experienced right hip joint pain with developmental dysplasia of the hip and femoroacetabular impingement owing to acetabular retroversion. (A) Image of the right hip joint indicating Kellgren–Lawrence classification grade 1 and showing a center edge (CE) angle of 18° and acetabular head index (AHI) of 69%. (B) Image of the right hip joint showing retroversion of the right hip acetabulum as indicated by a positive cross-over sign (dotted line) and ischial spine sign (black arrow) (C) Cross table lateral radiograph of the right hip joint showing an α angle of 72.9°. AW, anterior wall; PW, posterior wall; AHI, A/B × 100.

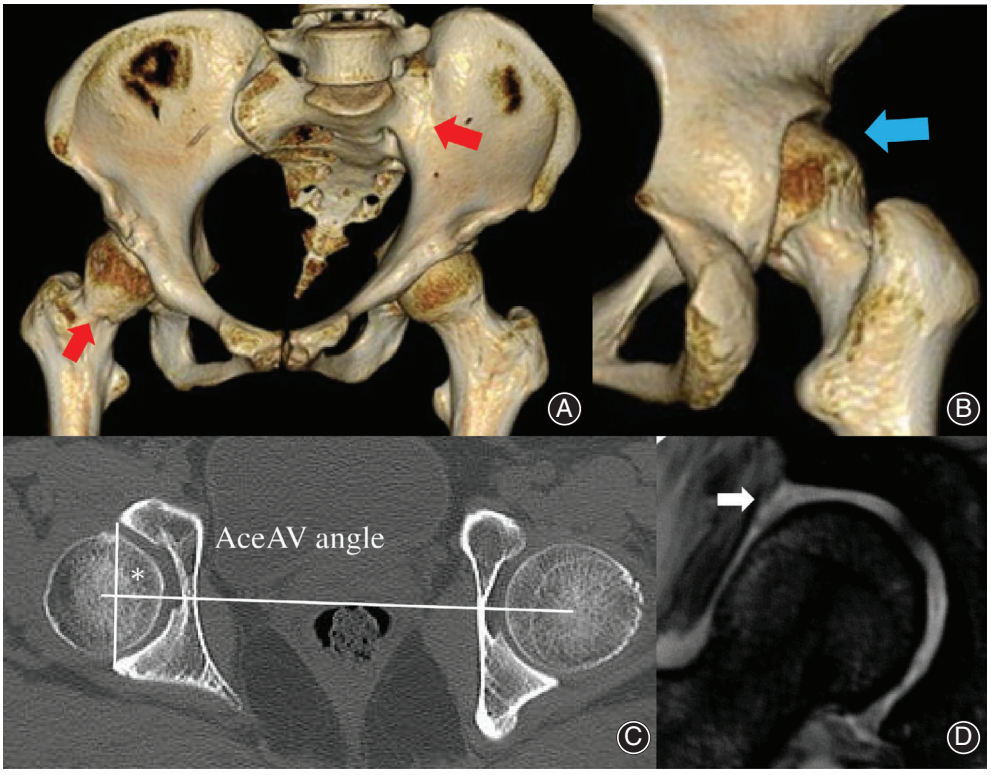

Fig 2 Preoperative computed tomography (CT) and magnetic resonance images. (A) Three-dimensional CT images showing left sacroiliac joint fusion and cam lesions in the right femoral neck in the right hip joint (indicated by red arrows). (B) Insufficient coverage of the posterior acetabulum owing to developmental dysplasia of the hip and acetabular retroversion (indicated by the blue arrow). (C) Axial CT image showing acetabular retroversion of 1° in the right acetabulum. (D) Magnetic resonance image showing a change in brightness in the anterolateral region of the labrum of the right acetabulum, suggesting a labrum tear (indicated by the white arrow). AceAV angle, acetabular anteversion angle.

results for the Patrick sign and anterior impingement sign for the right hip joint. Her Harris hip score (HHS)[10] for the right side was 55.7 points just prior to surgery.

Imaging Study

Kellgren–Lawrence classification[11] grade 1 was determined from an anteroposterior radiographic view of the hip joint, with a center edge (CE) angle of 18° and an acetabular head index (AHI) of 69% in the right hip joint (Fig. 1A). The right hip joint showed a positive cross-over sign and an ischial spine sign; this suggested AR (Fig. 1B). A cross table lateral view showed an α angle of 72.9°, suggesting a cam lesion in the femoral neck (Fig. 1C).

Three-dimensional CT images showed left sacroiliac joint fusion and cam lesions in the right femoral neck (Fig. 2A). A posterior view of the three-dimensional CT scan showed that coverage of the posterior acetabulum was deficient because of developmental dysplasia (Fig. 2B, blue

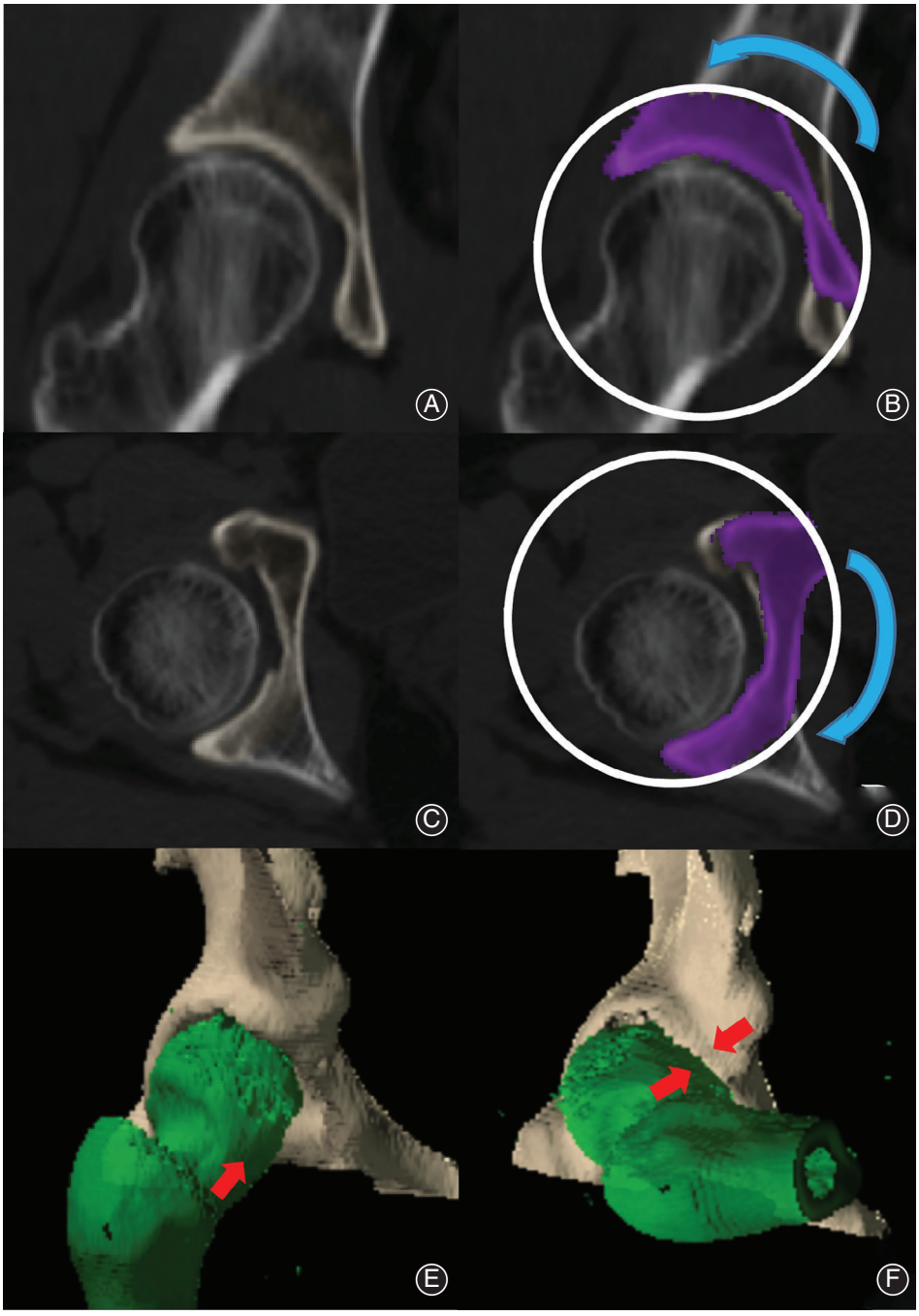

Fig 3 Preoperative planning views from computed navigation guidance.
(A) Preplanning coronal image from the computer navigation system. (B) Planning of the osteotomy direction for DDH coverage on the coronal image. The white circle shows the osteotomy line; the osteotomy direction is indicated by the purple fragment and blue arrows.
(C) Preplanning axial image from the computer navigation system. (D) Planning of the osteotomy direction for acetabular version on the axial image.
The white circle shows the osteotomy line; the osteotomy direction is indicated by the purple fragment and blue arrows.
(E) Oblique view of the three-dimensional navigation images showing the neutral position of the right hip joint in the preoperative simulation.
The femur is shown in green; the cam lesion is indicated by a red arrow.
(F) Oblique view of the three-dimensional navigation images showing simulation of impingement between the acetabulum and the femoral neck at 90° hip flexion (indicated by red arrows). DDH, developmental dysplasia of the hip.

arrow), and axial CT showed an acetabular anteversion (AceAV) angle of −1°, indicating right acetabulum retroversion (Fig. 2C). Radial magnetic resonance imaging showed a change in brightness in the lateral and anterolateral regions of the labrum, suggesting a labrum tear (Fig. 2D). The diagnosis was DDH with FAI owing to AR, and the planned treatment involved ERAO and cam lesion resection.

Surgery

Surgery involved ERAO[3], and the direction of rotation was adjusted using a computer navigation system (Stryker Orthopedics, Mahwah, NJ, USA), as planned before surgery. The procedure is performed using a lateral transtrochanteric approach. The osteotomy site begins approximately 20 mm from the joint space, and eccentric osteotomy using a chisel with a 45-mm radius results in medialization of the femoral head center. ERAO enables reorientation of the acetabulum with rotational degrees of freedom, and the use of a computer navigation system can set the rotational direction of the acetabulum to improve the coverage of the acetabulum and AR (Fig. 3A–D). Three-dimensional navigation images showed impingement between the acetabulum and femoral neck at 90° hip flexion (Fig. 3F) from a neutral position (Fig. 3E). The hip joint was flexed after the osteotomy, and the site where the cam lesion met with the acetabular rim at the femoral neck was observed. The cam lesion was resected until the impingement disappeared during deep hip flexion. Finally, the hip labrum tear was repaired using a surgical anchor with sutures (Panalock loop; Johnson & Johnson, Raynham, MA, USA).

Postoperative Outcomes

Postoperative radiographs showed an improvement in the coverage of the acetabulum, with a CE angle of 43° and an AHI of 93% (Fig. 4A). Three-dimensional CT confirmed the resection of the cam lesion (Fig. 4B), and axial CT showed improvement in the AceAV angle from 1° retroversion to 9° anteversion (Fig. 4C).

For postoperative rehabilitation, range of motion exercises were started the day after surgery, and partial weight bearing began from 4 weeks after surgery. Weight bearing was gradually increased, and full weight bearing was allowed

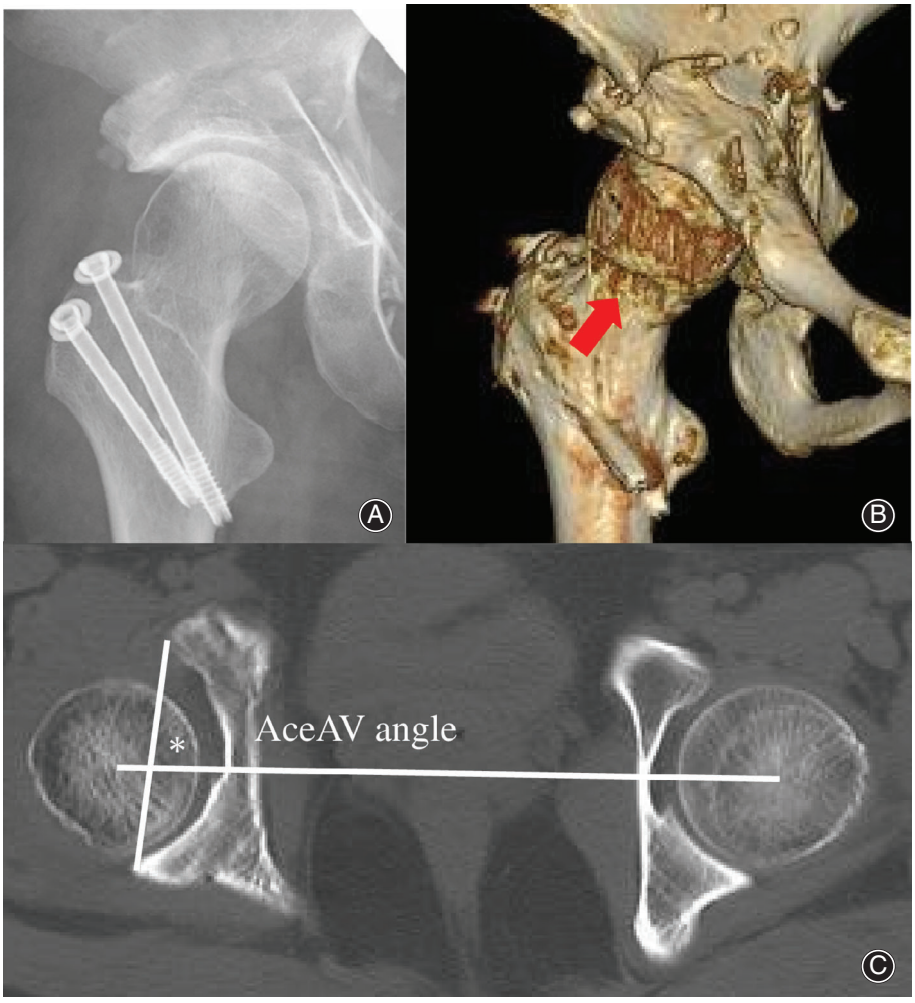

Fig 4 Postoperative radiographs and computed tomography (CT) images. (A) Image of the right hip joint showing improvement in coverage of the acetabulum, with a CE angle of 43° and an AHI of 93%. (B) Cam lesion resected from the right femur (indicated by the red arrow). (C) Axial CT images showing improvement in the acetabular anteversion angle from 1° retroversion to 9° anteversion in the right acetabulum CE, center angle; AHI, acetabular head index; AceAV angle, acetabular anteversion angle.

8 weeks after surgery. Ten months after surgery, the range of motion of the right hip joint improved to 110° flexion, 20° extension, 50° abduction, 20° adduction, 70° external rotation, and 10° internal rotation. Pain disappeared during walking, standing, and hip flexion, and the HHS improved from 55.7 to 100 points.

Discussion

This report presents a rare case of DDH with sacroiliac fusion and FAI owing to AR. Using computer navigation system, ERAO was performed, which accurately improved the coverage and retroversion of the acetabulum. Resection of the cam lesion prevented impingement.

Regarding AR, Ezoe *et al.*[8] investigated various hip diseases and reported that AR was present in 20% patients with osteoarthritis (OA), 18% patients with DDH, and 68% patients with Legg–Calve–Perthes disease. Fujii *et al.*[9] investigated DDH and reported that AR was found in 18% patients. Further, they found that AR causes earlier hip pain. In this case, a low AHI and CE angle confirmed DDH, and the cross-over sign and ischial spine sign denoted AR (Fig. 1A, B); this further confirmed the coexistence of DDH and AR. Furthermore, the high α angle of the femoral neck and cam lesion suggested a mixed type of FAI (Fig. 1C, 2A). Because of DDH, the femoral head has inadequate acetabular coverage and is loaded in a very small area of the hip joint, making it unstable and causing cartilage damage and pain (Fig. 2A, B). In addition, AR causes impingement between the anterior edge of the acetabulum and the anterior part of the femoral neck during hip flexion, causing pain (Fig. 3C, D). In this case, both DDH and AR were present along with a mixed-type FAI owing to AR. Accordingly, we planned ERAO to improve acetabular coverage and correct AR simultaneously. ERAO was introduced by Hasegawa *et al.* to improve coverage of the acetabulum and femoral head medialization by eccentric cutting of the acetabulum using a chisel with a 45-mm radius, and favorable long-term results have been reported[3]. Imai *et al.*[12] reported successful AR correction using ERAO under computer navigation system in a patient with posterior instability. A similar method improved AR in our case.

Additionally, the cam lesions of the femoral neck were resected under direct vision, which may have prevented the progression of OA caused by impingement. Siebenrock *et al.* reported good results with periacetabular osteotomy, particularly with reorientation of the acetabulum, for FAI owing to AR[5]. They also recommended resection of the cam lesion using periacetabular osteotomy. However, Steppacher *et al.*[13] reported that the transition to total hip arthroplasty was 6.17 times more in patients with preoperative impingement who underwent acetabular osteotomy than in those without preoperative impingement. Therefore, in this case, cam resection was performed to prevent future OA progression.

To our knowledge, our case of DDH with fusion of the contralateral sacroiliac joint and AR is rare, as no similar reports exist in the literature. Morgan *et al.*[14] reported that 21% of patients with arthrodesis owing to sacroiliac joint arthrosis had AR. This suggests that reduced mobility of the sacroiliac joint may cause AR, similar to the pathological condition in our case.

In conclusion, we experienced a rare case of DDH with sacroiliac fusion and FAI owing to AR. ERAO was performed using computer navigation system, which accurately improved the coverage and retroversion of the acetabulum, and resection of the cam lesion prevented impingement. To our knowledge, this is the first report to describe the treatment of DDH with sacroiliac fusion and AR with ERAO using computer navigation system. This report will help to treat similar cases.

Disclosure

The authors declare that there is no conflict of interest.

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