Spinopelvic fixation surgery in relation to the femoroacetabular impingement syndrome under the ultrasonography

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INTRODUCTION: Adult spinal deformity (ASD) is an increasingly prevalent condition, particularly among aging populations, and frequently requires long-segment spinal fusion to achieve optimal sagittal and coronal alignment. Spinopelvic fixation, which extends instrumentation to the pelvis, is often employed to stabilize severe sagittal imbalance and to prevent distal junctional failure. While the benefits of spinopelvic fixation in spinal realignment are well established, the implications for adjacent joint health—specifically the hip—are not fully understood. Femoroacetabular impingement syndrome (FAIS) is a well-recognized cause of early-onset hip osteoarthritis, marked by abnormal contact between the femoral head-neck junction and the acetabular rim. Theoretically, spinopelvic fixation alters spinopelvic motion and reduces pelvic mobility, potentially increasing compensatory hip motion and mechanical stress at the femoroacetabular junction. However, little is known about whether such biomechanical changes contribute to the development of FAIS-related pathology, particularly in the early stages before radiographic osteoarthritis becomes apparent. While magnetic resonance arthrography (MRA) is the gold standard for evaluating intra-articular hip abnormalities, its invasiveness, high cost, and limited accessibility render it impractical for routine or longitudinal assessment. In contrast, musculoskeletal ultrasonography (US) is a non-invasive, real-time imaging modality that allows dynamic evaluation of soft tissue and joint morphology, and has gained increasing utility in orthopedic research and clinical practice. This study aimed to investigate whether spinopelvic fixation in ASD patients is associated with early FAIS-related changes in the hip joint, as detected by US. We hypothesized that patients who underwent spinopelvic fixation would demonstrate a higher prevalence of FAIS-related findings—including labral degeneration and cam lesions—compared to patients who did not receive pelvic fixation.

METHODS: This retrospective study was conducted at a single institution and enrolled 80 patients (14 males, 66 females, 160 hips) that underwent surgery for ASD between January 2013 and September 2024. All patients provided informed consent at the time of follow-up, and the study protocol was approved by the institutional ethics committee of author's affiliated institution. The inclusion criterion was patients who underwent spinal fusion surgery for ASD more than 4 segments, while the exclusion criterion was a history of previous hip surgery (e.g., osteotomy or arthroplasty). Accordingly, a total of 9 hips that underwent arthroplasty were excluded from the analysis. They were divided into two groups based on the presence (Group F) or absence (Group N) of sacroiliac joint fixation. Ultrasound examinations were conducted at the final follow-up using a high-resolution linear transducer (SNiBLE2, L11-3 MHz; Konica Minolta, Tokyo, Japan) by two orthopedic surgeons trained in musculoskeletal ultrasonography. Examinations were performed with patients in the supine position, with hips in a neutral position. Longitudinal views were obtained along the femoral neck axis. Evaluated features included labral degeneration (graded 0–2 using a modified staging system; Figure 1), cam lesions (non-spherical femoral head-neck contour) and acetabular osteophytes. Standing radiographs were used to assess KL grade and alpha angle at baseline and final follow-up. The anterior impingement test was also performed as a clinical indicator of FAIS. Statistical comparisons were made using chi-squared tests for categorical data and Student's t-tests for continuous variables. Significance was defined as $p < 0.05$. Inter- and intra-observer reliability was assessed using Cohen's kappa and intraclass correlation coefficients (ICCs).

RESULTS: A total of 151 hips from 26 males and 125 females were included (Table 1). Hips with KL grade ≥ 2 at the time of surgery or at the final follow-up were excluded from the analysis. Specifically, 13 hips (grade 2: 12 hips; grade 3: 1 hip) that already exhibited KL grade ≥ 2 at the time of surgery, as well as 14 hips that progressed from KL grade 0-1 at the time of surgery to grade ≥ 2 at the final follow-up (12 hips from grade 0 to 2; 2 hips from grade 1 to 2), were excluded. As a result, a total of 27 hips were excluded, and 124 hips (24 males, 100 females)were analyzed (Table 2). At the final follow-up, labral degeneration was significantly more frequent in Group F than in Group N (69.5% vs. 37.9%, $p = 0.0076$), with a higher proportion of severe degeneration (Grade 2: 21.1% vs. 3.4%). Cam lesions were also more prevalent in Group F (30.5% vs. 6.9%, $p = 0.01$). Although acetabular osteophytes and positive anterior impingement test results were more frequent in Group F (53.7% vs. 34.5%, and 13.7% vs. 3.5%, respectively), these did not reach statistical significance ($p = 0.07$ and $p = 0.13$). The mean alpha angle was similar between groups at the time of surgery (46.6° vs. 46.4°, $p = 0.58$) but increased significantly in Group F compared to Group N at the final follow-up (48.7° vs. 46.7°, $p = 0.01$). The change in alpha angle over time was significantly greater in Group F (2.0° vs. 0.3°, $p < 0.0001$). US demonstrated excellent interobserver reliability for qualitative features including labral degeneration ($\kappa = 0.93$), cam morphology ($\kappa = 0.87$), and acetabular osteophytes ($\kappa = 0.86$). ICCs for radiographic alpha angle were 0.89.

DISCUSSION: This study demonstrated a significantly higher prevalence of labral degeneration and cam lesions in patients with sacroiliac joint fixation compared to those without fixation. These FAIS-related abnormalities, identified via US, support the hypothesis that spinopelvic fixation imposes increased mechanical stress on the hip joint, potentially leading to early intra-articular degeneration. The mechanism likely involves decreased lumbar and pelvic mobility after long-segment fusion, resulting in compensatory hip flexion during activities such as sitting or stair climbing. This may increase femoroacetabular contact forces, particularly in the anterosuperior labrum region—an area commonly affected in FAIS [1]. Previous studies have shown that spinal fusion shifts biomechanical stress to adjacent segments, and sacroiliac fixation has been linked to hip joint degeneration [2]. Our results are consistent with these findings and emphasize the clinical relevance of early detection. US enabled the visualization of labral degeneration and cam lesions with high inter-rater reliability [3]. Although MRA remains the gold standard, its invasiveness and cost limit its use in serial follow-up. US, in contrast, offers a practical, non-invasive alternative for monitoring postoperative changes in ASD patients undergoing spinopelvic fixation. The need for a standardized ultrasonographic grading system remains, especially for evaluating labral changes in severely degenerated joints. These findings underscore the importance of integrating ultrasound surveillance in postoperative care to better understand the progression of hip joint pathology following Spinopelvic fixation.

SIGNIFICANCE/CLINICAL RELEVANCE: In this study, labral degeneration, and cam lesion had greater prevalence in the sacroiliac joint fixation group than in the non-fixation group. These findings suggest that FAIS has a relation with the hip osteoarthritis in patients following ASD surgery. Hip osteoarthritis and the pathology after spinopelvic fusion surgery should be closely monitored.

REFERENCES: 1. Rivière C+. Orthop Traumatol Surg Res. 2017. 2. Kozaki T+. Eur Spine J. 2021. 3. Martinoli C+. Ultrasound of the musculoskeletal system. 2007.

IMAGES AND TABLES:

Figure 1

Table 1

Sex	Males 26 (17.2%), Females 125 (82.8%)
Age (years)	70.1 ± 7.9
BMI (kg/m²)	23.6 ± 3.5
KL grade at surgery Grade 0–1 / 2 / 3 / 4	138 (91.4%), 12 (7.9%), 1 (0.7%), 0 (0%)
Number of fixation segments (segments)	9.7 ± 3.4
Follow-up period (months)	52.7 ± 39.6
KL grade at ultrasound Grade 0–1 / 2 / 3 / 4	124 (82.1%), 18 (11.9%), 6 (4.0%), 3 (2.0%)

Table 2

	Group F (95 hips)	Group N (29 hips)	P value
Sex (Males / Females)	16 / 79	8 / 21	0.20
Age (years)	71.0 ± 6.9	66.0 ± 11.3	0.0044
BMI (kg/m²)	23.5 ± 3.6	24.6 ± 3.6	0.16
Follow-up period (months)	46.8 ± 36.0	70.2 ± 48.8	0.0059
Number of fixation segments (segments)	10.6 ± 2.5	6.0 ± 4.1	<0.0001
Radiographic findings			
KL grade 0–1	95 (100%)	29 (100%)	0.93
Alpha angle at surgery (degrees)	46.6 ± 3.5	46.4 ± 4.5	0.58
Alpha angle at final follow-up (degrees)	48.7 ± 3.9	46.7 ± 4.7	0.01
Δ alpha angle (degrees)	2.0 ± 1.1	0.3 ± 0.6	<0.0001
Ultrasound findings			
Labral degeneration (%)			
grade 0	29 (30.5%)	18 (62.1%)	0.0076
grade 1	46 (48.4%)	10 (34.5%)	
grade 2	20 (21.1%)	1 (3.4%)	
Cam lesion (%)	29 (30.5%)	2 (6.9%)	0.01
Acetabular osteophyte (%)	51 (53.7%)	10 (34.5%)	0.07
Clinical testing			
Anterior impingement test (%)	13.7 (13.7%)	1 (3.5%)	0.13