Factors Influencing Ipsilateral Lower Limb Alignment Changes and Clinical Outcomes After Total Hip Arthroplasty for Dysplastic Hip Osteoarthritis

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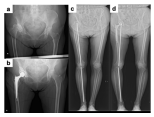
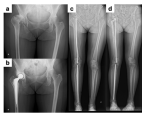
INTRODUCTION: Dysplastic hip osteoarthritis (DHOA) frequently induces ipsilateral lower limb malalignment stemming from femoral head subluxation and resultant altered biomechanics. While total hip arthroplasty (THA) effectively addresses DHOA, factors influencing postoperative limb alignment alterations, particularly those evaluated with three-dimensional (3D) imaging, and their impact on hip and knee function remain inadequately defined. This study aimed to identify CT-derived anatomical factors associated with varus and valgus alignment changes after THA for DHOA and to assess their relationship with clinical outcomes.

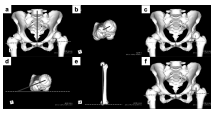
METHODS: This IRB-approved retrospective study included 121 DHOA patients (20 men, 101 women; mean age 64.1±9.7 years; predominantly Crowe Type I/II severity) undergoing unilateral primary THA via a posterior approach between January 2018 and January 2022. Exclusion criteria were prior total knee arthroplasty or lumbar fusion within one year, history of surgery affecting lower extremity alignment, or missing data. Preoperative and 1-year postoperative full-length lower extremity radiographs measured hip-knee-ankle angle (HKAA). Patients were categorized by HKAA change: neutral (<3°), varus (≥3° varus shift), or valgus (≥3° valgus shift). Preoperative and 1-week postoperative CT scans assessed Crowe classification, leg length discrepancy (LLD), femoral offset (FO; defined as distance from femoral head center to femoral axis), acetabular offset, femoral anteversion, femoral length (FL; head center to knee center along femoral mechanical axis), and vertical center of rotation (V-COR; vertical distance, head center to tear drop) (Figure 1). Clinical evaluations included Japanese Orthopaedic Association (JOA) hip score (pain 40, ROM 20, gait 20, ADL 20; total 100 points) and Visual Analogue Scale (VAS; 0-100mm) for knee pain, preoperatively and at 1 year postoperatively. Univariate (ANOVA with Bonferroni post-hoc, Fisher's exact test) and multivariate logistic regression analyses (adjusting for age, sex, BMI) identified predictive factors.

RESULTS: The cohort comprised 88 neutral, 18 varus, and 15 valgus change patients. The valgus change group was significantly older (69.5±7.6 years) than the neutral group (64.0±9.9 years, P=0.018) (Table 1). Preoperative FO was significantly smaller in the varus group (23.9±6.1mm) compared to neutral (29.6±6.3mm) and valgus (30.7±4.3mm) groups (P<0.001). Change in femoral offset (ΔFO) post-THA significantly differed among groups (Neutral: 4.1±5.4mm, Varus: 10.2±5.6mm, Valgus: 1.9±4.0mm; P<0.001). Change in femoral length (ΔFL) also significantly differed (Neutral: 8.1±6.9mm, Varus: 6.3±7.1mm, Valgus: 13.1±6.9mm; P=0.014) (Table 2). Multivariate analysis identified increased ΔFO as a significant factor for varus alignment change (OR 1.25; 95%CI: 1.07–1.46; P=0.005). Factors associated with valgus alignment change were older age (OR 1.10; 95%CI: 1.01–1.19; P=0.037), increased ΔFL (OR 1.15; 95%CI: 1.04–1.27; P=0.005), and smaller ΔFO (OR 0.84; 95%CI: 0.71–1.00; P=0.043) (Table 3). Postoperative JOA subscores (ROM, gait, ADL) and total scores were significantly poorer in the valgus change group (e.g., total score: Valgus 84.2±16.1 vs Varus 92.5±12.1, P=0.046; other subscores also poorer). Knee VAS scores improved significantly and similarly across all groups postoperatively (Table 4).

DISCUSSION AND CONCLUSION: Increased change in femoral offset during THA for DHOA is strongly associated with postoperative varus limb alignment (Figure 2). Conversely, older age, greater change in femoral length (i.e., leg lengthening), and smaller change in femoral offset (less offset restoration) correlate with valgus alignment (Figure 3). While ipsilateral knee pain improved regardless of alignment changes at one-year follow-up, patients developing valgus alignment exhibited poorer postoperative hip function, potentially linked to their older age and insufficient femoral offset (suggesting abductor mechanism compromise). These CT-based, 3D anatomical evaluations underscore the critical importance of precise preoperative THA planning to optimize limb alignment and functional hip outcomes in DHOA patients.







Table

Table 1. Patient demographics

	Neutral change group	Varus change group	Valgus change group	*P* value
Number of cases	38	18	15	
Gender (women/men)	16/72	8/18	4/11	0.859
Age (y)	64.0±8.9	60.2±7.5	69.5±7.6	0.010*
Height (cm)	156.3±8.7	153.1±6.8	155.8±6.7	0.323
Weight (kg)	59.2±12.3	55.8±8.9	53.2±10.2	0.104
Body mass index (kg/m^2)	24.2±4.2	23.6±4.3	22.1±3.4	0.189
Previous hip surgery (cases)	13	2	1	0.652
Laterality (right/left)	47/41	11/7	8/7	0.838

Data are shown as mean ± standard deviation or number.

* Comparison between the neutral and valgus change groups.