Leg length discrepancy should be assessed based on the whole length of the lower limb in patients with osteoarthritis secondary to developmental dysplasia of the hip

Cite this article:
Bone Jt Open 2024;5(2):
79–86.

DOI: 10.1302/2633-1462.
52.BJO-2023-0152.R1

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Aims
This study aimed to investigate the incidence of ≥ 5 mm asymmetry in lower and whole leg lengths (LLs) in patients with unilateral osteoarthritis (OA) secondary to developmental dysplasia of the hip (DDH-OA) and primary hip osteoarthritis (PHOA), and the relationship between lower and whole LL asymmetries and femoral length asymmetry.

Methods
In total, 116 patients who underwent unilateral total hip arthroplasty were included in this study. Of these, 93 had DDH-OA and 23 had PHOA. Patients with DDH-OA were categorized into three groups: Crowe grade I, II/III, and IV. Anatomical femoral length, femoral length greater trochanter (GT), femoral length lesser trochanter (LT), tibial length, foot height, lower LL, and whole LL were evaluated using preoperative CT data of the whole leg in the supine position. Asymmetry was evaluated in the Crowe I, II/III, IV, and PHOA groups.

Results
The incidences of whole and lower LL asymmetries were 40%, 62.5%, 66.7%, and 26.1%, and 21.7%, 20.8%, 55.6%, and 8.7% in the Crowe I, II/III, and IV, and PHOA groups, respectively. The incidence of tibial length asymmetry was significantly higher in the Crowe IV group (44.4%) than that in the PHOA group (4.4%). In all, 50% of patients with DDH-OA with femoral length GT and LT asymmetries had lower LL asymmetry, and 75% had whole LL asymmetry. The incidences of lower and whole LL asymmetries were 20% and 42.9%, respectively, even in the absence of femoral length GT and LT asymmetries.

Conclusion
Overall, 43% of patients with unilateral DDH-OA without femoral length asymmetry had whole LL asymmetry of ≥ 5 mm. Thus, both the femur length and whole LL should be measured to accurately assess LL discrepancy in patients with unilateral DDH-OA.

Take home message
- Whole leg length (LL) asymmetry occurred in 42.9% of patients with developmental dysplasia of the hip with osteoarthritis (DDH-OA) without femoral asymmetry.
- Whole LL asymmetry did not occur in 25% of patients with DDH-OA with femoral asymmetry.
- In patients with unilateral DDH-OA, the assessment of leg length discrepancy (LLD) by assessing only the side-to-side difference in femoral length may be inaccurate.

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Thus, bilateral whole LL, including lower LL, should be assessed to accurately assess preoperative LLD and avoid LLD after total hip arthroplasty.

Introduction

Leg length discrepancy (LLD) after total hip arthroplasty (THA) is considered a major factor that affects postoperative hip function and patient satisfaction, which can become a subject for litigation.[1-3] Furthermore, LLD is associated with other complications, including postoperative dislocation, aseptic loosening, increased component wearing, low back pain, nerve palsy, and gait abnormality.[1,4-10] LLD is usually radiologically evaluated based on anteroposterior (AP) pelvic radiographs, with a teardrop line or ischial bottom line being the pelvic reference point and the greater trochanter (GT) or lesser trochanter (LT) being the femoral reference point. This evaluation was based on the assumption that there is no difference between bilateral femoral and tibial lengths beyond the GT or LT.[11,12]

A previous study reported femoral length asymmetry in patients with unilateral developmental dysplasia of the hip (DDH) and showed a left-right femoral length difference of > 5 mm in 24% of patients.[13] Furthermore, another study reported a mean difference of 2.1 mm in tibial length, measured using full-body CT data of cadaver bones.[14] In studies with CT data of healthy volunteers, tibial length difference has been reported to be 0.1 to 0.8 cm in males and 0.1 to 0.7 cm in females.[15] Therefore, assessing LLD using AP radiographs may be inaccurate if asymmetry is found in the lower leg length (LL) and femoral length of patients with osteoarthritis (OA) secondary to DDH (DDH-OA). However, no detailed reports have been published on lower and whole LL asymmetries in patients with hip OA.

Therefore, this study aimed to identify the incidence of lower and whole LL asymmetries in patients with unilateral DDH-OA and primary hip OA (PHOA), and the relationship between femoral length asymmetry and lower and whole LL asymmetries.

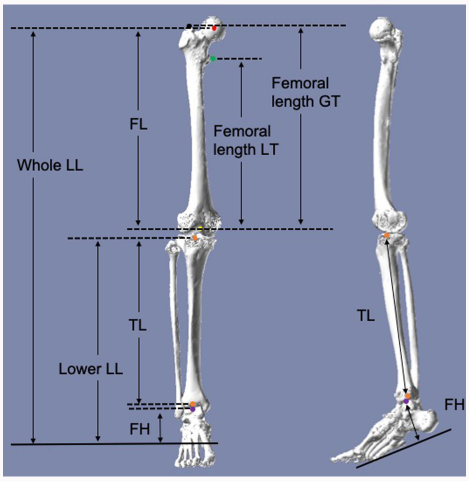

Fig. 1

Measurements in this study. Anatomical femoral length (FL) was defined as the distance between the centre of the femoral head (red point) and the knee centre of the femur (yellow point). Femoral length greater trochanter (GT) was defined as the vertical distance from the top of the GT (black point) to the mostdistal end of the intercondylar notch (yellow point). Femoral length lesser trochanter (LT) was defined as the vertical distance from the most medial prominence of the LT (green point) to the most distal end of the intercondylar notch (yellow point). Lower leg length (LL) was defined as the sum of tibial length (TL) andfoot height (FH). Whole LL was defined as the sum of FL and lower LL.

Methods

Patients

This is a cross-sectional study. We retrospectively reviewed 190 consecutive patients with DDH-OA or PHOA who underwent primary THA at Osaka University Hospital, Japan, between January 2016 and December 2018. All the patients were scheduled for primary THA and underwent preoperative CT for surgical planning and navigation. All procedures involving human participants were conducted in accordance with the ethical standards of the Institutional Research Committee and 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The requirement of formal consent was waived due to the retrospective cohort study design.

Hip OA was defined as Kellgren-Lawrence grade ≥ 2 on preoperative AP pelvic radiographs.[16] Definitive DDH was defined as a lateral centre-edge angle (LCEA) < 20°, sharp angle > 45°, or an irregularity of the Shenton's line. Patients with borderline DDH, defined as a LCEA between ≥ 20° and < 25°, were excluded.[17] Primary hip OA was a diagnosis of exclusion after ruling out osteonecrosis, trauma, sepsis, Paget's disease, rheumatoid arthritis, and childhood hip diseases, such as DDH, Perthes' disease, and slipped capital femoral epiphysis.[18] Patients with unilateral DDH-OA or PHOA were considered potentially eligible. Exclusion criteria were patients with bilateral hip OA or those who had previously undergone spinal, pelvic, or lower limb surgeries. Patients with DDH-OA were categorized into three groups, according to the Crowe classification: Crowe I, II/III, and IV.[19] All the patients underwent scanning of the entire pelvis, bilateral femora, and bilateral lower legs using a helical CT scanner (Hi Speed Advantage; GE Medical Systems, USA), with a slice pitch of 1 mm and slice thickness of 1.25 mm.

Measurements of lower limb length from CT data

All measurements were performed using image analysis software (3D Template; Kyocera Medical, Japan). The following parameters were measured using the CT data (Figure 1).

Tibial length

Tibial length was evaluated using the coordinate system described in Figure 2. The tibial axis was defined as a straight line passing through the midpoint of the Akagi line and centre of the ankle joint. The length from the tibial articular surface to the centre of the ankle joint at the tibial axis was defined as the tibial length (TL).[20] Tibial length asymmetry was defined as an absolute side-to-side difference of ≥ 5 mm in tibial length.

Foot height

Foot height was evaluated using the coordinate system shown in Figure 3. A sphere was placed congruent to the medullary cavity of the talus pulley, and its centre was defined as the centre of the talus (point 1). The sagittal plane of the foot was composed of three feature points shown in Figure 3a.[21]

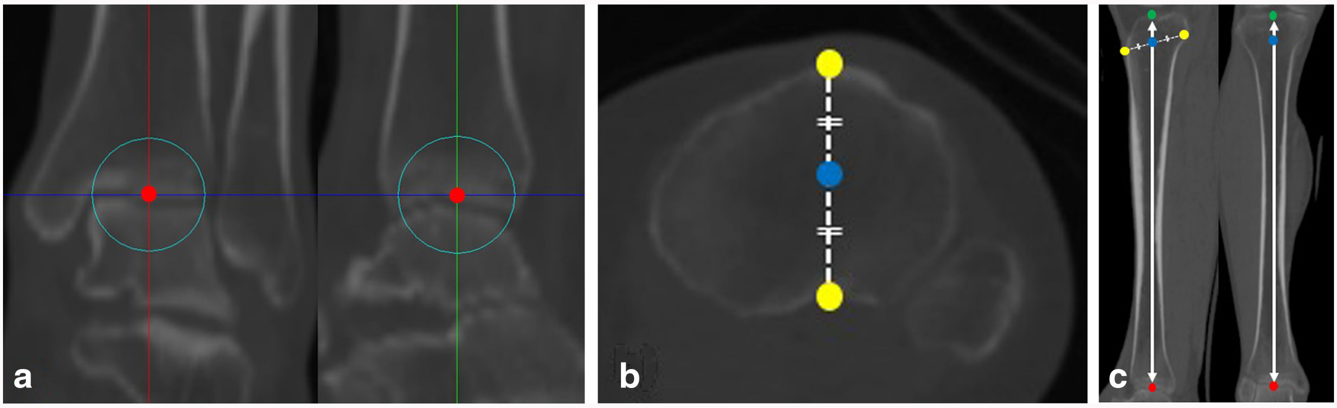

Fig. 2
a) Placement of a sphere that fits the distal tibial articular surface, and its centre is defined as the ankle joint centre (red point). b) Midpoint of the Akagi line (blue point). c) Straight line passing through the midpoint of the Akagi line (blue point), and the centre of the ankle joint (red point) was defined as the tibial axis.

As described in Figure 3b, the axial plane of the foot was constructed with respect to the sagittal plane of the foot. Foot height was defined as the distance from the top of the talus to the axial plane of the foot in the foot sagittal plane (Figure 3b).[22] Foot height asymmetry was defined as an absolute side-to-side difference of ≥ 5 mm in foot height.

Femoral length

Femoral length was evaluated using the following coordinate system: a posterior condylar plane, including the most posterior point of the trochanteric region of the femur and the medial and lateral posterior condyles, as a coronal plane was set.[23] The vertical axis was projected onto the posterior condylar plane through the trochanteric fossa and knee centre of the femur. The centre of the femoral head was defined by fitting a sphere to the normal subchondral bone of the femoral head. If the femoral head was a mushroom or rugby ball shape, the methods previously reported by Oliver et al were used.[24] The most distal end of the intercondylar notch was defined as the knee centre of the femur. In the femoral coordinate system, anatomical femoral length (FL), femoral length GT, and femoral length LT were defined as depicted in Figure 4a, 4b and 4c, respectively. Femoral length asymmetry was evaluated based on the method reported by Tamura K et al[13] The absolute side-to-side differences in femoral length GT and LT were defined as change in GT and change in LT, respectively. Femoral length GT and LT asymmetries were defined as an absolute side-to-side difference of ≥ 5 mm in femoral length GT and LT.

Lower and whole LLs

Lower LL was defined as the sum of tibial length and foot heights. Whole LL was defined as the sum of femoral length and lower LL. Lower and whole LL asymmetries were defined as an absolute side-to-side difference of ≥ 5 mm in lower and whole LLs.

Statistical analysis

All parameters were measured in the Crowe I, II/III, IV, and PHOA groups. Side-to-side differences were assessed and compared between the groups using the Wilcoxon signed-rank test. Incidences of femoral length and lower LL asymmetries were calculated for each group. Statistical significance was assessed using the Fisher's exact test. Furthermore, the patients in each group were divided into subgroups based on whether they had femoral length GT and LT asymmetries. The incidences of lower and whole LL asymmetries were compared groups with and without femoral length asymmetry using the chi-squared test. All statistical analyses were performed using JMP version 14.0 (SAS Institute, USA). A p-value < 0.05 was considered statistically significant.

Reliability of lower limb length measurement

To assess the intra- and inter-measurer (measurers A and B) reliability of the lower limb length measurements, we randomly selected ten patients from each group, except for the Crowe IV (n = 9). Two authors (RS, HH) measured the FL, TL, and FH. One author (RS) measured these items twice within a two-week interval. Intra- and inter-class correlation coefficients (ICCs; 1.1 and 2.1, respectively) were determined.

Results

In this study, 93 patients with unilateral DDH-OA (Crowe I (n = 60), II/III (n = 24), and IV (n = 9)), and 23 patients with unilateral PHOA, were included. There were no statistically significant differences in patient demographic data (Table I). In the Crowe I group, affected-to-unaffected differences in femoral and lower leg morphologies of DDH-OA, FH, and lower LL on the operated side were longer than those on the healthy side (Table II). The incidence of LL asymmetry is shown in Figure 5. The incidence of femoral length asymmetry was significantly higher in the Crowe II/III and IV groups (50% and 66.7%, respectively) than that in the Crowe I and PHOA groups (11.7% and 4.4%, respectively). The incidence of tibial length asymmetry was significantly higher in the Crowe IV group (44.4%) than the other groups (Crowe I 10%, p = 0.007; Crowe II/III 8.3%, p = 0.020; and PHOA 4.4%, p = 0.006). No statistically significant differences in the incidence of foot height asymmetry were observed

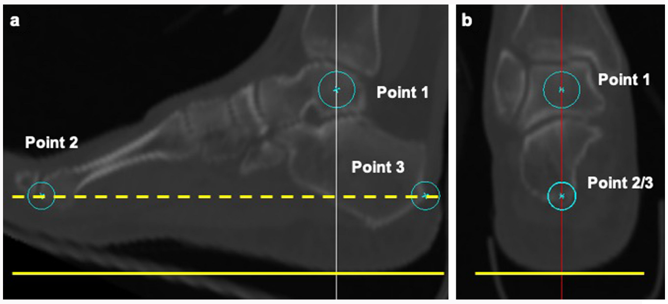

Fig. 3
a) Sagittal plane of the foot consisted of the centre of the talus (point 1), the most distal point of the head of the second metatarsal (point 2), and the most proximal point of the calcaneus (point 3). b) Plane perpendicular to the sagittal plane of the foot, including points 2 and 3, was defined as the plane parallel to the horizontal foot plane (yellow dotted line: plane 1). The plane parallel to plane 1 to the lowest point of the plantar surface of the heel was defined as the axial plane of the foot (yellow straight line).

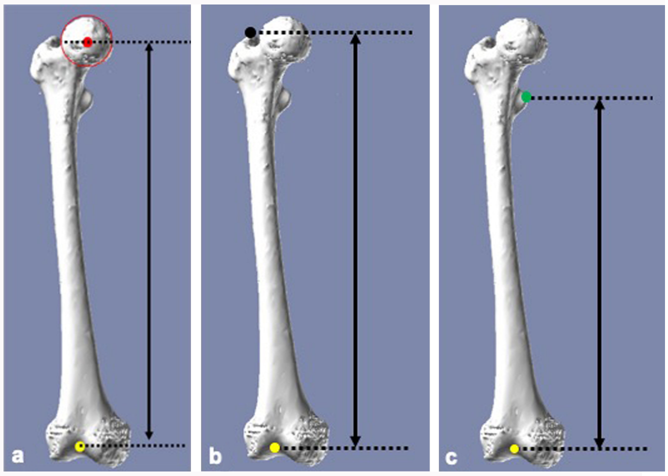

Fig. 4
a) Anatomical femoral length was defined as the distance between the centre of the femoral head (red point) and the knee centre of the femur (yellow point). b) Femoral length greater trochanter (GT) was defined as the vertical distance from the top of the GT (black point) to the most distal end of the intercondylar notch (yellow point). c) Femoral length lesser trochanter was defined as the vertical distance from the most medial prominence of the lesser trochanter (green point) to the most distal end of the intercondylar notch (yellow point).

between the DDH-OA and PHOA groups (Crowe I 3.3%; Crowe II/III 8.3%; Crowe IV 11.1%; and PHOA 0%). The incidence of lower and whole LL asymmetries was highest in the Crowe IV group (55.6% and 66.7%, respectively). More than 40% of the patients with DDH-OA and 26.1% of those with PHOA had whole LL asymmetry.

The relationship between femoral and lower limb length asymmetries in the DDH-OA and PHOA groups is shown in Table III. In the DDH-OA group, patients with femoral length GT and LT asymmetries had a higher incidence of femur length and lower and whole LL asymmetries than those without femoral length GT and LT asymmetries. Approximately 25% of patients with DDH-OA with femoral length LT asymmetry did not have whole LL asymmetry, while 42.9% of those with DDH-OA without femoral length LT asymmetry had whole LL asymmetry. Similar results were obtained in the presence and absence of femoral length GT asymmetry.

Regarding the reliability of measurements of the lower limb length, intra- and inter-measurer reliabilities were excellent (ICC ≥ 0.809), irrespective of which groups were analyzed (Table IV).

Discussion

Leg length discrepancy after THA affects postoperative hip function and is associated with other complications, such as postoperative dislocation, aseptic loosening, increased component wear, back pain, nerve palsy, and gait abnormalities.[1-10] Femoral length asymmetry has been reported to occur in 24% of patients with unilateral DDH.[13] However, no detailed reports have been published on lower and whole LLs in patients with DDH or hip OA. The results in this study showed that the incidence of lower and whole LL asymmetries was higher in patients with DDH-OA than that in those with PHOA. Interestingly, 42.9% of the patients with DDH-OA without femoral length GT and LT asymmetries had whole LL asymmetry, and 25% of the patients with DDH-OA with femoral length GT and LT asymmetries did not have whole LL asymmetry. These results showed that, in some cases of DDH-OA, the presence or absence of whole LL asymmetry could not be assessed on plain radiographs of the hip up to the proximal femur. Therefore, it is necessary to evaluate the whole LL of both lower limbs to determine the anatomical preoperative true LLD and avoid LLD after THA.

Table I. Patients' demographic data in this study.

Variable	Crowe I (n = 60)	Crowe II/III (n = 24)	Crowe IV (n = 9)	PHOA (n = 23)	p-value
Sex, M:F	9:51	6:18	0:9	5:18	0.331*
Mean age, years (SD; range)†	66.9 (10.9; 42 to 88)	63.9 (10.7; 49 to 88)	72.4 (4.7; 66 to 78)	65.6 (13.9; 35–87)	All combinations were statistically p > 0.05.†
Mean height, cm (SD; range)	154.2 (7.5; 126.0 to 169.0)	156.4 (7.4; 143.3 to 170.0)	148.1 (8.0; 138.5 to 164.0)	157.5 (9.8; 144.0 to 179.6)	All combinations were statistically p > 0.05.†
Mean weight, kg (SD; range)	56.7 (15.2; 29.5 to 110.0)	56.7 (9.6; 43.1 to 83.0)	50.9 (6.1; 42.5 to 61.4)	56.7 (13.4; 41.7 to 89.9)	All combinations were statistically p > 0.05.†

*Chi-squared test.
†Steel-Dwass's multiple comparison test.
PHOA, primary hip osteoarthritis; SD, standard deviation.

Table II. Affected-to-unaffected differences in femoral and lower leg morphology in the DDH-OA and PHOA groups.

Variable	Crowe I (n = 60)	p-value*	Crowe II/III (n = 24)	p-value*	Crowe IV (n = 9)	p-value*	PHOA (n = 23)	p-value*
Mean change FL, mm (SD; range)	1.1 (6.1; −18.5 to 9.3)	0.922	−2.6 (11.8; −36.8 to 15.7)	0.299	−1.9 (14.2; −29.3 to 15.3)	0.684	0.6 (3.0; −6.8 to 4.6)	0.365
Mean change in GT, mm (SD; range)	0.5 (3.1; −8.2 to 8.6)	0.204	0.6 (6.6; −8.2 to 24.9)	0.644	1.0 (10.9; −14.3 to 23.2)	0.783	0.4 (2.6; −5.2 to 4.8)	0.464
Mean change in LT, mm (SD; range)	0.3 (3.0; −6.1 to 7.3)	0.492	0.9 (7.4; −10.2 to 29.7)	0.543	0.0 (12.4; −28.5 to 13.9)	0.998	0.1 (3.0; −6.8 to 7.4)	0.619
Mean change TL, mm (SD; range)	0.5 (3.1; −7.5 to 6.9)	0.242	2.0 (6.9; −4.0 to 32.0)	0.176	0.2 (6.3; −9.8 to 8.2)	0.922	0.4 (2.6; −4.3 to 5.7)	0.607
Mean change FH, mm (SD; range)	1.0 (1.1; −3.3 to 10.0)	†0.002	0.2 (3.0; −4.4 to 7.5)	0.786	−0.7 (4.1; −9.7 to 4.1)	0.604	0.1 (2.7; −4.3 to 4.4)	0.822
Mean change in lower LL, mm (SD; range)	1.5 (4.0; −7.6 to 14.9)	†0.006	2.1 (8.7; −5.9 to 38.0)	0.243	−0.5 (9.4; −19.3 to 12.3)	0.871	0.6 (2.6; −4.5 to 5.9)	0.474
Mean Δ whole LL, mm (SD; range)	1.1 (6.1; −19.4–13.0)	0.170	0.4 (15.4; −26.1–52.9)	0.893	−2.8 (19.4; −41.1–19.4)	0.677	1.2 (4.1; −6.3–7.4)	0.230

Each p-value represents a paired comparison of each parameter between the affected and unaffected sides.
*Wilcoxon's signed-rank test.
†Significant difference.
DDH-OA, osteoarthritis secondary to developmental dysplasia of the hip; FH, foot height; FL, femoral length; GT, femoral length from top of the greater trochanter to the centre of the knee; LL, leg length; LT, lesser trochanter; PHOA, primary hip osteoarthritis; SD, standard deviation; TL, tibial length.

Table III. Incidence of lower and total leg asymmetries associated with femoral length asymmetry.

Variable	Change in LT < 5 mm	Change in LT ≥ 5 mm	p-value*	Change in GT < 5 mm	Change in GT ≥ 5 mm	p-value*
DDH-OA, n (%)						
Femoral length	15/77 (19.5)	10/16 (62.5)	0.026†	14/77 (18.2)	11/16 (68.8)	0.009†
Tibial length	7/77 (9.1)	5/16 (31.3)	0.030†	6/77 (7.8)	6/16 (37.5)	0.004†
Foot height	2/77 (2.6)	3/16 (18.8)	0.026†	2/77 (2.6)	3/16 (18.8)	0.026†
Lower leg length	15/77 (19.5)	8/16 (50)	0.015†	15/77 (19.5)	8/16 (50)	0.015†
Whole leg length	33/77 (42.9)	12/16 (75)	0.017†	33/77 (42.9)	12/16 (75)	0.017 †
PHOA, n (%)						
Femoral length	0/20 (0)	1/3 (33.3)	0.036†	1/22 (4.6)	0/1 (0)	0.763
Tibial length	1/20 (5)	0/3 (0)	0.692	1/22 (4.6)	0/1 (0)	0.827
Foot height	0/20 (0)	0/3 (0)	N/A	0/22 (0)	0/1 (0)	N/A
Lower leg length	2/20 (10)	0/3 (0)	0.567	2/22 (9.1)	0/1 (0)	0.752
Whole leg length	4/20 (20)	2/3 (66.7)	0.086	6/22 (27.3)	0/1 (0)	0.544

*Chi-squared test.
†Significant differences.
DDH-OA, osteoarthritis secondary to developmental dysplasia of the hip; GT, greater trochanter; LT, lesser trochanter; N/A, not applicable; PHOA, primary hip osteoarthritis.;

Leg length discrepancy and offset differences of ≥ 5 mm after THA have been reported to result in gait abnormalities, awareness of LLD, and decreased clinical scores.[25,26] Radiological evaluation of LLD on AP pelvic radiographs is based on the assumption that no difference exists between bilateral femoral and tibial lengths beyond the GT or LT.[11,12] In this study, 19.5% of the patients with DDH-OA without femoral length GT and LT asymmetries had lower LL asymmetry. Moreover, 50% of the patients with DDH-OA and femoral length GT and LT asymmetries had lower LL asymmetry. A previous study evaluating only the femur bone in patients with DDH have recommended preoperative evaluation of the femur and whole leg length using CT data, since > 60% of patients with DDH have a difference in femur length of > 5 mm.[26] Our results, in which the entire lower limb was evaluated by CT, also showed that LLD in patients with unilateral DDH-OA could be inaccurately assessed by only assessing a side-to-side difference in femoral length. Therefore, in patients with DDH-OA, LLD should be evaluated by assessing the whole LL, including the lower LL, to avoid inaccurate measurement. Among the patients with PHOA, only a few had femoral length GT and LT asymmetries, and

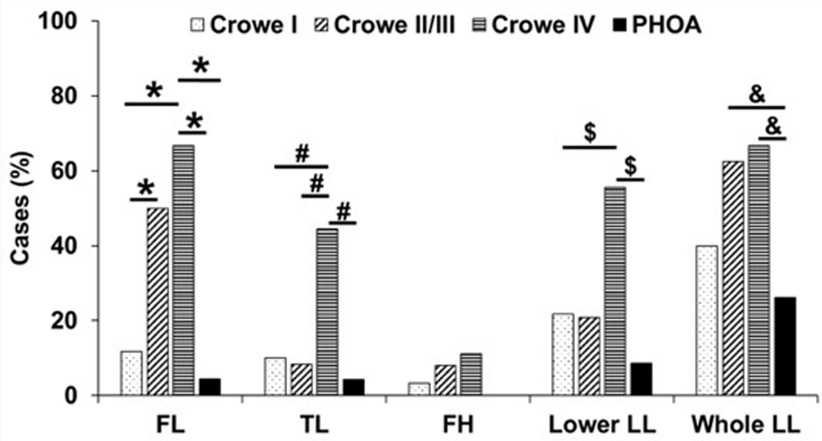

Fig. 5

Comparison of asymmetry in anatomical femoral length (FL), tibial length (TL), foot height (FH), lower leg length (LL), and whole LL between the osteoarthritis secondary to developmental dysplasia of the hip (DDH-OA) and primary hip osteoarthritis (PHOA) groups. *, #, $, & Statistically significant difference ($p < 0.05$, Fisher's exact test).

Table IV. Reliability of measurements of lower limb length.

Type	Variable	Intra-measurer ICC (1, 1)*	95% CI	p-value	Inter-measurer ICC (2, 1)†	95% CI	p-value
Crowe I	Femoral length	0.998472	0.993296 to 0.999653	< 0.001	0.96694	0.862276 to 0.992389	< 0.001
	Tibial length	0.999997	0.999986 to 0.99999	< 0.001	0.996373	0.984138 to 0.999174	< 0.001
	Foot height	0.944254	0.775953 to 0.987051	< 0.001	0.808867	0.365263 to 0.953097	< 0.001
Crowe II/III	Femoral length	0.999933	0.999705 to 0.999985	< 0.001	0.924905	0.706993 to 0.982423	< 0.001
	Tibial length	0.994562	0.976293 to 0.998762	< 0.001	0.994597	0.976444 to 0.998770	< 0.001
	Foot height	0.99404	0.974040 to 0.998642	< 0.001	0.912017	0.663248 to 0.979300	< 0.001
Crowe IV	Femoral length	0.992208	0.961982 to 0.998422	< 0.001	0.984984	0.927746 to 0.996951	< 0.001
	Tibial length	0.998994	0.995025 to 0.999797	< 0.001	0.995719	0.978967 to 0.999134	< 0.001
	Foot height	0.98216	0.914625 to 0.996374	< 0.001	0.905963	0.607139 to 0.980280	< 0.001
PHOA	Femoral length	0.999225	0.996592 to 0.999824	< 0.001	0.99753	0.989179 to 0.999438	< 0.001
	Tibial length	0.999975	0.999890 to 0.999994	< 0.001	0.994788	0.977268 to 0.998813	< 0.001
	Foot height	0.983729	0.930335 to 0.996279	< 0.001	0.949263	0.794484 to 0.988238	< 0.001

All p-values have significant differences.
*Intra-class correlation coefficient (ICC; 1,1) was determined by RS.
†Inter-class correlation coefficient (ICC; 2,1) determined by HH.
CI, confidence interval; ICC, intra- and inter-class correlation coefficients; PHOA, primary hip osteoarthritis.

most patients without femoral length GT and LT asymmetries did not have whole LL asymmetry (femoral length LT: 80%; femoral length GT: 72.7%). Thus, in patients with PHOA, the classical measurement of LLD using the difference between the pelvis-based teardrop line and femur-based LT may not lead to an inaccurate LLD measurement.[11,12]

In a previous study using full-body CT data of cadaver bones, the mean side-to-side difference in the tibial length was 2.1 mm.[14] In another study conducted among healthy participants, absolute side-to-side difference in lower LL was 0.1–0.7 mm, and the side-to-side difference in tibial length, which was measured using a 3D model of the tibia, was not significant.[15] However, this study showed that patients with DDH-OA have tibial length and lower LL asymmetry. In particular, the tibial length and lower LL asymmetry were observed in approximately half of the patients in the Crowe IV group. Patients with DDH are known to have femoral length asymmetry.[13,26] Consequently, it is conceivable that there is a similar disease specificity in DDH for tibial length and lower LL. Thus, it is necessary to pay attention to the differences in lower LL, while assessing LLD in patients with DDH-OA.

This study has some limitations. First, the relatively small sample size may have affected the results, especially when the patients were divided into three categories for subgroup analysis. In fact, the number of patients in each group was lower than that required for the power analysis. To ensure that this was not confined to the observed population, a larger series would be required. Second, there were considerably more patients with DDH than with primary OA over the three-year period. As previously reported, this was thought to be because most Japanese patients with hip OA have DDH.[27] Finally, this study examined anatomical limb length asymmetry using CT data of the whole leg in the supine position. Side-to-side differences in the lower limb length may be influenced by flexion contracture of the knee joint, changes in alignment due to knee joint degeneration, and changes in alignment due to the standing position.[2,25] Past reports have suggested that leg length differences may be more closely correlated with alignment in the coronal or sagittal plane of the knee than with femoral or tibial length.[20] However, these factors were not considered in this study. Thus, further studies are needed to validate the results taking into consideration these factors.

In conclusion, lower LL asymmetry is more common in patients with unilateral DDH-OA than in those with PHOA. More than 21% of the patients with unilateral DDH had a side-to-side difference of > 5 mm in the lower LL. Additionally, 42.9% of the patients with unilateral DDH-OA without femoral length GT and LT asymmetries had whole LL asymmetry, whereas 25% of the patients with unilateral DDH-OA with femoral length GT and LT asymmetries did not show whole LL asymmetry. In patients with unilateral DDH-OA, the assessment of LLD by assessing only the side-to-side difference in femoral length may be inaccurate. Thus, bilateral whole LL, including lower LL, should be assessed to accurately assess preoperative LLD and avoid LLD after THA.

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Funding statement

The author(s) received no financial or material support for the research, authorship, and/or publication of this article.

ICMJE COI statement

N. Sugano reported that the grant (paid to Osaka University Graduate School of Medicine) from Kyocera Medical was not related to this study. M. Takao declares payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from DePuy, Zimmer Biomet, Stryker and Daiichi Sankyo; and a leadership or fiduciary role for the International Society for Computer Assisted Orthopaedic Surgery, all of which are also unrelated.

Data sharing

The data that support the findings for this study are available to other researchers from the corresponding author upon reasonable request.

Ethical review statement

This study was approved by the Institutional Review Board (ID: 17170-2).

Open access funding

The authors report that the open access funding for this manuscript was self-funded.