The Leg Length Discrepancy in The Entire Lower Limbs after Total Hip Arthroplasty Influences The Coronal Alignment of Pelvis and Spine.

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Introduction: Leg length discrepancy (LLD) causes pelvic obliquity in the coronal plane and lumbar scoliosis, which leads to low back pain\(^1\). However, when we consider LLD after total hip arthroplasty (THA), radiographs of the pelvis are commonly used\(^2\) and the LLD in the entire lower leg is rarely measured. The purpose of the present study was to investigate the influence of the LLD in the entire lower limbs on the coronal alignment of the pelvis and spine after THA.

Methods: A total of 84 patients (64 female and 20 male) who underwent primary THA were included in this study. The mean age at surgery was 63 years (range, 39-81). Preoperative diagnoses were as follows; 67 of osteoarthritis, 14 of idiopathic osteonecrosis of the femoral head, 2 of rheumatoid arthritis, and 1 of pigmented villonodular synovitis. For the radiological assessment of LLDs and the coronal alignment of the pelvis and spine, we obtained anteroposterior radiographs of the pelvis, both lower legs in entirety, and whole spine in a standing position before and 1 year after THA. Radiographs at 1 year after THA were obtained in 49 of 84 patients. We measured the vertical distance from the inter-teardrop line to the bilateral tips of the lesser trochanter and to the centers of bilateral femoral heads on the radiographs of the pelvis. We defined the discrepancy between the heights of the bilateral lesser trochanters as the “pelvic LLD”.

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**Pelvic LLD**

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Operative side

inter-teardrop line

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*We defined the measurement value of the pelvic LLD as “plus” when the height of the lesser trochanter on the operative side was lower than that on the contralateral side. On the radiographs of the lower legs in entirety, we measured the length of the mechanical axis (MA) (i.e., the distance from the center of the hip joint to the center of the ankle joint). We defined the discrepancy between the bilateral MA lengths that had been corrected according to the bilateral heights of the centers of the femoral heads as the “whole-leg LLD”.*
We defined the measurement value of the whole-leg LLD as “plus” when the corrected MA length value on the operative side was larger than that on the contralateral side.
To assess the coronal alignment of pelvis, we measured the angle between the inter-teardrop line and the horizontal line (pelvic obliquity angle).

We defined the pelvic obliquity angle as “plus” when the inter-teardrop line tilted to the operative side. Cobb angles of the lumbar and thoracic spines were also...
measured on radiographs of the whole spine. We defined Cobb angles as “plus” when the convexity directed toward the operative side. For statistical analysis, paired t-test was performed on different sets of data and the correlation analysis for numerical data was performed with Pearson’s test. Differences were considered significant when the p value was less than 0.05. For all statistical
Results: Preoperatively, the average pelvic LLD value was -9.5mm (SD, 10.9mm) and the average whole-leg LLD value was 8.6mm (SD, 11.4mm) (p = 0.14). Although the difference between both LLDs was not significant, the difference in each patient varied from -25.4mm to +20.7mm before THA. At 1 year after THA, the average pelvic LLD value was 2.2mm (SD, 7.1mm) and the average whole-leg LLD value was 0.6mm (SD, 7.7mm) (p = 0.07). Although the difference between both LLDs was not significant, the difference in each patient varied from -11.5mm to +20.3mm at 1 year after THA. Preoperatively, the average pelvic obliquity angle was 0.8° (SD, 3.6°), the average Cobb angle of the lumbar spine was 0.6° (SD, 7.4°), and the average Cobb angle of the thoracic spine was -1.2° (SD, 8.0°). At 1 year after THA, the average pelvic obliquity angle was -0.8° (SD, 2.5°), the average Cobb angle of the lumbar spine was -0.4° (SD, 6.7°), and the average Cobb angle of the thoracic spine was -1.5° (SD, 8.3°). The pelvic obliquity angle changed after THA (p = 0.004), however, Cobb angles of the lumbar and thoracic spine did not significantly change after THA. Preoperatively, the pelvic LLD correlated with the pelvic obliquity angle (r = -0.38, p < 0.001), whereas the pelvic LLD and the lumbar or thoracic Cobb angles did not significantly correlate. On the other hand, preoperatively, the whole-leg LLD correlated with the pelvic obliquity angle (r = -0.48, p < 0.01), the lumbar Cobb angle (r = -0.26, p < 0.01), and the thoracic Cobb angle (r = 0.23, p = 0.02). At 1 year after THA, the pelvic LLD correlated with the pelvic obliquity angle (r = -0.49, p < 0.01), whereas the pelvic LLD and the lumbar or thoracic Cobb angles did not significantly correlate. On the other hand, at 1-year after THA, the whole-leg LLD correlated with the pelvic obliquity angle (r = -0.75, p < 0.01), the lumbar Cobb angle (r = -0.36, p < 0.01), and the thoracic Cobb angle (r = 0.26, p = 0.04).

Discussion: Leg length discrepancy and contracture of the hip had been believed to be the cause of pelvic obliquity. In the present study, we demonstrated that both pelvic and whole-leg LLDs correlated with the pelvic obliquity angle, and the pelvis tilted to the shorter extremity. However, the whole-leg LLD correlated with the pelvic obliquity angle more strongly than the pelvic LLD; the determination coefficient [R^2] value of the whole-leg LLD was 0.23 before THA and 0.57 at 1 year after THA, whereas R^2 value of the pelvic LLD was 0.14 before THA and 0.24 at 1 year after THA. Moreover, a significant correlation was not found between the pelvic LLD and the lumbar or thoracic Cobb angles, whereas a significant correlation was observed between the whole-leg LLD and the lumbar or thoracic Cobb angles; the lumbar spine convexity directed toward the shorter extremity and the thoracic spine convexity directed toward the longer extremity. The present study showed that both pelvic and whole-leg LLDs had a greater impact on the coronal alignment of pelvis at 1 year after THA than preoperatively. This is thought to be a result that the contracture about the hips improved after THA. The present study also showed that the whole-leg LLD had a greater impact than the pelvic LLD on the coronal alignment of pelvis and spine. Measurement of the LLD on pelvic radiographs may be inaccurate in cases with varus or valgus deformity of the lower limbs. Our study demonstrated the importance of the whole-leg LLD in terms of the influence on the coronal alignment of pelvis and spine. When we correct the LLD by performing THA, we should consider correcting the whole-leg LLD rather than the pelvic LLD.

Significance: The leg length discrepancy in the entire lower limbs greatly influenced on the coronal alignment of pelvis and spine. We should consider the leg length discrepancy in the entire lower limbs when performing total hip arthroplasty.

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