Risk Factors for Deterioration of Sagittal Spinal Alignment in the Course After Total Hip Arthroplasty

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INTRODUCTION: Patients with hip osteoarthritis (OA) often have poor sagittal spinal alignment due to flexion contracture of the hip. Total hip arthroplasty (THA), the standard treatment for hip OA, often improves the sagittal spinal alignment as the hip flexion contracture improves. In some cases, however, sagittal alignment deteriorates in the postoperative course. Deterioration of sagittal spinal alignment can significantly interfere with daily life, so efforts should be made to prevent it. Therefore, the purpose of this study was to identify risk factors for deterioration of sagittal spinal alignment in the postoperative course after THA.

METHODS: Patients who underwent THA in our hospital between 2016 and 2018 were included in this study. Female who had been followed for at least 3 years and had whole-spine lateral radiographs taken preoperatively and at 3 years postoperatively were included. To identify factors associated with deterioration of sagittal spinal alignment, we analyzed the following clinical parameters before THA; age, body mass index (BMI), lumbar bone mineral density (BMD), spinopelvic parameters, grip strength, abdominal trunk muscle strength (ATMS), knee extensor muscle strength (KEMS), functional reach test (FRT), walking speed, 2-step test, and 25-Geriatric Locomotive Function Scale (GLFS-25). Comparing sagittal vertical axis (SVA) preoperatively and 3 years after surgery, the patients with the value of ≥40 mm with an increase of ≥30 mm were categorized into the deterioration group, and the other patients were into the non-deterioration group. Factors related to the deterioration of sagittal spinal alignment were investigated by univariate and multivariate analysis. Finally, the receiver operating characteristic (ROC) curve analysis was used to determine the optimal cutoff of the deterioration of sagittal spinal alignment.

RESULTS: This study included a total of 103 patients. The mean change in SVA for 3 years was -2.6 mm (range: -103.7 to 156.5). 11 of 103 patients (10.7%) were in the deterioration group. Compared to the non-deterioration group, the deterioration group had smaller sacral slope (SS) and lumbar lordosis (LL), lower values of ATMS and KEMS, and shorter FRT distance (Table 1). There was no significant difference in preoperative SVA between the two groups. Multiple logistic regression analysis showed that small SS and weak ATMS were significant risk factors for the deterioration of sagittal spinal alignment. ROC analyses showed that ATMS ≤4.35 kPa (95% confidence interval 0.643-0.909, P = 0.004, area under curve 0.776) and SS ≤31.9 degree (95% confidence interval 0.607-0.897, P = 0.001, area under curve 0.752) were found to be the best predictors of the deterioration of sagittal spinal alignment in the study cohort.

DISCUSSION AND CONCLUSION: In general, THA improves the flexion contracture of the hip joint, resulting in a retroverted pelvis, decreased SVA, and improved spinal sagittal alignment. On the other hand, patients with a small SS have less ability for retroversion of pelvis, and therefore, their pelvis does not rotate backward after THA, and their spinal sagittal alignment does not improve. In addition, patients with small SS have less ability to compensate for the progressive decrease in lumbar lordosis over time. Corrective surgery for lumbar kyphosis, which increase the risk of hip dislocation after THA, is often necessary for these patients. Therefore, THA cup alignment should be determined considering future corrective surgery for lumbar kyphosis for patients with small SS. Furthermore, the results of this study indicate that patients with weak ATMS are more likely to deteriorate sagittal spinal alignment. This is thought to be because the abdominal trunk muscle group maintains spinal balance by supporting the spine from the front. The device we used to measure ATMS can also strengthen ATMS, and muscle strengthening using this device has the potential to prevent deterioration of sagittal spinal alignment.

Table 1	deterioration group	Non-deterioration group	P-value
N	11 (10.7%)	92 (89.3%)	
age	64.7 ± 9.3	63.8 ± 8.7	0.902
BMI	25.0 ± 7.7	23.1 ± 3.8	0.860
lumbar BMD (g/cm^2)	1.2 ± 0.2	1.1 ± 0.2	0.122
grip strength (kg)	20.5 ± 4.9	21.1 ± 4.8	0.435
ATMS (kPa)	2.5 ± 1.6	5.2 ± 2.9	0.013
KEMS (N/kg)	2.9 ± 1.4	3.9 ± 1.2	0.026
FRT (cm)	26.1 ± 6.4	30.9 ± 7.1	0.019
walking speed (m/s)	0.8 ± 0.4	0.9 ± 0.2	0.359
2-step score	0.8 ± 0.3	1.0 ± 0.3	0.342
GLFS-25	52.6 ± 18.7	43.8 ± 18.5	0.173
preoperative spino-pelvic parameter			
PI (°)	51.0 ± 12.6	57.2 ± 11.6	0.075
SS (°)	32.7 ± 10.2	42.7 ± 12.4	0.006
PT (°)	18.3 ± 8.9	14.4 ± 11.4	0.175
LL (°)	40.1 ± 18.7	53.3 ± 17.9	0.019
SVA (mm)	47.9 ± 26.1	45.3 ± 47.2	0.665

PI, pelvic incidence; SS, sacral slope; PT, pelvic tilt; LL, lumbar lordosis; SVA, sagittal vertical axis