The influence of knee flexion angle on sagittal spinopelvic alignment in patients with knee osteoarthritis

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INTRODUCTION: Abnormal spinopelvic alignment in the sagittal plane is thought to contribute to the sagittal imbalance and the pathogenesis of chronic low back pain. Knee flexion is proposed as a compensatory mechanism in cases of sagittal imbalance. In contrast, the malalignment of the osteoarthritic knee might contribute to abnormal spinopelvic alignment in the sagittal plane. The purpose of this retrospective study was to assess the relationship between knee flexion angle (KFA) and sagittal spinopelvic alignment parameters of patients with end-stage knee osteoarthritis in a weight-bearing standing position using a low-dose biplanar imaging system.

METHODS: According to a priori power analysis (G*Power 3.1; Institut fur Experimentaelle Psychologie, Dusseldorf, Germany), 84 patients with end-stage knee osteoarthritis and no history of severe spinal deformity, spinal fracture, or spinal surgery (33 male, 51 female, average age 65) underwent anteroposterior and lateral standing x-rays (EOS imaging). Sagittal alignment parameters were measured: thoracic kyphosis (TK), lumbar lordosis (LL), sagittal pelvic tilt (PT), sagittal vertical axis (SVA) and KFA (Figure 1). TK and LL were the angles between the superior endplate of T4 and the inferior endplate of T12, and the superior endplate of L1 and the endplate of S1, respectively. PT was the angle between the vertical and the line through the midpoint of the sacral plate to femoral head axis. SVA was the distance between C7 plumb line and posterior edge of sacral plate. KFA was the angle between the femoral axis and the tibial axis. The correlations between KFA and TK, LL, PT, SVA were evaluated using the Spearman's rank-order correlation coefficient (r_s). The probability level accepted for statistical significance was set to $p < 0.05$ (SPSS version 24; SPSS, Inc., Chicago, IL, USA).

RESULTS: The mean value, standard deviation, and range of each parameter are shown in Table 1. TK, LL, PT, SVA, KFA were 43.1°±13.5°, 52.2°±10.7°, 16.1°±8.6°, 31.3±34.1 mm, and 10.0°±9.4°, respectively. Significant correlations between KFA and LL (r_s = -0.222, p = 0.042), and KFA and SVA (r_s = 0.417, p < 0.001) were found. There were no significant correlations between KFA and TK or PT.

DISCUSSION AND CONCLUSION: The sagittal spinopelvic alignment was significantly influenced by KFA in patients with end-stage knee osteoarthritis. The more flexed knee led to reduced LL and larger SVA. According to Murata et al., LL was significantly reduced in patients whose limitation of extension of the knee was more than 5°. Patients with larger SVA are reported to be usually imbalanced and have higher disability scores. The correction of the sagittal malalignment of the knee by realignment surgery such as total knee arthroplasty may improve the sagittal imbalance.

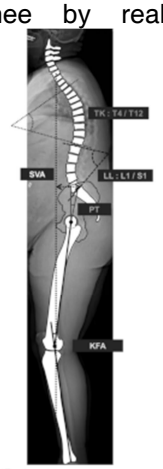

Figure 1 The alignment parameters
Thoracic kyphosis (TK): the angle between the superior endplate of T4 and the inferior endplate of T12
Lumbar lordosis (LL): the angle between the superior endplate of L1 and the endplate of S1
Sagittal pelvic tilt (PT): the angle between the vertical and the line through the midpoint of the sacral plate to femoral head axis
Sagittal vertical axis (SVA): distance between C7 plumb line and posterior edge of sacral plate
Knee flexion angle (KFA): the angle between the femoral axis and the tibial axis

Table 1. Descriptive analysis of the measured variables

	Mean	SD	Range
Age (years)	65.2	11.0	42 - 86
Thoracic kyphosis (°)	43.1	13.5	15.9 - 83.8
Lumbar lordosis (°)	52.2	10.7	20.2 - 78.2
Sagittal pelvic tilt (°)	16.1	8.6	-2.6 - 40.1
Sagittal vertical axis (mm)	31.3	34.1	-43.5 - 136.2
Knee flexion angle (°)	10.0	9.4	-9.6 - 55.2

Thoracic kyphosis: larger angles have a more kyphotic alignment; Lumbar lordosis: larger angles have a more lordotic alignment; Sagittal pelvic tilt: the larger values mean posterior pelvic tilt; Sagittal vertical axis: positive value means vertical axis through C7 in anterior to the posterior edge of the sacral plate; Knee flexion angle; Knee flexion angle: the negative values mean extension angle