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Original article

Relation among the knee, sagittal spinal alignment, and the spinal range of motion: Investigation in local medical check-ups using the SpinalMouse

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Abstract

Background: This study was designed as an investigation in a local population to assess the relation between the knee joint and spinal alignment in a population-based study using the SpinalMouse.
Methods: Medical check-ups were conducted for residents of a mountain village in Japan. The study population included 107 men and 157 women (528 knees) with a mean age of 71.1 ± 6.8 years (range, 60–87 years). A questionnaire dealing with any current symptoms involving the knees was administered, and physical examinations dealing with the range of motion (ROM) of knee were conducted. The SpinalMouse was used to measure sagittal spinal alignment and spinal ROM. The parameters considered were thoracic kyphosis angle, lumbar lordosis angle (LLA), sacral inclination angle (SIA), and trunk angle of inclination (INC). The patients were divided into a group with knee flexion contracture (FC group) and a group without knee FC (non-FC group) to conduct a comparative study of both groups.
Results: With regard to static spinal alignment, LLA and SIA decreased significantly in the FC group ($p < 0.05$). With regard to spinal ROM, LLA and INC decreased significantly in the FC group ($p < 0.05$).
Conclusion: Results suggested that the knee and the spine affect each other and that the spinal ROM is also involved. The current study may explain the development of knee-spine syndrome.

Keywords: knee; sagittal spinal alignment; SpinalMouse; spinal range of motion

Introduction

Knee osteoarthritis often causes flexion contractures (FC), which affect the ability to perform daily activities.[1] Tsuji et al[2] reported a correlation between the spinal alignment and the knee joint, which they called knee–spine syndrome; however, the pathogenesis has not been clarified. In addition, previous studies have examined outpatients or simulated knee FCs, and little has been reported on the relationship between the knee and the spine. Moreover, few reports have described the relationship between the knee joint and spinal alignment as ascertained from a population-based study.

This study was designed as a population-based study using the SpinalMouse to assess the relationship between the knee joint and spinal alignment in a local population. Our hypothesis is that the knee and the spine affect each other and that the

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spinal range of motion (ROM) is involved in the pathogenesis of knee osteoarthritis.

Materials and methods

This cross-sectional study was approved by the institutional Review Board of our institution. All patients, prior to giving their consent to participate in this study, were informed that their data would be published. To help prevent lifestyle-related diseases and aid the early detection of cancer, medical check-ups were conducted in Japan for residents of a mountain village, where agroforestry and tourism are the main industries. A statistical power analysis based on the median effective dose indicated an optimal sample size as > 100 patients, with a significance level of 5% and statistical power of 0.95. The study included 107 men and 157 women (528 knees), with a mean age of 71.1 ± 6.8 years (range, 60–87 years).

A questionnaire was administered regarding the patients' age and sex. We also conducted physical examinations to determine the ROM of the knees in the supine position using a goniometer. The goniometer axis was set on the lateral epicondyle of the femur, while the proximal arm was set parallel to the long axis of the femur and the distal arm was set parallel to the long axis of the fibula and pointing at the lateral malleolus. We used the SpinalMouse (Idiag AG, Volketswil, Switzerland), an electronic computer-aided measuring device, to measure the sagittal spinal ROM and intersegmental angles noninvasively, according to a so-called surface-based technique, to determine the sagittal spinal alignment and ROM (Fig. 1).[3,4] The device was connected to a standard personal computer via an analogue-to-digital converter. The SpinalMouse was placed manually on the patient's skin surface and moved paravertebrally along the patient's spinal column from C7 to S3, while adhering to the body surface of the patient. The device was moved gently to prevent erroneous measurements. The system recorded the outline of the skin surface over the sagittal spinal column. The patient was asked to take three consecutive positions: erect, maximal flexion, and maximal extension of the spine. One measurement was taken in each position. The relevant parameters recorded in each position were as follows: all individual motion segment angles (T1/2–L5/S1), thoracic kyphosis angle (TKA; T1/2–T11/12), lumbar lordosis angle (LLA; T12/L1 to the sacrum), sacral inclination angle (SIA), and trunk angle of inclination (INC; angle subtended between the vertical and a line joining C7 to the sacrum). The intraclass coefficients for the curvature measurements obtained using the SpinalMouse were calculated to be 0.92–0.95.[3,4] To conduct a comparative study of two groups, the patients were divided into a group with knee FCs of knee extension loss > 5° (FC group) and a group without knee FCs (non-FC group). The differences between the two groups in terms of age, sex, ROM of the knee, TKA, LLA, SIA, and INC were compared using Welch *t* test and the Chi-square test. All statistical analyses were conducted using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). Significance was inferred for $p < 0.05$.

Results

The FC group included 229 knees, and the non-FC group included 299 knees. Significant differences were found between the two groups for age (72.2 ± 6.2 years in the FC group; 70.2 ± 7.0 years in the non-FC group, $p < 0.01$), but not for sex (males accounted for 39.3% of the patients in the FC group and 41.8% of the patients in the non-FC group, $p = 0.272$; Table 1). The degree of knee flexion was significantly lower in the FC group (142.3 ± 6.9 in the FC group and 139.4 ± 9.5 in the non-FC group). With regard to static spinal alignment, the results for the FC group were TKA 37.6 ± 15.6°, LLA −18.9 ± 12.3°, SIA 10.7 ± 7.5°, and INC

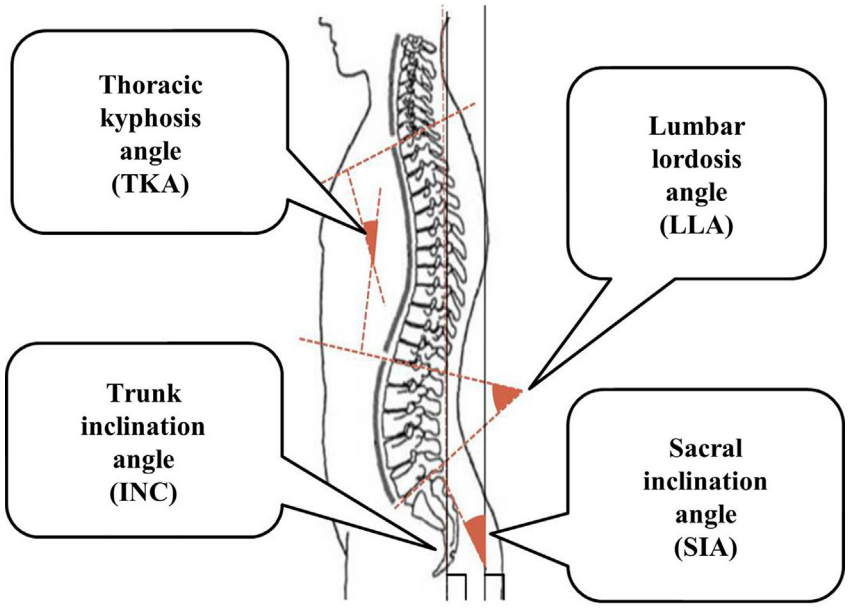

Fig. 1. An electronic computer-aided measuring device was used to measure the sagittal spinal range of motion (ROM) noninvasively. Intersegmental angles were used with a surface-based technique to measure the sagittal spinal alignment and ROM.