Analysis of Spinal Alignments for Three Body Sizes in Upright Seating Posture and Reclined Posture.

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I. INTRODUCTION

Some studies have reported higher injury risks due to a reclined seating posture [1]. It can be anticipated that individual variabilities in spinal alignments affect the severity of injuries, but the effect of body size on changes of spinal alignments in seated postures has not yet been clarified. We have analysed the correlation between the angles of lumbar lordosis (LL) and sacral slope (SS) in a reclined posture using X-ray data from subjects [2]. In this study, the tendencies of LL and SS among three body sizes were described.

II. METHODS

To reproduce the seated posture in an automotive driver seat, an original device equipped with a seat from a Mazda3 (MY2013-2016) was constructed [3]. The X-ray facility, with its seat-back inclined at 24 or 45 degrees and seat pan inclined at 21.5 degrees, was used for both upright and reclined postures (Fig. 1a). X-ray images were taken using the AeroDR One Shot Stitching (KONICA MINOLTA, Japan), a digital radiography system at the Department of Radiological Technology, Yamaguchi University Hospital. All procedures were determined by Yamaguchi University Graduate School of Medicine and Mazda Motor Co. and received prior approval from the ethical committees of both institutions. The five angles from the cervical spine to the sacrum were measured (Fig. 1a). These measurements were performed by an orthopaedic surgeon from Yamaguchi University Hospital. X-ray photography was conducted on 100 asymptomatic volunteers (50 males and 50 females) with no medical history of vertebral or pelvic conditions, who had given informed consent. Subjects equivalent to AF05, AM50, and AM95 were selected based on the height (H) and weight (W) defined for Hybrid III dummy. Volunteers within the range of ±1.65σ for height and weight were included (Fig. 1b).

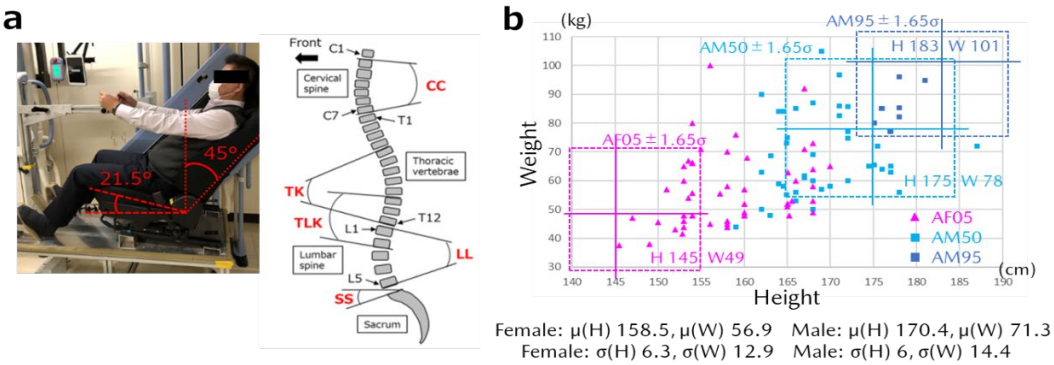

Fig. 1. **a**. X-ray scenarios in reclined posture and measurement items for the spine.
b. Distribution of the subjects equivalent to AF05, AM50 and AM95.

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III. INITIAL FINDINGS

The correlation between the LL and SS angles, based on the data of AF05, AM50, and AM95 subjects, is shown in Fig. 2a. The postural change from 24 degrees to 45 degrees resulted in increased lumbar lordosis and pelvic rearward rotation for each subject. In comparison of the average angle for each part of spinal alignment, the angles of thoracic kyphosis (TK) and thoracolumbar kyphosis (TLK) showed little variation among body sizes, whereas substantial differences in the angles of LL and SS were observed, particularly for AF05 (Fig. 2b).

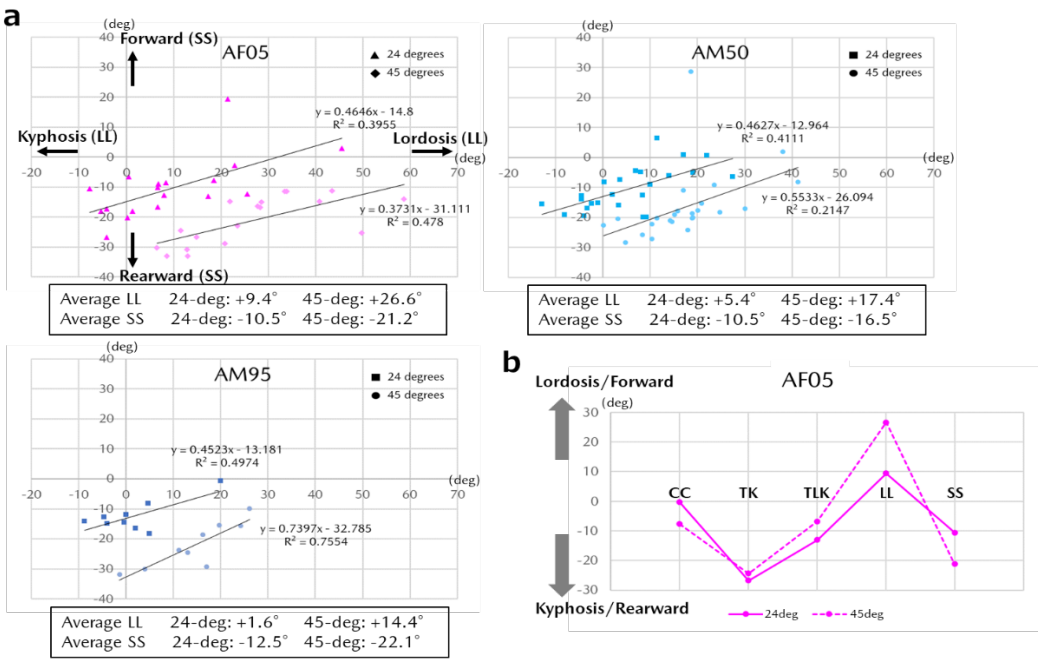

Fig. 2. **a**. The graphs of the correlation between LL and SS angle for each body size.
b. The changes of average angles from CC to SS on AF05 subjects.

IV. DISCUSSION

TK and TLK showed little variation between upright and reclined postures for each body sizes, whereas substantial differences in LL and SS were observed (Fig. 2). These results indicated that TK and TLK have no effect on the LL angle and LL is a critical factor for classifying the type of spinal alignment [4]. Furthermore, both LL and SS are significantly affected by changes in seating posture. Of the three body sizes, the considerable change in the LL angle, particularly of AF05, suggests that smaller and slimmer women can be more directly affected by the shape of the seat due to less back fresh and the position of the lumbar spine with the lumbar support.

In order to understand the mechanism of dynamic transformation in spinal alignment, temporal analysis of skeletal kinematics using an X-ray motion system, in addition to static analysis, will be needed in the future.

V. REFERENCES

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