Introduction: The posterior longitudinal ligament (PLL) is recognized as an important stabilizer in the functional spinal unit of the cervical spine. Therefore, mechanical abnormalities of the PLL may induce to changes in kinematics of the cervical spine. Recently, mechanical properties of the PLL have been reported [1,2,3,4,5,6]. The PLL consists of two primary components, the central bundle and the lateral bundle. Therefore, there is a possibility that local-dependent variations in the mechanical and microstructural properties exist in the PLL of the cervical spine. However, no studies have dealt with location-dependent variations in the mechanical and microstructural properties of the cervical PLL. The purpose of this study was to clarify location-dependent variations in mechanical and microstructural properties of the cervical PLL with respect to the differences between the central and lateral bundles and also among the spinal levels.

Materials and Methods: For this study, total 35 cervical motion segments were obtained from fresh frozen cervical spines (C2 to C7) of mature Landrace-Lange White-Duroe (LWD) pigs. From each motion segment, a pair of bone-central and lateral bundle PLL-bone complexes were isolated (Fig. 1). For each band, 25 complexes were used for mechanical evaluation and the other 10 were used for the histological observation. The cross-sectional area of the ligament was measured using an area micrometer. Tensile tests for the bone-ligament bundle-bone complexes were performed at a cross-head speed of 5 mm/min. Strain in the ligament substance was determined with a video dimension analyzer. Tensile strength, tangent modulus, and strain at failure of each ligament band were determined from the stress-strain curve. Histologically, we analyzed the crimp patterns in PLL bundles using polarized light microscopy. A two-way analysis of variance (ANOVA) was used for statistical analysis.

Results: 1) The tangent modulus and the tensile strength of the central bundle was significantly higher than those of the lateral bundle (the tangent modulus: p<0.005, the tensile strength: p<0.001), while there were no significant differences in these parameters among five levels (Fig. 3). 2) For variations among the cervical level, there were no significant differences in these parameters among five levels (Fig. 3). Histologically, collagen fibers in the central bundles were tightly packed and oriented in parallel arrangement along the long axis as compared to the lateral bundles (Fig. 4).

Discussion: The results in the present study first demonstrated location-dependent variations in the mechanical and microstructural properties of the PLL in the cervical spine. That is, the tensile strength and the tangent modulus of central bundles of the cervical PLL were significantly higher than those of lateral bundles, while there were no significant differences among the spinal levels. In addition, histological findings suggested that regular microstructural arrangement of collagen fibers in the central bundle reflected their superior mechanical properties. These findings indicate that the central bundle of the cervical PLL play an important role as a stabilizer in the functional spinal unit. Therefore, the impairment of the central bundle of the cervical PLL may significantly induce abnormality of the kinematics in the cervical spine.


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