ABSTRACT INTRODUCTION:
Mechanoreceptors in the periarticular tissues contribute to proprioceptive sensibility and modulate the protective muscle responses. Our objective was to quantitatively analyze the distribution of the encapsulated nerve endings in the human PIP joint. The capsuloligamentous complex of the PIP joint was divided into six parts based on the anatomical and biomechanical background, and the distribution of nerve endings was examined in each part. Such observation may help provide a better understanding of the neurophysiological functions of the periarticular tissues during the movement of the PIP joint.

METHODS:
We used twelve right PIP joints of index fingers from fresh cadavers (mean 85yrs, range, 64-103) and transverse sections in thickness 50-µm were processed for immunohistochemistry of the anti-protein gene product 9.5 (PGP9.5) and silver staining. For quantitative analysis the PIP joint was divided into distal, middle and proximal parts (Fig. 1a). We further divided transverse sections into six regions based on the anatomical soft tissue structure of the PIP joint as Zancolli reported: 1 the dorsal capsule (DC), the radial capsule (RC), the ulnar capsule (UC), the volar plate (VP), the radial assemblage nucleus (RAN) and ulnar assemblage nucleus (UAN) (Fig. 1b). Statistically, the densities of mechanoreceptors (numbers/µm²) per parts were compared with one-way ANOVA and Tukey post-hoc test (α=.05) to each longitudinal and transverse plane.

RESULTS:
According to the modified Freeman and Wyke Classification, 2 type I (Fig.2) and type II endings (Fig.3) were identified in the human PIP joint, but no type III ending was identified in any region observed. In general the densities of both type I and type II nerve endings in proximal portion of the PIP joint were higher than those in middle or distal portion of the PIP joint (Fig. 4). The extensive analysis of multiple comparisons among different regions of the transverse sections revealed that the density of type I nerve endings in the VP of the proximal portion was significantly higher than those in the RAN, UAN, RC, UC and DC in the proximal portion (Fig. 4a). The density of type II nerve endings in the RAN in the proximal portion was significantly higher than those in the VP, RC, UC, DC in the proximal portion (Fig. 4b). The density of type II nerve endings in the UAN in the proximal portion was significantly higher than those in the VP and DC in the proximal portion (Fig. 4b).

DISCUSSION:
The density of type I nerve endings was highest in the volar plate at the proximal portion of the PIP joint, suggesting that they may sense the stretching of the volar plate during the movement of the PIP joint. On the other hand, the density of type II nerve endings was highest in the assemblage nuclei at the proximal portion of the PIP joint, suggesting that they may primarily sense mechanical stimuli from the accessory collateral ligament, retinacular ligament and C1 pulley during finger movement. The C1 pulley in particular might act as a sensory generator that transmits a traction force originating from the flexor tendon to the assemblage nuclei.

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