Fluorescent Immunohistochemical Study of Nerve Endings in the Human Inter-Ligamentous Wrist Dorsal Capsule

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Introduction: Articular nerve endings have been studied in various joint models. Animal studies have been published reporting the characteristics of nerve endings located in joint capsule and ligaments. Also included were characterizations of afferent neural signal resulting from joint manipulation.[1] Recently, studies of nerve endings of the human wrist joint have been published.[2,3] From a gross anatomic perspective, the posterior interosseous nerve (PIN) is associated with the dorsal wrist joint capsule, including the dorsal radiocarpal (DRC) and dorsal intercarpal (DIC) ligaments and the intervening joint capsule. Recently published reports have focused on the nerve endings found in the DRC and DIC ligaments, but none have evaluated the non-ligamentous joint capsule.[2,3] There is a large non-ligamentous region of the dorsal wrist capsule which forms a triangular region between the DRC and DIC. The detailed anatomy and distribution of nerve endings are important as part of understanding joint innervation and proprioception and may have implications in designing surgical approaches to the joint. The primary purpose of this study is to investigate the number and distribution of nerve endings in the dorsal wrist capsule.

Materials and Methods: 12 dorsal wrist capsules were harvested from 6 paired fresh cadavers (4 males, 2 female, mean age 62.2±7.9 yrs) within 18 hours of death. The exclusion criteria were communicable diseases, metabolic and neuromuscular disorders, arthritic conditions and preexisting deformities. The tissues were fixed in 4% paraformaldehyde in 0.1 M phosphate-buffered saline, pH 7.4, at 4°C for 24 to 48 hours. Each tissue was serially sectioned at 60 μm thickness using a cryostat. The sections were serially collected on glass slides and processed for fluorescent immunohistochemistry using PGP9.5 and a secondary antibody conjugated to a fluorescent tag (Alexa Fluor 488).[4] The sections were evaluated with a confocal laser microscope (LSM 5 Live; Carl Zeiss, Inc., Thornwood, NY). Labeled nerve endings and nerve fibers were mapped, recorded, reconstructed, and analyzed.

Results: The number of nerve endings found in each dorsal capsule ranged from 0-9 with the mean number of 2.3±2.8. There was a significant difference in the number of nerve endings in the dorsal capsule compared to the dorsal radiocarpal ligament. Approximately 93% of nerve endings were found in both radial and ulnar ends of the joint capsule. 57% were found in the superficial half of the tissue. Nerve endings were equally distributed in the epiligamentous sheath and perifascicular spaces (Figure 1). According to Freeman and Wyke's classification, 39.3% were Type I, 3.6% were Type II, and 57.1% were Type III (Figure 2). 

Discussion: Three-dimensional image analysis reconstructed the images with maximum accuracy. Even though we used Freeman and Wyke's classification as a foundation for our identification, the morphology and size of some of the nerve endings studied had some discordance with their description. There may be many factors contributing to those differences in morphologic characteristics, such as species and weight bearing status of the joints. The dorsal wrist capsule had fewer nerve endings than the adjacent dorsal radiocarpal and dorsal intercarpal ligaments. When considering previously reported data, this may suggest that articular innervation of the PIN is more pronounced in the dorsal wrist ligaments, whereas the dorsal wrist capsule may play a more minor role in afferent nerve function. There is a higher concentration of nerve endings at or near the bony attachments, similar to the pattern found in the DRC ligament.[2,3] The preferential location of mechanoreceptors near the bony attachments suggests that the bony attachment serves as a reference point that could standardize the angle of joint motion as measured by tension of the tissue.[5] These details may have potential implications in our understanding of the sensory function in normal and pathologic joints.


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