INTRODUCTION:
The anterior and posterior interosseous nerves have been demonstrated to innervate the central two thirds of the anterior and posterior wrist joint capsule. Partial denervation of the wrist has been clinically applied to reduce chronic wrist pain. However, the normal anatomic relationships and functional roles of these nerves related to wrist proprioception remain unknown. An investigation of the mechanoreceptor populations in the wrist joint capsule associated with the anterior and posterior interosseous nerves has been undertaken to determine the extent and nature of their role in wrist proprioception. This specific study addresses the mechanoreceptor population in the dorsal radiocarpal (DRC) ligament.

METHODS:
Eight DRC ligaments were harvested from bilateral wrists of four fresh cadavers, average 82.7 years of age, within 12 hours of death. Before the ligaments were dissected from the joint capsule, radiographs were taken to exclude any arthritic conditions of the wrists. The isolated ligaments were fixed, sectioned with a cryostat and serially collected on glass slides. The slides were processed for fluorescence immunohistochemistry using PGP 9.5 antibody, a pan neural marker, which was conjugated to a secondary antibody, Alexa Fluor 488, a fluorescent tag. The sections were evaluated with an LSM-510 confocal laser scanning microscope and a Kontron KS 400 image analyzer. Labeled mechanoreceptors were mapped, measured and categorized according to the classification by Freeman and Wyke (1967).

RESULTS:
Three major types of mechanoreceptors, including Type I (Ruffini ending), Type III (Golgi tendon organ) and Type IV (free nerve ending), could be identified in all DRC ligaments. More Type I and IV receptors could be identified compared to Type III receptors. The mechanoreceptors were distributed primarily over the superficial two thirds of the ligament (> 70%), and near the attachments to the bones (> 80%). More than 70% of the mechanoreceptors were identified in epiligamentous spaces rather than in perifascicular spaces. Type I receptors measured from 100 to 400µm in length. The shape was variable, ranging from ovoid to irregular. Occasionally, Type I receptors were found in small clusters of 2 to 4 corpuscles. The terminal nerve fibers ranged from 1.5 to 3.5µm in diameter. Type III receptors were generally fusiform in shape and were between 500 and 650µm in diameter. The terminal fibers measured from 2 to 2.5µm in diameter. Type IV receptors were identified either as single strands or ramifying arborizations of terminal fibers with diameters ranging from 1.0 to 1.5µm. Other receptors were found which defied standard classification. Meissner’s corpuscles were identified, although infrequently and in only one ligament studied.

CONCLUSION:
From this investigation, we have discovered that the DRC ligament has a rich sensory innervation from the posterior interosseous nerve. As with other joint tissues previously studied, the location of the mechanoreceptors was primarily near the zone of ligament attachment to bone. A new discovery was that the mechanoreceptors were found in the superficial half of the ligament. Although the significance of this finding remains unknown, it is possible that mechanoreceptors located in the superficial layers of the ligaments are exposed to more strain than those in the deeper aspects, and hence exposed to a greater differential of displacement. This information, along with ongoing studies of the specific afferent electrical activities obtained from the posterior interosseous nerve and studies of proprioceptive acuity in the wrist, will contribute to our understanding of the factors involved in joint proprioception. The tissue processing protocol developed for this study provides a consistently high level of resolution and detail of mechanoreceptor morphology, allowing for three-dimensional image analysis and is highly specific for nerve tissue.