

An immunohistochemical study of mechanoreceptors in lumbar spine intervertebral discs

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FROM ABSTRACT

The aim of our study was to determine the types of mechanoreceptors in the two lower intervertebral discs in normal adult cadaveric donors and to review the literature.

Twenty-five lumbar (L4–5 and L5–S1) intervertebral discs were retrieved from 15 fresh cadavers.

We utilized immunoreactivity against the S-100 protein to localize specialized nerve endings. Immunoreactivity showed receptors in 92% of discs.

The most frequent type had morphology resembling the Ruffini type receptor (88%), followed by the Golgi type.

Free nerve fibers were frequently present.

All neural structures were found in the superficial layers of the annulus fibrosus, in longitudinal ligaments, or between these two.

The anterior part of the L5–S1 disc had a greater frequency of encapsulated receptors than the other parts, which may be correlated with the high shear forces to which the lumbosacral junction is subjected.

KEY POINTS FROM THIS STUDY:

1) “The presence of nerve structures in intervertebral discs is well documented” since 1932.

2) “These receptors have a key role in the perception of joint position and adjustment of the muscle tone of the vertebral column.”

[Important: these nerves are responsive to changes in joint position and alignment, and they control vertebral column muscle tone].

3) “An important component of low back pain is an intense muscle spasm of the vertebral musculature, elicited through reflex arches mediated by specialized nerve endings.”

- 4) There are four categories of joint receptors:
 - A)) type I: encapsulated mechanoreceptors similar to Ruffini endings
 - B)) type II: encapsulated mechanoreceptors similar to Pacinian corpuscles
 - C)) type III: encapsulated mechanoreceptors similar to Golgi endings
 - D)) type IV: unmyelinated free nerve endings and unencapsulated plexuses that have nociceptive function.
- 5) The 25 discs used in this study were harvested from 15 human cadavers with the mean age of 45.4 years (range, 15–66 years). “None had any history of chronic low back pain.”
- 6) Nerves were not found in 2 out of 25 discs (8%).
- 7) The receptors most frequently encountered showed Ruffini receptor morphology [mechanoreceptors]. Ruffini receptors help maintain muscle tone (low threshold, slow adaptation).
- 8) The second most common receptors found had Golgi tendon organ morphologically [mechanoreceptors]. Golgi receptors are activated at extremes of joint motion (high threshold, slow adaptation).
- 9) Free nerve fibers [pain afferents] were a frequent finding. In 16 of the 25 discs [64%], free nerve fibers were found. “It is assumed that those close to blood vessels have a vasomotor role [sympathetic] while those away from vessels may have a nociceptive (small caliber) or a proprioceptive role (large caliber).”
- 10) The neural elements were found in the longitudinal ligaments, the space between the longitudinal ligaments and the annulus fibrosus, and in the outer third of the annulus fibrosus.
- 11) The greatest amount of mechanoreceptors were found at the anterior part of the L5–S1 disc “which may be correlated with the high shear forces to which the lumbosacral junction is subjected.”
- 12) “All neural structures detected were located either in the longitudinal ligaments, or the superficial lamellae of the annulus fibrosus, which are the areas sustaining the greatest pressure or tension during extremes of movement.”
- 13) “During axial loading of a motion segment, compressive stresses in the nucleus will generate tensile stresses in the peripheral annulus, which is rich in neural receptors.”

14) "In conclusion, this study confirms the existence of an abundant network of encapsulated and non-encapsulated receptors in the intervertebral discs of the lower lumbar spine in normal human subjects. The principal role of encapsulated structures is assumed to be the continuous monitoring of position, velocity and acceleration (kinesthesia). Free nerve fibers are likely to be involved in nociception or regulation of vessel tone (autonomic fibers)."

COMMENTS FROM DAN MURPHY

It is chiropractically important to understand that the intervertebral disc is innervated with nerves that communicate with the central nervous system. These nerves tell the CNS about the mechanical status of spinal function and alignment of the spine.

Undoubtedly, chiropractic adjustments influence these nerves both during an adjustment and afterwards as a consequence of improved biomechanical function and posture.