Sensory and Autonomic Innervation of the Cervical Intervertebral Disc

The Pathomechanics of Chronic Discogenic Neck Pain

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KEY POINTS FROM DAN MURPHY

1) This study used rats. The authors note that prior studies have shown that rats and humans have similar spinal innervation patterns. However, they also note that these findings should be reaffirmed on human specimens.

2) This study is an immunohistological analysis of the cervical intervertebral disc (IVD) to investigate its sensory and autonomic innervation. The authors used the neuro-tracer Fluoro-gold (FG) to stain ten C5–C6 IVDs. They stained for the following neurons:

- Dorsal root ganglions (DRG) from level C1–C8 [sensory {afferents} cell bodies; this would include pain afferents]
- Stellate ganglion (SG) [inferior cervical sympathetic efferent ganglion]
- Nodose ganglion (NG) [Vagus nerve parasympathetic sensory ganglion to the nucleus tractus solitarius].

3) Several studies have reported that sympathetic nerves participate in chronic pain; sympathectomy procedures can effectively treat chronic pain.

The DRGs, SG, and NG neurons were immune-stained for:

- Calcitonin gene-related peptide (CGRP); found in inflammatory pain neurons.
- Isolectin B4 (IB4); found in neuropathic (nerve injury) neurons.

4) Findings for the innervation of the C5-C6 IVD:

- The neurons innervating the C5–C6 IVD were derived from the C2–C8 DRGs, but not from the C1 DRG.
- 3% of the neurons were for neuropathic (nerve injury) pain: Isolectin B4 (IB4); [therefore pain afferents]
- 21% of the neurons were for inflammatory pain: Calcitonin gene-related peptide (CGRP); [therefore pain afferents]
THEREFORE, 24% of the neurons were pain afferents [3% + 21% = 24%]

- 9% of the neurons were from the stellate (inferior cervical) ganglion: [therefore sympathetic efferents]
- 11% of the neurons went to the nodose ganglion: [these are parasympathetic afferents that synapse in the nucleus tractus solitarius]

THEREFORE, 20% of the neurons were from the autonomic nervous system [9% + 11% = 20%]

- 56% of the neurons were non-pain afferents [the authors imply that these are large diameter afferents for proprioception, therefore they are mechanoreceptors]

THEREFORE, neurons innervating cervical IVDs are be divided into 3 groups:

• Sensory neurons (DRG cell body neurons)
• Sympathetic autonomic neurons
• Parasympathetic autonomic neurons

5) Overall, 80% of the nerve fibers innervating the IVD were sensory nerves [24% pain afferents and 56% other afferents {probably mechanoreceptors}] and 20% were autonomic nerves.

6) “Chronic neck pain is a significant public health problem.”

7) Multiple studies indicate that the cervical intervertebral disc (IVD) is a source of neck pain.

8) Patients with painful cervical IVDs experience wide-ranging neck pain, suggesting that the sensory innervation of the cervical IVD is not segmental.

9) Discogenic neck pain “often becomes chronic, and many clinicians are challenged with treating this chronic pain.”

10) It is known that the cervical facet joints are innervated from multiple segmental levels which “may explain the wide-ranging nature of some neck pain.”

11) There is increasing interest in the involvement of the “sympathetic nervous system in the maintenance of chronic muscle pain syndromes.”
“Various sympathectomy procedures as well as sympathetic nerve blockage have been reported to be effective for the treatment of chronic pain in multiple studies.”

This study suggests that the neurons that have the overriding responsibility for discogenic lower back pain are the inflammatory sensing pain afferents.

The authors also present evidence that facet joints are also innervated by several segmental levels, further explaining the wide-ranging nature of neck pain.

This study “confirmed the presence of efferent sympathetic and parasympathetic neurons innervating the cervical IVDs.”

“Sympathetic activation is correlated with chronic pain of various etiologies.”

Patients experiencing various forms of chronic pain are effectively treated by blocking sympathetic nerves, including the blockage of SGs.

“The C5–C6 IVD receives multisegmental innervation from the C2–C8 DRG, SG, and NG neurons.”

These findings help explain the wide-ranging and chronic discogenic pain that occurs via the somatosensory and autonomic nervous system.

COMMENTS FROM DAN MURPHY

For more than a century, chiropractors have observed and documented changes in visceral function occurring as a consequence of spinal adjusting. As David Goldstein notes in his 2001 book *The Autonomic Nervous System in Health and Disease* (2001), it is the balance of the sympathetic and parasympathetic nervous system functions that are primarily responsible for whole body homeostasis (health). Over the years I have posted a number of articles showing how spinal mechanics (adjusting) influences both the sympathetic and parasympathetic nervous systems. This study adds to the biologic plausibility of chiropractic spinal adjusting influencing visceral function (health) by noting the intervertebral disc is innervated with nociceptors, mechanoreceptors, sympathetic and parasympathetic neurons. Importantly, since these discogenic parasympathetic neurons fire to the nucleus tractus solitarius (a major relay for neuroimmunology), it adds to the biological plausibility for both the osteopathic and chiropractic documented increased survivability of the most sick patients during the 1918 flu pandemic (see Rhodes in FREE STUFF). As Dr. Kirkaldy-Willis notes in his books *Managing Low Back Pain* (Churchhill Livingstone), every spinal adjustment to the facet joint affects the IVD.

Additionally, it appears that discogenic back pain is conveyed primarily by inflammation sensing nociceptors. We should balance the innate omega-6/omega-3 fatty acid inflammatory profile ratios [to 1.5-4/1].
Visceral Afferents

Heart
Lungs
GI

Stellate Ganglion
Inferior Cervical Sympathetic

Nucleus Tractus Solitarius
Parasympathetic Nervous System

Nodose Ganglion

DRG
C2
C3
C5
C6
C7
C8

Other Non-Pain Afferents = 56% of Neurons
Pain Afferents = 2.4% of Neurons

C5-C6 Disc

VAR
NR

11%
9%

Immune Organs
Blood Vessel
Viscera
Intramuscular Fibers of the Muscle Spindle