

Central Hypersensitivity in Chronic Pain After Whiplash Injury

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FROM ABSTRACT:

Objective:

The mechanisms underlying chronic pain after whiplash injury are usually unclear.

Injuries may cause sensitization of spinal cord neurons in animals (central hypersensitivity), which results in increased responsiveness to peripheral stimuli.

In humans, the responsiveness of the central nervous system to peripheral stimulation may be explored by applying sensory tests to healthy tissues.

The hypotheses of this study were:

- (1) Chronic whiplash pain is associated with central hypersensitivity.
- (2) Central hypersensitivity is maintained by nociception arising from the painful or tender muscles in the neck.

Design: Comparison of patients with healthy controls.

Setting: Pain clinic and laboratory for pain research, university hospital.

Patients:

Fourteen patients with chronic neck pain after whiplash injury (car accident) and 14 healthy volunteers.

Outcome Measures:

Pain thresholds to single electrical stimulus (intramuscular), repeated electrical stimulation (intramuscular and transcutaneous), and heat (transcutaneous). Each threshold was measured at neck and lower limb, before and after local anesthesia of the painful and tender muscles of the neck.

Results:

The whiplash group had significantly lower pain thresholds for all tests, except heat, at both neck and lower limb.

Local anesthesia of the painful and tender points affected neither intensity of neck pain nor pain thresholds.

Conclusions:

The authors found a hypersensitivity to peripheral stimulation in whiplash patients.

Hypersensitivity was observed after cutaneous and muscular stimulation, at both neck and lower limb.

Because hypersensitivity was observed in healthy tissues [uninjured], it resulted from alterations in the central processing of sensory stimuli (central hypersensitivity).

Central hypersensitivity was **not** dependent on a nociceptive input arising from the painful and tender muscles.

THESE AUTHORS ALSO NOTE:

"Whiplash injury results in chronic neck pain and headache in about 20% of subjects."

Injuries may "cause sensitization of spinal cord neurons, which results in increased sensitivity to noxious stimuli and pain after innocuous stimuli (central hypersensitivity)."

Studies suggest that ongoing nociceptive input from damaged tissues in the periphery may or may not contribute to maintaining central hypersensitivity.

"Hypersensitivity can be demonstrated when sensory stimulation evokes pain at stimulus intensities that do not induce pain in normal subjects."

If hypersensitivity is observed after sensory stimulation of healthy uninjured tissues, its cause must be in the central nervous system.

If the "hypersensitivity is reduced by local anesthesia of the painful foci, this would indicate that an ongoing nociceptive afferent input is important for the maintenance of central hypersensitivity."

The hypotheses of this study were:

(1) chronic pain after whiplash injury is associated with central hypersensitivity

(2) central hypersensitivity is maintained by nociception arising from the painful or tender muscles in the neck.

In this study, sensory stimulation was applied at the skin and muscle of the injured neck and to the uninjured lower limb.

No patients suffered head-contact injury, loss of consciousness, post-traumatic amnesia, fractures or dislocations of the cervical spine.

All patients had neck pain for more than 6 months.

Psychological assessments were done with the NEO-FFI test (Neuroticism, Extraversion, Openness-Five Factor Inventory) and the SCL-90-R (Symptom Check List). Both tests are self-report questionnaires.

The NEO-FFI assesses 5 personality dimensions.

The SCL-90-R is used to assess psychological distress in patients, including patients with chronic pain.

The normal range of the scores of both NEO-FFI and SCL-90-L is 40 to 60. A score greater than 60 indicates an abnormality.

Intensity of the neck pain was assessed with a 10-cm visual analog scale (VAS), where 0 indicates no pain and 10 the worst pain imaginable.

“Activation of the C-fibers is primarily involved in the induction of central hypersensitivity.”

RESULTS

Whiplash Group:

Neck pain began within 24 hours after the accident in all patients.

The median duration of pain was 40 months.

The median intensity of neck pain before the infiltration at rest was 3.2 cm.

The median intensity of neck pain during movement was 6.4 cm.

The patients exhibited no abnormal personality traits.

On the SCL-90-R, whiplash patients exhibited profiles of distress, with major elevations in somatization, depression, and general severity index, and lesser elevations in obsession-compulsion, anxiety, hostility, and paranoid ideation.

There were no statistically significant changes in the pain thresholds after local anesthesia of the painful and tender points.

"The basal pain thresholds were significantly lower in the whiplash group than in the control group for all tests, except heat."

"This difference was observed at both neck and lower limb."

There was no difference between the whiplash group and the control group on pain tolerance to heat stimulation. [IMPORTANT]

DISCUSSION

"We found that the stimulus intensity that has to be applied to evoke pain is lower in [whiplash] patients than in healthy subjects."

"This indicates a state of hypersensitivity of the nociceptive system to peripheral stimulation."

The hypersensitivity was observed with both cutaneous and muscular stimulation, applied at both the injured neck and to the uninjured lower limb.

"This indicates that an alteration in the processing of sensory stimuli in the central nervous system is involved in the generation of hypersensitivity."

"Because the local anesthesia of the painful and tender points did not affect the pain thresholds, the central hypersensitivity was not maintained by a nociceptive input arising from these areas."

CENTRAL HYPERSENSITIVITY

Tissue damage causes an increased responsiveness of ipsilateral and contralateral spinal cord neurons to peripheral stimulation.

"After injury, responses of dorsal horn or thalamic neurons are elicited by stimuli applied at peripheral tissues that did not evoke any response of the same neurons before the injury (expansion of receptive fields)."

"As a result, a peripheral stimulus activates a higher number of dorsal horn neurons and hyperalgesia may also be evoked in areas outside the injured region."

These observations suggest that patients with neck pain after whiplash injury have central sensitization and reduced pain thresholds.

“Nociceptive stimulation associated with the injury may produce excitation of the central nervous system, which in turn is responsible for reduced pain thresholds” in uninjured tissues.

“The fact that hypersensitivity was observed at both neck and leg to the same extent indicates a state of generalized central nervous system hypersensitivity.”

This central hypersensitivity is likely an amplification of a nociceptive input arising from a focus in the neck.

“The absence of objective signs of tissue damage is common in patients with neck pain after whiplash injury.” [IMPORTANT]

“Lesions in the zygapophysial joints associated with pain are frequently not detected by medical imaging or physical examination.”

“Central hypersensitivity could explain exaggerated pain after minimal nociceptive input arising from minimally damaged tissues in the neck.”

Patients with fibromyalgia also have generalized hyperalgesia that is detectable in nonpainful tissues.

Fibromyalgia patients have “increased levels of substance P and excitatory amino acids in the cerebrospinal fluid, which may be involved in the induction of generalized hyperexcitability of the central nervous system.”

In this study there was a significant difference between the groups in the pain threshold with all the tests used, except heat. [This shows that the whiplash patients are genuine and their pain is organic], because previous studies show that tissue damage does not result in secondary hyperalgesia to heat stimulation.

In this study, the hypersensitivity was not maintained by nociception arising from the painful and tender [muscular] points.

“In whiplash patients a nociceptive focus located in deep tissues of the neck [like the facet capsules] maintains the state of central hypersensitivity, and the painful and tender [muscular] points are areas of referred pain.”

The authors cite a study on a group of whiplash patients in which local anesthetic blocks of the nerves that supply the facet joints abolishes their pain.

Central hypersensitivity may not require an ongoing nociceptive input, but an initial peripheral event is required to induce central hypersensitivity.

“Once established, central hypersensitivity may be independent of the peripheral input.”

“Central hypersensitivity in whiplash patients may persist after resolution of the initial tissue damage.”

PSYCHOLOGICAL FACTORS

These authors found psychological distress in whiplash patients.

“The psychological profile of whiplash patients as assessed by the SCL-90-R is similar to the profile of patients with chronic pain resulting from other musculoskeletal injuries.”

If psychological factors were the primary determinant of altered pain perception, it would affect all the pain thresholds and not spare the heat pain thresholds.

Descending inhibitory pathways may affect the development of spinal cord hyperexcitability after inflammation and tissue injury.

The authors hypothesized that psychological distress causes a dysregulation in the descending modulation of spinal cord excitability in whiplash patients, which results in enhancement of the injury-induced central hypersensitivity. [Suprasegmental driven descending pain inhibitory controls].

CONCLUSIONS

“Chronic pain after whiplash injury is associated with central hypersensitivity.”

Central hypersensitivity was not affected by local anesthesia of the painful and tender areas [in muscles].

“This alteration in the central processing of nociceptive stimuli is not necessarily associated with detectable tissue damage and modifications in the personality traits.”

There are 3 mechanisms to cause central hypersensitivity:

- (1) Maintenance of central hypersensitivity by an ongoing peripheral nociceptive input.
- (2) Persistent central hypersensitivity after resolution of the primary peripheral injury [after all possible tissue healing has occurred].

(3) Imbalance of the descending pain inhibitory system.

“Central hypersensitivity should be considered as a possible mechanism underlying whiplash pain, even when no organic lesions are identified by the common diagnostic methods.”

KEY POINTS FROM DAN MURPHY

(1) 20% of those injured in whiplash will develop chronic pain.

(2) This chronic pain from whiplash is not confined to the region of injury, but extends to non-injured tissues in other regions of the body. This pain can be elicited by non-painful sensory input.

(3) The altered pain thresholds in non-injured distant tissues following whiplash can only be explained by peripheral tissue injury / inflammation driven central (spinal cord and brain) hypersensitivity.

(4) This central (spinal cord and brain) hypersensitivity requires a peripheral nociceptive trigger to become established.

(5) The tissue source of the nociceptive trigger is not the muscles, but probably a deeper foci, like the facets.

(6) Chronic whiplash pain is not psychological, but pain induced psychological involvement can alter the descending pain inhibitory controls, leading to enhanced pain.

(7) The SCL-90-R psychological assessment shows that the psychological profile of chronic whiplash pain sufferers is similar to those with other organic musculoskeletal conditions, again implying an organic basis for their pain.

(8) One can have organic chronic pain following whiplash injury, even in the absence of objective signs of tissue damage.

(9) Facet joint lesions associated with pain are frequently not detected by imaging or physical examination.

(10) The post whiplash chronic pain central hypersensitivity could arise from minimal nociceptive input arising from minimally damaged tissues in the neck.
[Low Impact]

(11) One can have ongoing central pain after all possible tissue healing has occurred.

