Academy of PHYSICAL MEDICINE

Research Paper Review

This review is published with the permission of Research Review Service (www.researchreviewservice.com)

Cerebral perfusion in patients with chronic neck and upper back pain: Preliminary observations

Journal of Manipulative & Physiological Therapeutics 2012; 35: 76-85

Bakhtadze MA, Vernon H, Karalkin AV et al.

ABSTRACT

Objective

The purpose of this study was to determine the correlation between cerebral perfusion levels, Neck Disability Index (NDI) scores, and spinal joint fixations in patients with neck pain.

Methods

Forty-five adult patients (29 were female) with chronic neck/upper thoracic pain during exacerbation were studied. The subjects were grouped according to NDI scores: mild, moderate, and severe. The number of painful/blocked segments in the cervical and upper thoracic spine and costovertebral joints, pain intensity using the visual analog scale, and regional cerebral blood flow of the brain using single-photon emission computed tomography (SPECT) were obtained. The SPECT was analyzed semiquantitatively. Analysis of variance tests were conducted on total SPECT scores in each of the NDI groups ($P < .05$). Univariate correlations were obtained between blockage, pain, and SPECT scores, as well as age and duration. A multivariate analysis was then conducted.

Results

Group 1 (mild) consisted of 14 patients. Cerebral perfusion measured by SPECT was normal in all 8 brain regions. Group 2 (moderate) consisted of 16 patients. In this group, a decrease in cerebral perfusion was observed (range, 20%-35%), predominantly in the parietal and frontal zones. Group 3 (severe) consisted of 15 patients. In this group, the decrease in cerebral perfusion observed was from 30% to 45%, again predominantly in the parietal and frontal zones. A significant difference was found between NDI groups ("moderate" and "severe" showed significantly greater hypoperfusion than "mild"). Total blockage score correlated with SPECT scores at $r = 0.47$, $P = .001$. In a multivariate analysis, NDI scores contributed 39% of the variance of SPECT scores.

Conclusion

In this group of patients with neck and/or upper back pain, NDI scores strongly predicted cerebral hypoperfusion. Spinal joint dysfunction may be involved via hyperactivity in the regional sympathetic nervous system.

ANALYSIS

Reviewed by Dr. Jeff Muir DC (Research Review Service)

Author's Affiliations

Center for Manual Therapy, Moscow, Russia; Canadian Memorial Chiropractic College, Toronto, Ontario; Russian State Medical University, Moscow, Russia

Background Information

Neck pain is second only to LBP in frequency in the general population and musculoskeletal practice (1). Assessment of patients with neck pain and the delineation of specific pathologies or dysfunctions in patients continue to be a challenge. The Neck Disability Index (NDI), first published in 1991, has become immensely useful in categorizing the severity and prognosis of patients with neck pain in general and, specifically, patients with whiplash associated disorder (WAD). However, the correlation of NDI scores to physical or organic disorders in neck pain has received less attention, with the major emphasis being on sensory changes indicative of central sensitization. One emerging method of assessing the organic nature of neck pain has been single-photon emission computed tomography (SPECT). Since the original work of Otte et al. (2), in which hypoperfusion in the parieto-occipital cortex was demonstrated in late whiplash subjects, several authors have assessed brain perfusion in WAD and non-WAD groups. The current study was undertaken to determine the correlation between NDI scores and SPECT findings in non-WAD patients with neck and/or upper back pain. The study subcategorized patients based on severity of NDI scores which represents a novel approach to this sort of analysis.

PERTINENT RESULTS

- A total of 45 patients were included in the study (mean ± SD age, 40 ± 10.9 years; 16 males; 29 females)
- Participants were stratified based on their NDI scores as follows: “mild pain” (group 1), “moderate pain” (group 2) and “severe pain” (group 3)
- Neck Disability Index and pain scores were significantly larger in group 3 vs. 2 vs. 1, as well as group 2 vs. 1
- Segmental dysfunction scores in groups 3 and 2 were significantly larger than those in group 1; however, groups 2 and 3 were not significantly different
- Analysis of variance test revealed a significant difference between NDI groups vs. total SPECT scores, with the “moderate” and “severe” groups showing significantly more hypoperfusion than the “mild” group ($F = 3.31$, $P = .001$)
- In groups 2 and 3, there was a significant difference favoring the parietal (75% of subjects had 20%-

45% reduction) and frontal (60% of subjects had 20-45% reductions) regions
- Age showed no correlation with total SPECT score, pain score, total blockage score, and NDI
- No correlation was noted between gender and total SPECT or NDI score

CLINICAL APPLICATION & CONCLUSIONS

The main finding of this study was that SPECT scores in NDI groups 2 and 3 were significantly higher than in group 1, indicating agreement between NDI and SPECT scores.

Three factors should be considered when interpreting these results:

1. There is now strong evidence that chronic pain itself is associated with changes in the brain.
2. There is now strong evidence of an association between NDI scores and psychosocial variables in patients with neck pain.
3. Reduced pain thresholds have been strongly correlated with NDI scores. These changes have been suggested to result from central sensitization due to chronicity and severity of pain.

Chronic pain is known or suspected to tie sensitization to activation of the sympathetic nervous system. The idea that sympathetic activation from spinal pain or stimulation of spinal sympathetic ganglia can be associated with, or even cause, cerebral hypoperfusion also has a long history (posterior cervical sympathetic syndrome of Barré, cervical migraine, and vertebrogenic migraine come to mind). Nociceptive stimuli from dysfunctional motion segments of the spine activate the segmental sympathetic nervous system, and these somatic afferent stimuli will cause reactions in the preganglionic sympathetic neurons both segmentally and suprasegmentally.

The findings here of a strong correlation between the number of painful spinal dysfunctions in the cervicothoracic- costal area in patients with neck pain and cerebral perfusion give some support to this somato-(spinal)-sympathetic theory. Future research is required to clarify this relationship, as well as assist us in applying this concept to patient care.

STUDY METHODS

- *Design*: cross-sectional correlation design
- *Recruitment*: Feb 2006 to Feb 2010
- *Inclusion criteria*: Subjects attending at the Moscow Manual Therapy Center who had chronic neck and upper thoracic pain (> 3 months)
- *Exclusion criteri*a: current whiplash injury, arterial hypertension, arteriosclerosis, migraine, diabetes, clinical depression, craniocerebral injury, stroke in anamnesis, and prior spinal surgery were excluded. Patients who were smokers or who were taking any medication known to interfere with cerebral function (opiates, antiepileptics, etc) were excluded. Patients with pain complaints in other areas such as low back pain were also excluded.

Procedures:
All subjects completed a Neck Disability Index (NDI) at the beginning of the study. Each subject was also examined via palpation by 1 assessor to identify sites of "segmental dysfunction" in the cervical and upper thoracic spine as well as the upper thoracic costovertebral joints. A spinal or costovertebral joint was graded as segmental dysfunction if the passive joint play was rated as painful and restricted.

SPECT Study:
The single-photon emission computed tomography (SPECT) was performed within 1 to 3 days after the clinical examination. Evaluation of perfusion was analysed by 2 nuclear physicians using VCS (visual colour scale) – more in depth information regarding VCS is available (3-6).

Data analysis:
The subjects were divided to 3 groups according to their NDI score: mild, moderate, or severe. Analysis of variance tests were conducted on total and regional SPECT scores and on segmental dysfunction scores in each of these groups ($P < .05$). Univariate correlations were obtained with Pearson correlation coefficient between blockage score, pain score, NDI, and total SPECT score (as a percentage of regional hypoperfusion [4 brain regions bilaterally]), as well as age and duration. Variables with significant correlations ($P < .05$) were then entered into a multivariate analysis.

STUDY STRENGTHS / WEAKNESSES

This study was unique and its findings certainly warrant further research in this area. The potential link among NDI scores, segmental dysfunction and SPECT scan results is certainly interesting, with a vast array of potential clinical applications pending further study.

Bearing in mind that this was a preliminary study, the authors correctly identified several limitations and potential improvements for future investigations:

- Sample size was deemed too small and future studies were recommended to recruit a larger cohort
- SPECT analysis was semiquantitative – more sophisticated quantitative analysis is recommended by the authors for future studies
- Bias may exist regarding identification of painful spinal dysfunction sites – future studies could use 2 assessors

Additional References

1. Nachemson A, Waddell G, Norlund AI. Epidemiology of neck and back pain. In: Nachemson A, Jonsson E, editors. Neck and back pain: the scientific evidence of causes, diagnosis and treatment. Philadelphia, PA: Lippincott Williams and Wilkins; 2000. p. 165-87.
2. Otte A, Mueller-Brand J, Nitzsche EU, Wachter K, Ettlin TM. Functional brain imaging in 200 patients after whiplash injury. J Nucl Med 1997; 38:1002.
3. Payne JK, Trivedi MH, Devous MD. Comparison of technecium-99m–HMPAO and xenon-133 measurements of regional cerebral blood flow by SPECT. J Nucl Med 1996; 37: 1735-40.
4. Catafau AM. Brain SPECT. in Clinical Practice. Part I: Perfusion. J Nucl Med 2001; 42:259-71.
5. Koyama M, Kawashima R, Ito H, Ono S, Sato K, Goyo R, et al. SPECT imaging of normal subjects with technecium-99m–HMPAO and technecium-99m–ECD. J Nucl Med 1997; 38:587-92.
6. Darcourt J, Mena I, Cauvin J-C, Miller B. Absolute calibration of HMPAO SPECT using 133Xe rCBF values. Alasbimn J 1999; 2 Article No AJ05-1.