Whiplash effects on the hypothalamus and the sympathetic system

In: Whiplash Injuries, Diagnosis and Treatment, R. BONIVER (1996) by A. Cesarani, Springer-Verlag, pp. 59-63

The author begins by briefly reviewing the posterior cervical sympathetic syndrome of Barre (1924).

KEY POINTS FROM THIS CHAPTER:

1) The author reviews a hypothesis of hypothalamic disintegration may explain vertigo after whiplash injury.

2) Cervical lesions that irritate the sympathetic vertebral nerves that control the vertebral artery result in a decreased blood flow to the labyrinth due to constriction of the internal auditory artery, causing vertigo.

3) The hypothalamus is unquestionably of great importance in mammalian physiology.

4) The hypothalamus integrates behaviour and regulates the basic life functions of the organism. This integration is carried out through its relationship with higher levels of the nervous system, and through the endocrine system.

5) The hypothalamus is an extremely important link of a system of complex circuits that is so strategically placed that its derangement may have profound effects. [1]

6) The hypothalamus is considered to be the most rostral portion of the reticular formation.

7) The hypothalamus is also the most caudal portion of the limbic system and thus is the brain region through which limbic system output comes to control autonomic and endocrine function. [A - H]

8) The paraventricular nucleus of the hypothalamus (PVN) is one of the most vascularised areas of the brain. It plays the dominant role in neuronally coupling brain stem autonomic centers (the nucleus of the solitary tract and the dorsal vagal complex), endocrine, and somatomotor responses to environmental stressors. [1]

9) The PVN of the hypothalamus innervates median eminence, the pituitary, brain stem nuclei, and spinal cord.

10) Patients with whiplash injury present with hypertonicity of the muscle tissues supporting the neck. [4] This overexcitation of the cervical proprioceptors is caused by excitation of sympathetic intrafusal fibers to the muscle spindles. [3]

11) Abnormal afferent impulses arising from the injured cervical soft tissues may ascend along the spinal-reticular tract to the brain stem, and terminate in the reticular formation of both the medulla oblongata and the pons. [5]

12) Some of the fibers of this (spinal-reticular) tract ascend directly to the midbrain and are connected to the lateral vestibular nucleus. [5]

13) This (spinal-reticular) tract terminates in the superior colliculus. [6]

14) The reticular formation of these parts of the brain, the lateral vestibular nucleus, and the superior colliculus, are active in both ocular and spinal reflexes related to body equilibrium. [L, P]

15) The median longitudinal fasciculus (MLF) is important in cases of vertigo, because this tract originates in the brain stem and is connected to both the oculomotor nuclei and the somatomotor cells in the ventral column. [M, N]

16) Thus, the MLF is especially important in the development of disequilibrium because of whiplash injury. [L]

17) The hypothalamus may also play an important role in producing vertigo due to whiplash injury since most patients with vertigo following whiplash injury have various autonomic symptoms, such as lacrimation, abnormal sweating and palpitation. [B, C, D]

18) The cerebellum is involved in the development of this type of vertigo, since it is closely connected to the proprioceptors of the cervical and lumbar regions as well as to the brain stem. [J]

19) There exists abnormal autonomic reactions in patients with whiplash injury due to increased firing of neck proprioceptors.

20) In patients with whiplash injury, delayed pupil constriction in response to light is probably because of increased firing of a sympathetic component in the hypothalamo-brain stem system brought about by afferent impulses from the injured neck and trunk proprioceptors. [A]

21) The spinoreticular tract is probably involved in the conduction of these impulses as this tract terminates in both the reticular formation of the brain stem and the periaqueductal gray matter of the midbrain. [5,6,7]

22) The periaqueductal gray matter of the midbrain is then connected to the hypothalamus. [R]

23) Over-stimulation of the hypothalamus suppresses the activity of the pupillo-constrictory center of the midbrain, leading to pupil dilatation. [A]

24) To summarize, a post-traumatic positive feedback loop is established:

"The over excitation of the arrival proprioceptors should be because of a hypersensitivity to sympathetic stimulation, inducing central disturbances by afferent nervous pathways at the level of brain stem, cerebellar and hypothalamus, affecting the oculomotor system and gait control."

1. The environmental stress of a MVA trauma emotionally fires the hypothalamus.

2. Hypothalamic firing causes sympathetically driven:

A. pupil dilation
B. lacrimation
C. abnormal sweating
D. palpitations
E. altered endocrine controls
F. [systemic vascular constriction]
G. [altered immune responses]
H. contraction of the intrafusal fibers to the muscle spindles

3. Contraction of the intrafusal fibers to the muscle spindles causes:

I. increases muscle spindle 1a firing

4. increases muscle spindle 1a firing:

J. fires to the cerebellum through the spinal cerebellar tracts
K. fires through the spinal ascending reticular tract to the brain stem (5, 6, 7)

5. to the vestibular nucleus:

L. causes disequilibrium
M. fires oculomotor nuclei
N. [fires spinal postural and segmental movers]

6. to the superior colliculus:

O. [affects visual integration]
P. affects visual-spinal coordination

7. to the periaqueductal grey of the midbrain:

Q. [affects pain inhibition]
R. fires the hypothalamus through the tegmento hypothalamic tract

COMMENTS FROM DAN MURPHY

This is a chapter from a 1996 book on whiplash. I have read most of the books written on whiplash, and most are organized in a similar manner, covering similar information and citing the same references. This book is a noted exception. It concentrates on the neurology of whiplash trauma, and consequently is very informative for the chiropractor.

The main topic of this chapter is the hypothalamus. This is very importing for chiropractors because the hypothalamus plays a key role in the descending inhibition of nociception, as well in visceral function, both of which are central to the practice of chiropractic.