

Spinal Kyphosis Causes Demyelination and Neuronal Loss in the Spinal Cord: A New Model of Kyphotic Deformity

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FROM ABSTRACT:

Study Design.

Histologic changes in the spinal cord caused by progressive spinal kyphosis were assessed using a new animal model.

Objectives.

To evaluate the effects of chronic compression associated with kyphotic deformity of the cervical spine on the spinal cord.

Summary of Background Data.

The spinal cord has remarkable ability to resist chronic compression, however, delayed paralysis is sometimes seen following the development of spinal kyphosis.

Results.

There was a significant correlation between the kyphotic angle and the degree of spinal cord flattening.

The spinal cord was compressed most intensely at the apex of the kyphosis, where demyelination of the anterior funiculus as well as neuronal loss and atrophy of the anterior horn were observed.

Demyelination progressed as the kyphotic deformity became more severe, initially affecting the anterior funiculus and later extending to the lateral and then the posterior funiculus.

Angiography revealed a decrease of the vascular distribution at the ventral side of the compressed spinal cord.

Conclusions.

Progressive kyphosis of the cervical spine resulted in demyelination of nerve fibers in the funiculi and neuronal loss in the anterior horn due to chronic compression of the spinal cord.

These histologic changes seem to be associated with both continuous mechanical compression and vascular changes in the spinal cord.

THESE AUTHORS ALSO NOTE:

“Delayed spinal cord paralysis due to spinal deformity, in particular, local kyphosis, is often observed clinically in patients with neurofibromatosis, spinal caries, congenital spinal kyphosis, and in those after radiotherapy, trauma, or osteoporotic fracture.”

The chickens (game fowl) used in this study were surgically given a kyphotic deformity of the cervical spine. The kyphotic angle was measured from a lateral cervical x-ray.

There was a strong correlation between kyphotic deformity and spinal cord flattening.

RESULTS

“At the apex of the kyphosis, the spinal cord was compressed severely, and spinal cord flattening was most evident,” yet none of the animals developed any apparent motor paralysis.

The animals with cervical kyphosis showed the following:

- 1) Spinal cord flattening.
- 2) Reduced number of neurons in lamina IX of the spinal cord.
[Recall: the spinal cord is arranged in layers, or lamina. Lamina IX is the most anterior lamina, closest to the vertebral body and intervertebral disc. Lamina IX contains the cell bodies for the alpha motor neurons, the motor nerves to the skeletal muscles].
- 3) The motor neurons arising from lamina IX showed severe atrophy.
- 4) There was severe demyelination in the anterior funiculus.
[Recall: the anterior funiculus is the white matter (axon) region of the spinal cord that contains the vestibular spinal tracts (descending medial longitudinal fasciculus), which control posture and muscle tone].
- 5) There was mild demyelination in the posterior funiculus.
[Recall: the posterior funiculus contains mechanical information to the brain stem, the dorsal columns, gracilis and cuneatus].

“Taking these results together, demyelination of the compressed white matter due to kyphotic deformity progressed in the order of anterior, lateral, and posterior funiculus; the posterior funiculus tended to be preserved even in the cases of severe compression.”

“The anterior funiculus in the [kyphotic] group, was the most extensively compressed, showed most marked histologic changes such as demyelination and irregularity of the spared myelin sheath.”

“It is known that the spinal cord vascular system of birds resembles that of humans.” **[Important]**

In the kyphotic group, “the small blood vessels in the compressed spinal cord showed a marked reduction in the network size, a decrease in number, interruption, and abnormal arrangement of the blood vessels. As the kyphotic angle increased, these changes became more marked, especially in the ventral side of the spinal cord that was directly exposed to mechanical compression.”

DISCUSSION

Birds are bipeds and try to maintain their head parallel to the ground, as do humans.

This is the first report on an animal model of spinal kyphotic deformity.

Spinal cord compression causes histologic changes in the spinal cord.

In this study, as the “kyphosis progressed, an increase in the degree of flattening of the spinal cord and histologic changes, including the loss of anterior horn cells and demyelination of the anterior funiculus, were observed.”

“As kyphosis progressed further, the demyelination of the axon spread to the lateral funiculus and then to the posterior funiculus. Marked histologic changes were seen on the ventral side of the spinal cord, probably because of continuous mechanical stress caused by the kyphotic deformity.”

Other studies have shown that kyphotic spinal cord flattening deforms the intramedullary blood vessels leading to ischemia.

In this study, angiography showed a reduction in the density of capillary networks and interruption of capillaries at the compressed spinal cord from kyphosis.

This study showed that the kyphotic changes in the capillary networks were most severe at the anterior spinal cord, and that the blood vessels abnormality worsened as the kyphosis progressed, which increased the histologic changes in the spinal cord, including demyelination and neuronal loss.

KEY POINTS FROM AUTHORS:

1) “As kyphosis progressed, the spinal cord flattening became more marked, causing histopathologic changes, including demyelination and neuronal loss.”

- 2) "Demyelination of the axons progressed in the order of the anterior, lateral, and then posterior funiculus."
- 3) Microangiography suggested that vascular disturbance and mechanical compression contribute to the development of spinal cord histologic changes.

KEY POINTS FROM DAN MURPHY:

- 1) This study was performed on birds, not humans. However, birds are bipeds and try to maintain their head parallel to the ground, as do humans.
- 2) The spinal cord vascular system of birds is very similar to that of humans.
- 3) This is the first report on an animal model of spinal kyphotic deformity.
- 4) Spinal cord compression causes histologic changes in the spinal cord.
- 5) Cervical kyphosis causes spinal cord compression and spinal cord flattening.
- 6) Spinal cord compression is greatest at the apex of the cervical kyphosis, causing demyelination of the anterior funiculus and neuronal loss and atrophy of the anterior horn spinal cord neurons.
- 7) Spinal cord demyelination progressed as the kyphotic deformity became more severe, initially affecting the anterior funiculus and later extending to the lateral and then the posterior funiculus.
- 8) The kyphotic spinal cord compression interferes with the blood flow to the anterior spinal cord.
- 9) The spinal cord histologic changes noted in this study are probably the results of both mechanical compression of the neurons as well as mechanical compression of the blood vessels creating vascular disturbances.

COMMENTS FROM DAN MURPHY:

Several chiropractic techniques, such as Spinal Stressology and Chiropractic Biophysics have stressed the adverseness of cervical kyphosis on spinal cord neurons and spinal cord blood supply. This influences systemic health and is related to demyelinating diseases such as multiple sclerosis. Chiropractic Biophysics has also stressed the importance of efforts to restore cervical lordosis. The patient video by chiropractor Tommy Dandrea [(732) 345-1377] on the treatment of multiple sclerosis patients with cervical curve restoration is remarkable. This article supports the work of these chiropractic techniques. This article also references the work of neurosurgeon Alf Breig, who wrote Adverse Tension of the Central Nervous System, 1978.