Cervical Spondylotic Myelopathy Associated with Kyphosis or Sagittal Sigmoid Alignment: Outcome after Anterior or Posterior Decompression

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FROM ABSTRACT:

Object. The effects of sagittal kyphotic deformities or mechanical stress on the development of cervical spondylotic myelopathy, or the reduction and fusion of kyphotic sagittal alignment have not been consistently documented. The aim in this study was to determine the effects of kyphotic sagittal alignment of the cervical spine in terms of neurological morbidity and outcome after 2 types of surgical intervention.

Methods. The authors retrospectively reviewed the records of 476 patients who underwent cervical spine surgeries for spondylotic myelopathy between 1993 and 2006 at their university medical center. Among these were identified 43 patients—30 men and 13 women, with a mean age of 58.8 years—who had cervical kyphosis exceeding 10° on preoperative sagittal lateral radiographs obtained in the neutral position, and their cases were analyzed in this study.

Conclusions. Kyphotic deformity and mechanical stress in the cervical spine may play an important role in neurological dysfunction.

In a select group of patients with kyphotic deformity ≥ 10°, adequate correction of local sagittal alignment may help to maximize the chance of neurological improvement.

THESE AUTHORS ALSO NOTE:

"The kyphotic deformity associated with cervical spondylosis is the result of progressive subluxation of the apophyseal joints due to degenerative changes in the facet joints and discs."

"In patients with kyphotic deformities, the spinal cord shifts to the anterior portion of the spinal canal and abuts the posterior aspect of the vertebral bodies at the apex of the deformity. With the progression of kyphosis, the mechanical stress applied to the anterior aspect of the spinal cord eventually increases."

"Dynamic forces caused by segmental instability, which is often seen at the level of kyphosis particularly in cervical flexion movement, contribute to compromised cord function."

This study was designed to investigate the effects of sagittal kyphotic deformities on the development of cervical spondylotic myelopathy.

Radiographs revealed 3 types of cervical spinal kyphotic deformities:

1) Kyphosis (a reversal of the entire cervical lordosis).

2) Sigmoid type (an "S" shape, with lordosis in the upper cervical spine and kyphosis in the lower cervical spine).

3) Reversed sigmoid type (kyphosis in the mid cervical spine, lordosis in the upper and lower cervical spine).

The kyphotic angle was assessed on the lateral cervical radiographs by measuring the angle between the 2 lines at the posterior body margin of the most cranial and caudal vertebral bodies forming maximal kyphosis through C2 to C7.

Segmental instability was determined when 2 of the following criteria were found in the evaluation of the flexion lateral cervical radiograph:

1) Segmental anterior vertebral translation ≥ 3 mm in the sagittal plane.

2) Segmental anterior rotation ≥ 10° in the sagittal plane; this angle is constructed by the intersection of the lines drawn on the inferior and superior aspect of adjacent vertebral bodies.

3) Reversed dynamic spinal canal stenosis of ≤ 12 mm on the flexion film; this is measured as the distance between the posterior superior edge of the vertebral body and the anterior edge of the lamina from the segment above, in the flexion position.

In this study, 60.5% of the patients had segmental instability. The most common segmental instability finding was reversed dynamic spinal canal stenosis at the adjacent level above the maximal local kyphosis, seen in 51% of the patients.

Importantly, 65.1% of the patients showed signs of spinal cord pathology at and around the level of the maximal kyphosis or segmental instability. This was best ascertained with the T2-weighted MRI image.

DISCUSSION

"Loss of lordosis or kyphotic alignment of the cervical spine and spinal cord may contribute to the development of myelopathy, and in patients with cervical kyphotic deformity, the spinal cord could be compressed by tethering over the apical vertebra or intervertebral disc or by ossification of the posterior longitudinal ligament."

Longitudinal spinal cord distraction is a possible factor in progressive spinal cord dysfunction, and this issue is "often discussed clinically in the pathophysiology of tethered spinal cord syndrome and tight dural tube mechanism."

These authors cite references and propose that cervical spine kyphosis distracts (tethers) the spinal cord, and the effects on the cord are maximal at the kyphotic apex, usually C4 and C5 levels. This causes disappearance of spinal cord evoked potentials in that area, causing injury to the anterior horn and the pyramidal tracts (both are muscle motor function).

A 1966 microvascular study demonstrated that cervical flexion produces flattening of the small feeding vessels to the spinal cord. "If the kyphotic deformity continues, there may be progression of myelomalacia and spinal cord atrophy. Patients with long-standing kyphotic deformities are at risk for progression of myelopathy with resultant permanent damage to the spinal cord." [Breig A, El-Nadi AF: Biomechanics of the cervical spinal cord: Relief of contact pressure on and overstretching of the spinal cord. Acta Radiol Diagn (Stockh) 4:602–624, 1966].

"Our results suggest that flexion mechanical stress caused by segmental instability could also contribute to the development of myelopathy and neurological dysfunction when the cervical spondylotic myelopathy associated with static compression has more than 10° kyphosis in the cervical spine."

CONCLUSIONS

"We conclude that the [cervical spine] sagittal kyphotic deformity related to flexion mechanical stress may be a significant factor in the development of cervical spondylotic myelopathy."

The cervical spine kyphosis and spinal cord flexion mechanism probably increases cord longitudinal stress and "seems to be closely associated with the resultant increase in the anterior compressive effect on the spinal cord."

These authors suggest that in patients with kyphotic deformity ≥ 10°, "a [surgical] reduction of local sagittal alignment may assist in maximizing the chances of recovering spinal cord function."

KEY POINTS FROM DAN MURPHY

1) This study looked at patients who had cervical kyphosis exceeding 10° on sagittal neutral lateral x-rays.

2) The kyphotic angle was assessed on the lateral cervical radiographs by measuring the angle between the 2 lines at the posterior body margin of the most cranial and caudal vertebral bodies forming maximal kyphosis from C2 to C7.

3) "The kyphotic deformity associated with cervical spondylosis is the result of progressive subluxation of the apophyseal joints due to degenerative changes in the facet joints and discs."

4) "In patients with kyphotic deformities, the spinal cord shifts to the anterior portion of the spinal canal and abuts the posterior aspect of the vertebral bodies at the apex of the deformity. With the progression of kyphosis, the mechanical stress applied to the anterior aspect of the spinal cord eventually increases."

5) "Dynamic forces caused by segmental instability, which is often seen at the level of kyphosis particularly in cervical flexion movement, contribute to compromised cord function."

6) There are 3 types of cervical spinal kyphotic deformities:
A)) Kyphosis (a reversal of the entire cervical lordosis).

B)) Sigmoid type (an "S" shape, with lordosis in the upper cervical spine and kyphosis in the lower cervical spine).

C)) Reversed sigmoid type (kyphosis in the mid cervical spine, lordosis in the upper and lower cervical spine).

7) These factors (2 of 3) are indicative of segmental instability, as determined by evaluation of the flexion lateral cervical radiograph:
A)) Segmental anterior vertebral translation ≥ 3 mm in the sagittal plane.

B)) Segmental anterior rotation ≥ 10° in the sagittal plane; this angle is constructed by the intersection of the lines drawn on the inferior and superior aspect of adjacent vertebral bodies.

C)) Reversed dynamic spinal canal stenosis of ≤ 12 mm on the flexion film; this is measured as the distance between the posterior superior edge of the vertebral body and the anterior edge of the lamina from the segment above, in the flexion position.

8) In this study, 60.5% of the patients had segmental instability. The most common segmental instability finding was reversed dynamic spinal canal stenosis at the adjacent level above the maximal local kyphosis, seen in 51% of the patients.

9) Importantly, 65.1% of the patients showed signs of spinal cord pathology at and around the level of the maximal kyphosis or segmental instability. This was best ascertained with the T2-weighted MRI image.

10) "Loss of lordosis or kyphotic alignment of the cervical spine and spinal cord may contribute to the development of myelopathy, and in patients with cervical kyphotic deformity, the spinal cord could be compressed by tethering over the apical vertebra or intervertebral disc or by ossification of the posterior longitudinal ligament."

11) Longitudinal spinal cord distraction is a possible factor in progressive spinal cord dysfunction, and this issue is "often discussed clinically in the pathophysiology of tethered spinal cord syndrome and tight dural tube mechanism."

12) Cervical spine kyphosis distracts (tethers) the spinal cord, and the effects on the cord are maximal at the kyphotic apex, usually C4 and C5 levels. This causes disappearance of spinal cord evoked potentials in that area, causing injury to the anterior horn and the pyramidal tracts (both are muscle motor function).

13) A 1966 microvascular study demonstrated that cervical flexion produces flattening of the small feeding vessels to the spinal cord. "If the kyphotic deformity continues, there may be progression of myelomalacia and spinal cord atrophy. Patients with long-standing kyphotic deformities are at risk for progression of myelopathy with resultant permanent damage to the spinal cord."

14) "Flexion mechanical stress caused by segmental instability could also contribute to the development of myelopathy and neurological dysfunction when the cervical spondylotic myelopathy associated with static compression has more than 10° kyphosis in the cervical spine."

15) "We conclude that the [cervical spine] sagittal kyphotic deformity related to flexion mechanical stress may be a significant factor in the development of cervical spondylotic myelopathy."

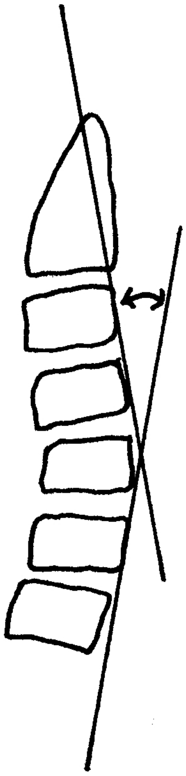
16) The cervical spine kyphosis and spinal cord flexion mechanism probably increases cord longitudinal stress and "seems to be closely associated with the resultant increase in the anterior compressive effect on the spinal cord."

17) These authors suggest that in patients with kyphotic deformity ≥ 10°, "a [surgical] reduction of local sagittal alignment may assist in maximizing the chances of recovering spinal cord function."

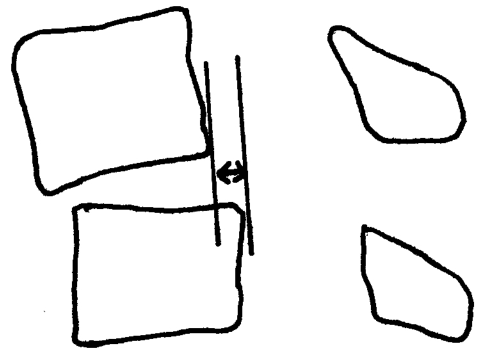
COMMENTS FROM DAN MURPHY

This is yet another article that emphasizes the adverseness of cervical spine kyphosis: accelerated spondylosis, spinal cord tethering and myelopathy. In addition, it adds the concomitant cervical spinal instability as contributing to the myelopathy, indicating that we should check for spinal instability in all patients with cervical kyphosis of greater than 10 degrees. The corrections of the kyphotic deformity in this study were once again surgical; there are several studies in the PubMed Database indicating that chiropractic can improve and even reverse cervical kyphosis. The procedures usually involve combinations of certain adjustments and extension traction. This study indicates that cervical spine kyphosis is often a serious clinical finding, especially if greater than 10 degrees of angulation.

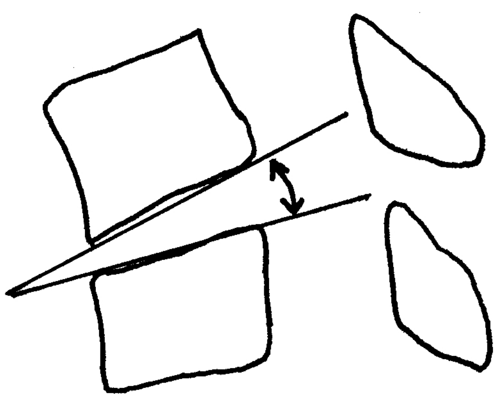
Cervical Kyphosis
> 10°



Anterior Vertebral Translation
≥ 3 mm



Anterior Rotation
≥ 10°



Reversed Dynamic Canal Stenosis
≤ 12 mm