Improving the maintenance of cervical kyphotic deformity correction

Chronic pain, numbness, weakness, tingling in the extremities, and restricted forward gaze are characteristic symptoms of mild to moderate cervical kyphotic deformity. In advanced cases, pain becomes debilitating and myelopathy from compression or stretching of the spinal cord can induce bowel and bladder dysfunction, gait instability, and weakness in the upper or lower extremities, or both. Swallowing and breathing difficulties can result from compression of the esophagus and trachea due to the deformity itself.

The two most common causes of kyphotic sagittal deformity are degenerative conditions, such as arthritis, and iatrogenic processes. For example, kyphosis can occur after initially successful fusion surgery because of stress above or below the fused area. Other causes include trauma, malignancy, infection, inflammatory diseases, and neuromuscular diseases and conditions.

The kyphosis resulting from some conditions is not as amenable to surgical correction as it is in others. Stephen Pirris, M.D., a neurosurgeon at Mayo Clinic in Florida, notes that, for example, patients with severely compromised bone strength due to osteoporosis or from immune-modulating drug therapy may not be good surgical candidates.

William E. Krauss, M.D., a neurosurgeon at Mayo Clinic in Minnesota, points out that surgical correction in appropriate candidates is more feasible now than it was 10 years ago because of improved instrumentation. Successful surgical correction depends on many factors, including:

- Overall health of the patient
- Cause of the kyphosis
- Surgical approach taken in reconstruction
- Accurate placement of posterior instrumentation

360° reconstruction

The surgical approach taken for correction of kyphotic cervical deformity can be unilateral (anterior or posterior) or circumferential (also known as a 360° approach).

As Naresh P. Patel, M.D., a neurosurgeon at Mayo Clinic in Arizona, explains, a circumferential approach allows surgeons to correct the deformity by decompressing and freeing the spinal cord and nerve roots and removing discs and bone from the front, replacing them with a bone graft. Then, from the back, the graft and other aspects of the correction are locked into place with rods and screws. Dr. Patel notes that reconstruction is more efficient from the front but that securing instrumentation from the back is optimal for maintaining certain types of correction.

Although a unilateral approach is a less extensive surgery and thus might have less perioperative risk, the 360° approach was found to be both safe and effective in a recent retrospective study led by Eric W. Nottmeier, M.D., a neurosurgeon at Mayo Clinic in Florida (Journal of Spinal Disorders & Techniques, 2009;22[6]). In their review of outcomes for 41 patients with a minimum follow-up period of 1 year, Dr. Nottmeier and his Mayo Clinic colleagues found that not only was there no loss of correction on follow-up, but also the fusion rate was 97.5%.

Not every kyphotic correction requires the 360° approach. In the Mayo practice, common indications for this approach include:

- Deformity secondary to postaminectomy instability
- Traumatic instability with marked ligamentous injury
- Multilevel corpectomy (removal of a vertebral body)
- Substantial risk of pseudoarthrosis

Another, less frequent indication is severe antecollis caused by dystonia. Mark A. Pichelmann, M.D., a neurosurgeon at Mayo Clinic in Minnesota, states that by using the circumferential approach, the surgeon can section dystonic muscles, as well as correct the deformity, from the front and that the optimal way to secure the instrumentation and bone graft in such severe cases is from the back.

Benefits of image guidance
Cervical kyphotic deformity correction may involve the upper thoracic spine, which is known to be a challenging area for screw placement. Visualizing the area with lateral fluoroscopy is difficult, and the pedicles in that region are small. The reported frequency of misplaced screws can be as high as 41%.

A 2009 Mayo Clinic study that used independent CT scan review of 34 patients who underwent cervicothoracic fusion found that with use of 3-D image guidance, 93% of the screws in the first three thoracic vertebrae were perfectly placed and that there was only a minimal breach of the bony pedicle in the remaining 7% (Bledsoe, et al., The Spine Journal, 2009;9[10]).

In image guidance, the surgeon’s instruments are equipped with light-emitting diodes that send signals to a camera connected to a computer. The computer then triangulates the location of the instrument on the patient’s anatomy and integrates it into the MRI image on a screen in the operating room. The integrated image may be 2-D or 3-D, depending on the type of image-guidance system used.

It can be challenging to use 3-D image guidance in the upper cervical spine at the C1 and C2 levels because of the physical difficulty of fixing the image-guided reference arc in a way that does not impede screw placement. To overcome this problem, Dr. Nottmeier and colleagues modified the technique by attaching the reference arc to the headholder.

A study of 18 patients who had screws placed with 3-D image-guidance modification at the occipital, C1, or C2 levels found that 81 of 82 screws were placed accurately (Operative Neurosurgery, 2010;66[1]). Dr. Pirris notes that image guidance not only facilitates accurate screw placement but also is helpful in detecting pathologic factors that may have gone unnoticed with standard imaging techniques.

Using 3-D image guidance modified when necessary and a 360° approach when indicated, Mayo Clinic surgeons are improving outcomes for the correction and maintenance of cervical kyphotic deformity reconstruction.