Mid-Cervical Spine Fusion

Anatomical Considerations: The cervical spine consists of several joints. It is an area where stability has been sacrificed for mobility, making the cervical spine particularly vulnerable to injury. The superior apophyseal (aka facet) joints of each segment face upward, backward, and medially. The inferior facets face downward, forward, and laterally. This facet orientation facilitates flexion and extension, but it prevents isolated rotation or side flexion. Thus, rotation and sidebending occur together (i.e., coupled) in the mid-cervical spine. These joints move primarily by gliding and are classified as synovial (diarthrodial) joints. The greatest flexion-extension of the facet joints occurs at C5 and C6; however, there is almost as much movement at C4-C5 and C6-C7. Because of this mobility, degeneration is most likely to be seen at these levels. The neutral or resting position of the cervical spine is slightly extended. The closed packed position of the facet joints is complete extension. The intervertebral discs make up approximately 25% of the height of the cervical spine.

Pathogenesis: The cervical spine can be structurally compromised by differing mechanisms, such as instability resulting from trauma or the degenerative processes associated with aging. The degenerative process involving the cervical spine is also known as cervical spondylosis. Disc degeneration and osteophyte formation are present on radiological studies in a majority of the population by the age of 55, yet many people never develop symptoms. Cervical disc degeneration occurs most commonly at the C5-C6 and the C6-C7 levels. The decreased water content of the disc may result in a narrowing of the disc space and loss of disc height, which increases the shearing motion at the affected disc space and further contributes to the degenerative process. Many people develop osteophytes along the spine as a result of the degenerative process. These osteophytes may compress or irritate the cervical nerve root at the affected level or levels. Fissures may develop in the annulus, which can allow portions of the nucleus to protrude through the annulus. Disc herniations may irritate or compress the spinal nerve roots exiting the spinal cord, causing pain or numbness along the distribution of the nerve. The degenerative process can also cause narrowing of the spinal canal (spinal stenosis), compression of the spinal cord, or compression of the vessels supplying the spinal cord, resulting in cervical myelopathy. Cervical myelopathy may produce numbness and weakness in the upper extremities (lower motor neuron signs) and can also cause long track (upper motor neuron) signs affecting lower extremity function. Infections or tumors of the vertebral column can greatly exaggerate the deleterious neurological changes and subsequent loss of function.

Epidemiology: Research into the epidemiology of cervical disc disease indicates that men are affected more often than women by a small margin. Most people with symptomatic herniated cervical discs are in their 40's and 50's. Cigarette smoking also is associated with increased incidence of cervical disc disease. The most common symptoms seen in patients for treatment of cervical degenerative disc disease are neck pain, occipital headaches, pain and numbness radiating to one or both shoulders, the scapular region, or arms and hands.
Many patients have radicular symptoms, which are pain, paresthesias, motor and sensory deficits due to disorders of the nerve roots, typically due to compression at the cervical lateral forminal canal. Radicular pain can be aggravated or relieved by the patient's neck and head position. Neck flexion can relieve symptoms in some patients, and lateral flexion or rotating the head

toward the affected arm may increase pain and numbness.

Diagnosis: A combination of plain radiographs and magnetic resonance imaging (MRI) with or without computed topography (CT) myelograms often is used in the diagnosis of patients presenting with symptoms of degenerative cervical disc disease. Plain x-ray films can be used to determine whether cervical entophytes are present and whether a loss of disc height is present in the cervical spine. The disc space and cervical nerve roots can be examined by MRI scan to identify disc herniation. Compression of the spinal cord or nerve roots can be identified with CT myelograms.

Non-operative versus Operative Management: Conservative treatment for patients with symptomatic degenerative disc disease includes rest, pain medication, non-steroidal anti-inflammatory medications, physical therapy including: intermittent cervical traction, positioning, ice/heat, ultrasound/phonophoresis, electrical stimulation, soft tissue mobilization, joint mobilization, nerve mobilization, exercises for flexibility, strength, coordination and overall fitness; posture and ergonomics. Many patients benefit from conservative treatment and experience a resolution of symptoms. Patients who continue to have pain, numbness, or weakness, despite conservative therapy for approximately 6 to12 months, may be candidates for surgical intervention. However, host factors that have a negative impact on obtaining a fusion play a role in determining whether a patient is a candidate for surgery. These factors include cigarette smoking (nicotine is a bone toxin), osteoporosis, chronic steroid use, and malnutrition.

Surgical Procedures:

Anterior Cervical Discectomy and Fusion (ACDF): The patient is placed supine on the table. Under general anesthesia, the neck is draped in sterile manner. The correct level is identified under x-ray control. A transverse incision of approximately 1.8 cm is made at the desired level. After the incision the sternocleidomastoid and the strap muscles are identified. The anterior surface of the cervical spine is exposed. The longus colli muscles are reflected laterally at the C4-5 level and the level is once again identified under x-ray control. A self-retaining Cloward retractor is placed and the disk space is identified.

Anterior Cervical Diskectomy: With the help of pituitary forceps and curettes, the disk is removed as posteriorly as possible. The posterior longitudinal ligament is visualized. Further disc is removed from the foramina on both sides. The foramen is probed with a nerve hook and further decompression is carried out with the help of Kerrison rongeur.

Anterior Cervical Fusion: The end plates are lightly burred with a high-speed burr to expose the bleeding subchondral bone. Sizing of the disc is performed. Appropriate allograft is taken and inserted in the disc space under tension. The graft fixation is checked for fit.

Cervical Plating: The appropriate sized cervical plate is selected. It is applied to the anterior surfaces of the involved vertebra. Position is identified under x-ray control. This is fixed to the vertebrae with the help of four 14mm screws. The fixation is checked. The wound is irrigated and deeper tissues are closed with sutures and then, the skin is closed with sutures. Marcaine is injected into the edges of the skin. A sterile dressing is applied and a cervical

collar is given. The patient is awakened and transferred to the recovery room.

Discectomy and Posterior Microendoscopic Fusion (Posterior Approach). This approach is commonly usually used with cervical spine fractures. The patient is placed in the semi-sitting position. A skin incision of 1.8 cm is made 1.5 cm laterally from the midline. Under radioscopy, the progressive dialators are inserted through the paravertebral muscles up to the cervical laminae. After the tubular retractor is inserted, the optic fiber and camera are adjusted. The remaining part of this procedure is very similar as the anterior approach. The semi-sitting position prevents the excess of venous epidural bleeding.

The ACDF procedure is associated with a low overall rate of complication. Retrospective studies of patients after ACDF indicate that 80-90% of patients have good to excellent outcomes, including relief of symptoms and successful fusion. However, there are many surgical complications. These include hoarseness of voice (usually temporary but can be permanent); temporary dysphasia; esophageal, tracheal, or vertebral artery injury; wound infection; injury to the spinal cord or nerve root; dura mater tears with associated cerebrospinal fluid leaks; pseudoarthrosis caused by nonunion of fusion; graft extrusion; and screw loosening.

Preoperative Rehabilitation: Preoperative treatment is to establish a conditioning program for surgery. Included in this program is keeping the affected joint from excessive mechanical forces and instructing the patient in proper postural body mechanics and exercise program. Medications such as non-steroidal anti-inflammatory drugs, acetaminophen, muscle relaxants, and possible narcotics are prescribed for pain control. Spinal injections can be used for both treatment and diagnostic purposes. Injections usually use a mixture of an anesthetic and some type of cortisone preparation. The anesthetic numbs the area of the injection site. If the injection takes away the pain immediately, suggests that the injection site is indeed the source of the pain. The cortisone decreases inflammation and can reduce the pain from an inflamed nerve or joint for a prolonged period of time. Types of injections include: epidural steroid in injection (ESI), selective nerve root injection, facet joint injections, and trigger point injections.

POSTOPERATIVE REHABILITATION

Note: The following rehabilitation progression is a combination of guidelines provided by Bhatnagar et al. Refer to this publication to obtain further details.

Phase I: 1-10 days post-op

Goals: Protect repair
Control pain
Independence in activities of daily living
Minimize deconditioning

Intervention:

- Patient may be instructed and fitted for home bone stimulation unit
- Instruct in proper positioning and controlled movement
- Other considerations:
  The wounds are usually sore for about 5 days. The hip will always hurt more than the cervical spine if this was the donor site.
  The patient is allowed to shower after about 2-3 days post-op. No bathing or swimming.
  It is common to have initial problems with swallowing.
  Complaints of a hoarse voice may be present - this should improve over the next 3 month.

Phase II: 2-12 weeks post-op.

Goals: Continue to protect fusion
Continue to control pain
Increase active and passive range of movement
Normalize movement patterns
Increase endurance, aerobic conditioning.

Intervention:

- Ergonomic instruction - The patient is advised to not lift more than 2 pounds and avoid sudden movements of the neck for the initial 6 weeks.
- Progressive ambulation for the first 6 weeks is the safest and easiest exercise to develop stamina. It is suggested that 2-4 shorter distance walks are more beneficial rather than once for long distance.
- After 6 weeks patient is advanced to other low-impact aerobic activities: Stairmaster, upper body ergo meter, stationary bicycle and swimming.
- Other Considerations: For the initial 6 weeks the patient is instructed to NOT vacuum, sweep, garden, make the bed, perform home repairs, or carry heavy items like children, wet laundry, or firewood. Some patients will be allowed to drive after about 6 weeks. Some patients might return to work after approximately 4-6 weeks depending on occupation, recovery and complications after surgery. All patients are instructed to refrain from heavy lifting (>22 pounds) for the first year.

Phase III: usually after 3 month.

- Progress therapeutic exercise programs to include passive extremity stretching strengthening with a full progressive resistive exercise program using isotonic, isometric, and isokinetic exercises.

- Other considerations: Minimal control is provided with soft collars but they provide warmth and proprioceptive feedback and are inexpensive and convenient.

Phase IV: Autonomous stage: (On-going)

Goals: Return to high level/high intensity activities for prolonged periods of time.

Intervention:

- Work hardening/conditioning
- Dynamic co-ordination and balance activities

  These post-surgical exercises are very similar activities used to prevent surgery and have been shown to be an effective treatment with long-term reductions in pain and functional disability in subjects diagnosed with cervical segment instability and chronic cervical pain. For operative or for non-operative patients the approach is the same, it is based on a motor learning model where faulty movement patterns are identified and components of movement are isolated so they can be retrained into functional tasks.

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