CHAPTER 12

Anterior Cervical Discectomy and Fusion

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Degenerative disc disease, lumbar or cervical, is common in the adult population and has a number of different presentations. Cervical degenerative discs may present as purely axial neck pain, as neck stiffness, or as headaches. In cases of disc herniation or osteophyte formation, radicular symptoms in the upper extremities (UEs) may be present. Progressive cervical degeneration may lead to the development of cervical spondylotic myelopathy (Figs. 12-1 and 12-2). Studies of the natural history of degenerative disc disease demonstrate that the majority of cases of neck pain and radiculopathy will resolve without surgical treatment. Myelopathy, however, tends to slowly progress.

SURGICAL INDICATIONS AND CONSIDERATIONS

Causes

Cervical disc degeneration is a progressive process similar to the degenerative cascade that occurs in other joints. Annular tears or incompetence and biochemical changes in the nucleus can lead to decreased water content in the disc, shrinking or herniation of nuclear tissue, and disc collapse. This places increased stress on the annulus and associated facet and uncovertebral joints, causing them in turn to degenerate, which can then lead to axial pain and stiffness. In addition, this can lead to the formation of bony spurs and disc herniations that may encroach on the neuroforamina, resulting in radiculopathy.[9] This entire process can be accelerated by an acute injury such as a cervical sprain in a motor vehicle accident.

The clinical presentation of cervical disc degeneration can vary and must be distinguished from other causes of neck pain, including muscular pain referred from the shoulders or viscera. Nonmechanical neck pain (i.e., pain at rest, without activity) is less likely to be related to disc disease, and other sources including tumor and infection must be considered. Mechanical neck pain caused by disc disease will often be exacerbated by neck extension and rotation to the affected side (affected side is loaded or squeezed). In contrast, muscular neck pain is often exacerbated by neck flexion and rotation away from the more painful side (muscle in affected side is stretched). In cases of lower cervical degenerative disease, the pain often radiates to the shoulder, upper arm, or infrascapular areas, and upper cervical disease may present as temporal pain and retro-orbital headaches. Associated radiculopathy presents as pain and paresthesias in a single or multiple nerve root distribution. *Spurling's sign* is a reproduction of radicular pain caused by extending the neck and rotating the head to the symptomatic side, which leads to further decreased caliber of the neuroforamina. Axial compression and the Valsalva maneuver may also reproduce symptoms. The *shoulder abduction sign* is the reduction of radicular symptoms by placing the hand of the affected arm on top of the head, which should decrease the stretch on the nerve roots.[10]

Other diagnostic tests, including imaging and electromyographic (EMG) or nerve conduction studies can be used to enhance the causative workup. Plain radiographs, including anteroposterior, lateral, oblique, and lateral flexion and extension views, can demonstrate developmental stenosis, disc space narrowing, loss of normal alignment, dynamic instability, and osteophyte formation. Findings on radiographs may be the cause of the clinical

Fig. 12-1 Preoperative lateral radiograph demonstrating a small bony spur formation and disc height loss at C6-7.

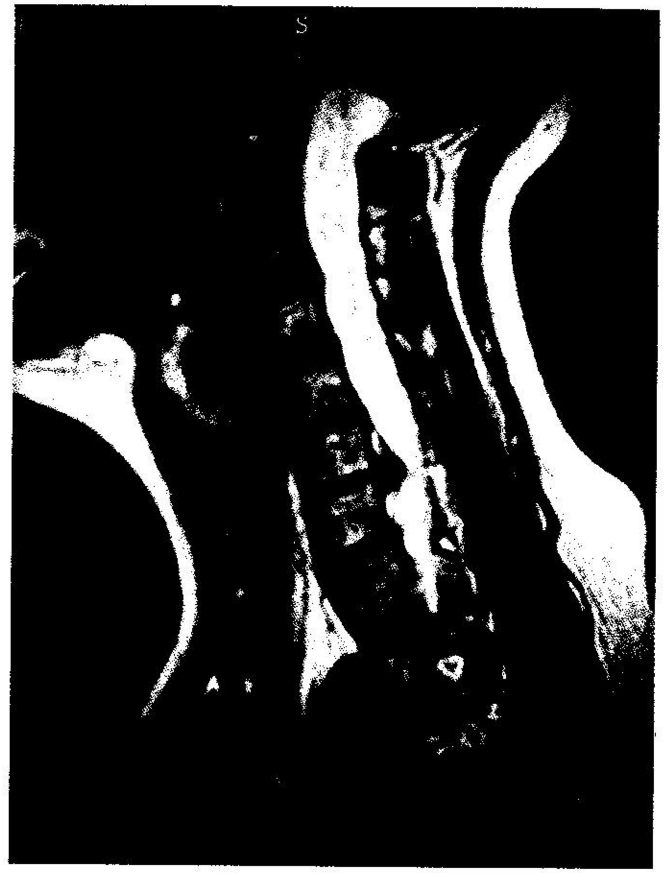

Fig. 12-2 Preoperative sagittal magnetic resonance image (MRI) showing C6-7 disc degeneration and a large herniation.

picture or may also be representative of normal age-related degenerative changes. When surgical intervention is being considered, magnetic resonance imaging (MRI) is usually obtained. MRI is the most sensitive modality for demonstrating spinal cord morphology in relation to the surrounding bony and soft tissue structures (Fig. 12-3). Cervical myelogram followed by computed tomography (CT) is a superior study for demonstrating foraminal stenosis and cortical bony margins, but it is invasive and does have a small risk of complications.[43] EMG and nerve conduction studies can help distinguish between nerve root compression and a peripheral neuropathy, and they are useful in patients with an unclear diagnosis. In cases of mechanical neck pain without radiculopathy, several studies support the use of provocative discography to confirm a discogenic origin of the pain and to clarify which disc levels are appropriate to treat.[20,48]

The majority of patients with axial neck pain can be expected to experience acceptable resolution of symptoms without surgical intervention. Cervical radiculopathy also tends to resolve, but many patients progress to experience recurrent or persistent symptoms.[35] Nonoperative treatment recommendations vary, however, and few good studies demonstrate the superiority of one modality over another. Activity modification and a brief period of soft collar use are often recommended, but prolonged inactivity may lead to deconditioning. Medical treatment usually begins with nonsteroidal anti-inflammatory drugs (NSAIDs) or acetaminophen. In cases of severe acute pain, narcotic analgesics may be used. Paraspinal muscle spasm may be relieved with muscle relaxants but is often improved with a soft collar alone. Occasionally a brief course of oral corticosteroids is tried.[15] All medications should be prescribed only with careful regard for the potential adverse reactions and interactions with other medications that the patient is taking. Physical therapy is a part of many practitioners' treatment programs and may include modalities such as traction and heat and cold therapy, as well as an isometric neck and shoulder stabilizing exercise program. The specifics of a physical therapy program are often left up to the discretion of the particular therapist.

Surgical intervention for patients with cervical radiculopathy is indicated when the symptoms are persistent or recurrent (despite appropriate conservative care), or they are severe or debilitating enough to merit surgery.[50] A more prolonged conservative course is recommended for treatment of axial neck pain alone. If surgery is being considered for axial neck pain and a workup has failed to

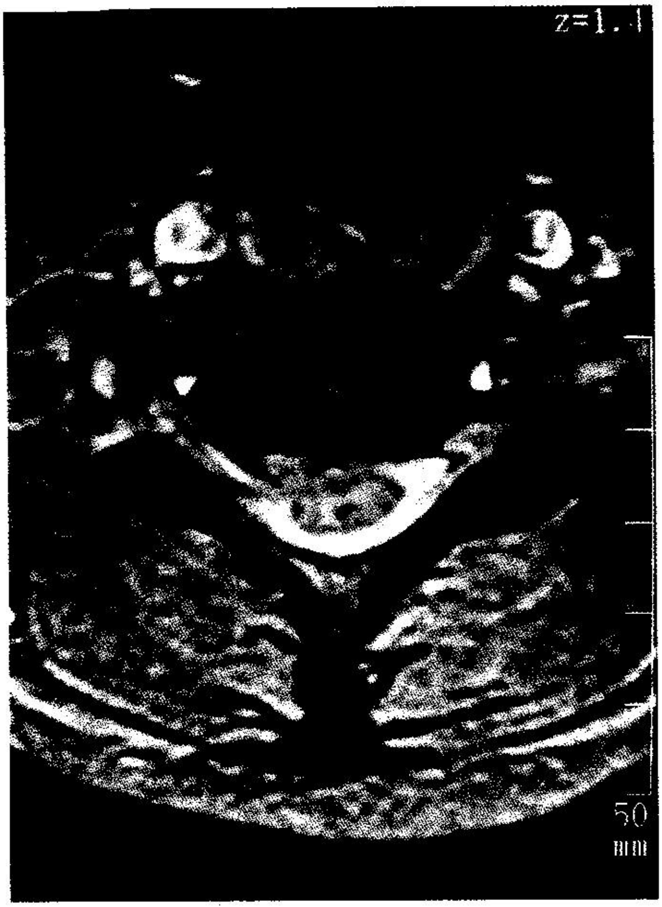

Fig. 12-3 Preoperative axial magnetic resonance image (MRI) showing large right-sided disc herniation at C6-7.

identify the specific level responsible for the pain, then a discogram is obtained to avoid fusing asymptomatic levels. As with any elective surgical procedure, appropriate patient expectations and selection should be considered before any surgical intervention is undertaken (Box 12-1). In general workers' compensation patients and those involved in litigation can be expected to have worse outcomes even after successful fusion surgery.[11,17]

Box 12-1 Indications for Anterior Cervical Discectomy and Fusion (ACDF) in Cervical Disc Disease

Strong indications:

1. Progressive cervical myelopathy
   Relative indications:
   a. Radiculopathy that has failed to respond to conservative treatment regimen of at least 6 weeks
   b. Recurrent radiculopathy
   c. Progressive neurologic deficit
   d. Severe, incapacitating axial neck pain that fails to respond to prolonged course of conservative treatment with consistent exam and diagnostic studies

SURGICAL PROCEDURE

Single-level cervical disc disease is most commonly treated with anterior cervical discectomy and fusion (ACDF). For one or more adjacent levels, some surgeons choose to perform a corpectomy of the intervening vertebral bodies instead of multilevel ACDF. After the disc is removed, graft choices include harvested iliac crest bone graft or allograft, usually a fibular ring or strut. Currently, most surgeons use an anterior cervical plate fixed to the adjacent vertebral bodies to prevent graft displacement anteriorly and to provide stability while the fusion matures. In cases of severe stenosis or instability, intraoperative neuromonitoring is often used in an attempt to prevent injury and assess adequacy of decompression.

Surgery begins with the induction of general endotracheal anesthesia. The patient is then placed in the supine position on a radiolucent operative table to allow imaging in both the anterior-posterior and lateral planes. A soft bump is placed transversly beneath the scapula, and a cervical traction collar is placed beneath the patient's chin and occiput; gentle traction is then applied. In addition, gentle skin traction is applied with wide tape on the shoulders pulling toward the foot of the bed. The anterior neck is then prepped and draped, with care taken not to restrict the surgical field. Palpating the bony landmarks (or alternatively by using a radio-opaque skin marker and a lateral radiograph) determines the level of the skin incision. A transverse incision is then made through the skin and subcutaneous fat, and bleeding is controlled using electrocautery. The platysma muscle is carefully cut in line with the incision to avoid cutting the large superficial veins just beneath it. Beneath the platysma muscle, the deep cervical fascia is identified and divided laterally to the anterior boarder of the sternocleidomastoid muscle where it is dissected inferiorly and superiorly off of the muscle belly. A finger is then used for blunt dissection between the carotid sheath laterally and the trachea and esophagus medially down to the prevertebral fascia. A hand-held Cloward retractor is then used to retract the midline structures, allowing direct visualization of prevertebral fascia and underlying longus colli muscles and disc spaces. When a disc space is identified, a short needle is inserted into the disc space and a radiograph is obtained to confirm that the appropriate level has been approached.

When the appropriate level is confirmed, the longus colli muscles are dissected off of bone laterally and a self-retaining retractor is placed, exposing the disc space to the uncovertebral joints. The operating microscope, sterilely draped, is then brought into the field (Fig. 12-4). Under direct visualization using the microscope, the disc is incised with a scalpel and the anterior portion is removed using a pituitary forceps and an angled curette. A high-speed drill may be used to complete the discectomy and expose the posterior longitudinal ligament (PLL).

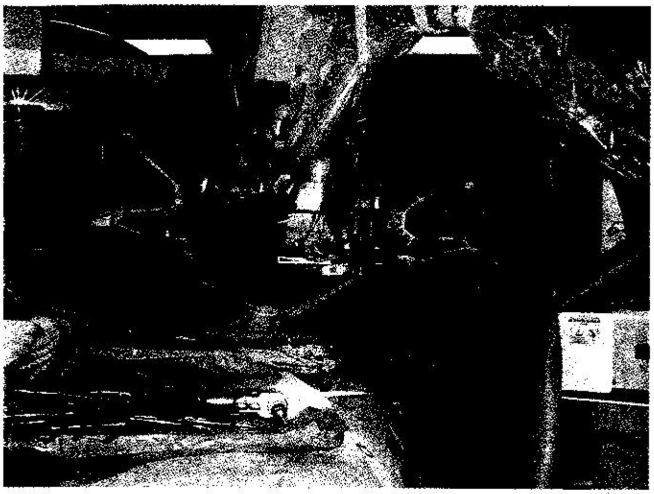

Fig. 12-4 Intraoperative photo showing primary surgeon and assistant using the microscope during discectomy.

Fig. 12-5 Postoperative lateral radiograph showing solid fusion of C6 and C7 with anterior cervical plate and screws.

After exposure the PLL is elevated off of the posterior aspect of the vertebral bodies using a small 4-0 forward-angled curette; it is then excised using 1 mm and 2 mm Kerrison rongeurs. The PLL does not need to be routinely removed if no nuclear protrusion or extrusion is found, but this has to be carefully explored. The posterior aspect of the uncinate process is then excised using the 3-0 curette, followed by the 1 and 2 mm Kerrison rongeurs. The foramina can be probed with the 90-degree angled nerve hook to confirm adequate decompression or any remaining loose disc fragments.

When the discectomy and foraminotomies are complete, the disc space is measured and an appropriately sized graft is chosen. While increased traction is applied on the halter traction device, the graft is gently impacted into position. When it is adequately positioned, all traction is removed. An appropriate-sized plate is then chosen and applied on the anterior aspect of the cervical spine. Care is taken when drilling screw holes to choose a length that will be contained in the vertebral body and to parallel the endplate of the disc space. When the plate is in position, a lateral radiograph is obtained and graft and hardware positioning is checked (Figs. 12-5 and 12-6).

After instrumentation is complete, the wound is copiously irrigated and thoroughly checked for hemostasis. Often a drain is used even if the wound appears very dry, because a postoperative hematoma may cause significant morbidity. The platysma muscle and subcutaneous tissue are then closed with interrupted absorbable sutures. A running subcuticular layer of suture may follow this closure, or Steri-Strips alone may be applied followed by a sterile dressing. The patient is then placed into a rigid cervical orthosis such as an Aspen collar before moving or extubation.

In the immediate postoperative period the head of the patient's bed is maintained in an elevated position to decrease swelling in the neck. The patient should be able to walk, void, swallow liquids, and tolerate a diet before discharge. Most patients are discharged the day after surgery. Patients commonly complain of sore throat and pain with swallowing in the first few days after surgery. If these complaints seem more severe than usual, then a single dose or short course of oral corticosteroids may be given in an attempt to minimize swelling.

Outcomes

Patients with radicular symptoms will often note immediate relief of symptoms after surgery. Most patients report a change in the quality of their axial neck pain to one more typical of postoperative pain. Generally patients treated for radicular symptoms achieve greater than 90% satisfactory results, whereas those treated for axial neck pain generally achieve about 80% satisfactory results.

One concern in the postoperative period is overactivity before fusion is achieved. Solid consolidation of fusion often requires 6 to 12 weeks, so excessive motion and loading are discouraged during this period. Often patients are maintained in a cervical collar for 6 to 12 weeks to restrict their activities, but patients frequently recover from their surgery much sooner and desire to remove

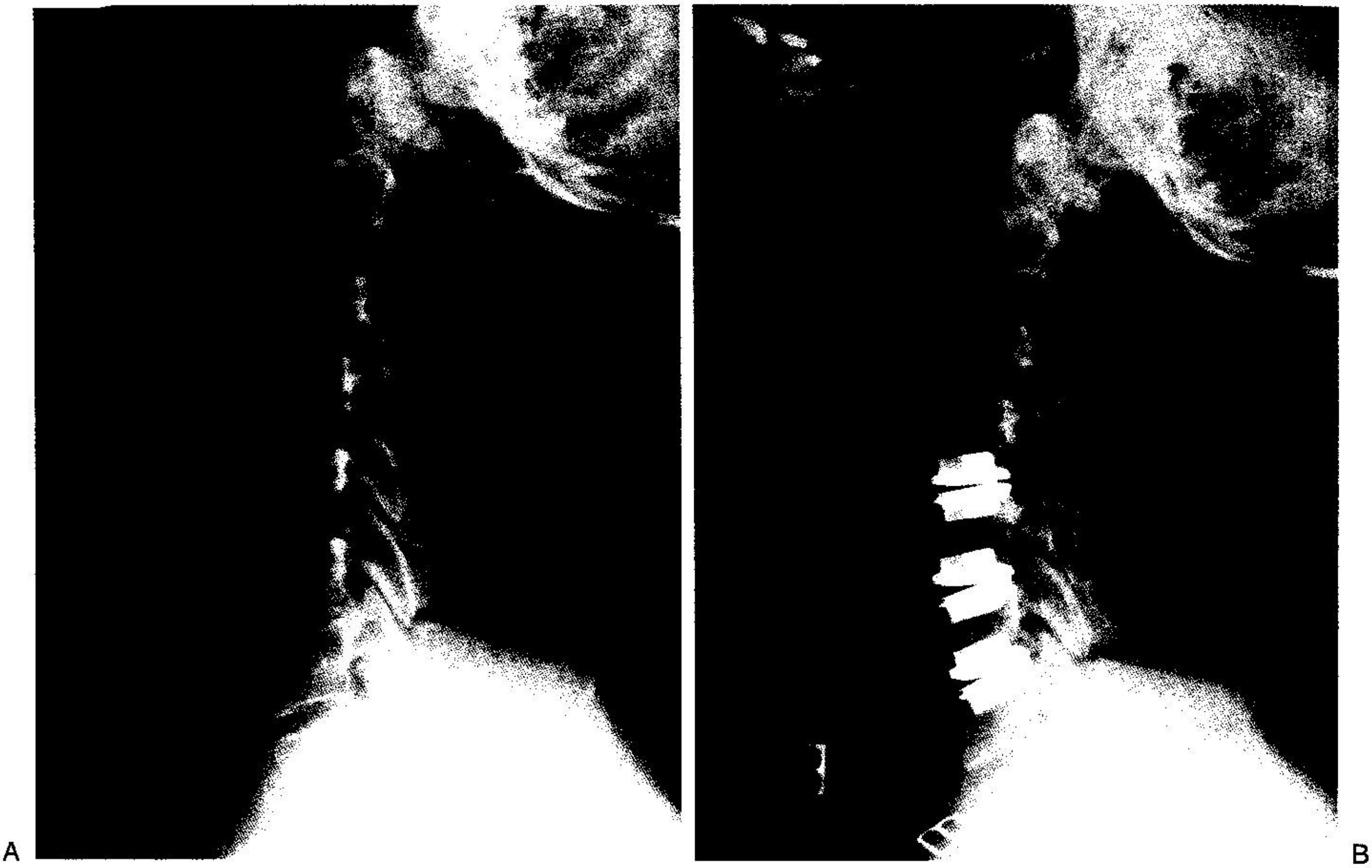

Fig. 12-6 A, Preoperative lateral radiograph showing multilevel cervical disc degeneration. B, Postoperative lateral radiograph of the same patient after three-level cervical disc replacement.

the orthosis and resume activities. Months of relative immobilization can result in significant deconditioning, which can be a challenge to the therapist. In the early period of return to activity and therapy, it is important to avoid injury caused by overly strenuous exercises or an overzealous patient.

Future Directions

Spinal fusion in general has had less satisfying results than some other commonly performed orthopaedic surgeries, leading medical researchers to search for alternative treatments. Recently the first lumbar disc replacement prosthesis gained Food and Drug Administration (FDA) approval in the United States (Charite lumbar artificial disc) with another pending (ProDisc-L lumbar artificial disc), and cervical disc replacements (e.g., ProDisc-C, Bryan, Prestige artificial cervical discs) have also completed clinical trials.[12-14,23,24] Further research is underway in the field of biologic disc replacement or rejuvenation. These treatments have the potential of offering shorter recovery times and more rapid return to activity and may help prevent the progression of spondylosis at adjacent levels.

THERAPY GUIDELINES FOR REHABILITATION

Rehabilitation after a surgery is a *science* and an *art*. The science of rehabilitation relies on a firm understanding of the body's normal response to injury and trauma. The art of rehabilitation rests in the clinician's ability to interpret the individual patient's unique signs and symptoms. The ability to formulate a plan of care that maximizes an individual's healing potential relies on the ability to blend the science and the art of rehabilitation. The initial portion of this chapter is designed to provide the clinician with an understanding of the role that tissue healing plays in the development of a rehabilitation program. This will serve as a scientific foundation upon which a clinician can base his or her clinical reasoning process. This tissue-healing model will then be placed in the context of ACDF. The activities and precautions of each phase of the rehabilitation process will be rooted in current understanding of the phases of tissue healing. Specific treatment options are provided throughout the chapter, but these should only serve as a guide to treatment and should not replace sound clinical reasoning or judgment when rehabilitating after ACDF.