

## CLINICAL PRACTICE

## Cervical Radiculopathy

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*This Journal feature begins with a case vignette highlighting a common clinical problem. Evidence supporting various strategies is then presented, followed by a review of formal guidelines, when they exist. The article ends with the authors' clinical recommendations.*

**A 37-year-old woman presents with a two-week history of severe neck pain radiating to her left shoulder girdle and extending to the arm, forearm, and dorsum of the hand. She reports having had no fever, weight loss, leg weakness, or urinary or bowel dysfunction. Physical examination reveals weakness of her left triceps, finger extensors, and wrist flexors, as well as hypoesthesia of the third digit and a diminished triceps reflex. How should her case be managed?**

## THE CLINICAL PROBLEM

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Cervical radiculopathy is a neurologic condition characterized by dysfunction of a cervical spinal nerve, the roots of the nerve, or both. It usually presents with pain in the neck and one arm, with a combination of sensory loss, loss of motor function, or reflex changes in the affected nerve-root distribution.<sup>1</sup>

## EPIDEMIOLOGY

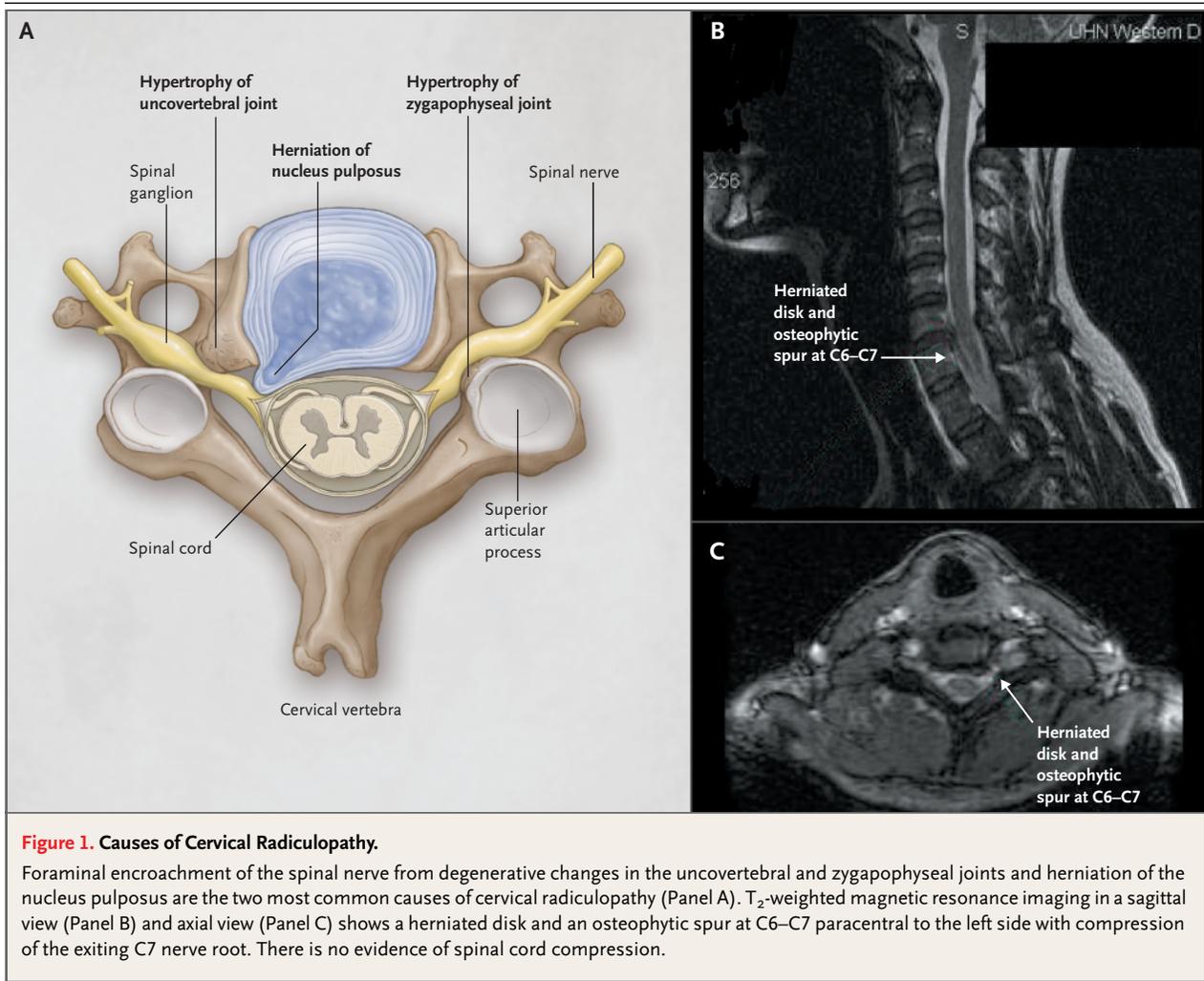
Population-based data from Rochester, Minnesota, indicate that cervical radiculopathy has an annual incidence rate of 107.3 per 100,000 for men and 63.5 per 100,000 for women, with a peak at 50 to 54 years of age.<sup>2</sup> A history of physical exertion or trauma preceded the onset of symptoms in only 15 percent of cases. A study from Sicily reported a prevalence of 3.5 cases per 1000 population.<sup>3</sup>

Data on the natural history of cervical radiculopathy are limited.<sup>2,4-6</sup> In the population-based study from Rochester, Minnesota, 26 percent of 561 patients with cervical radiculopathy underwent surgery within three months of the diagnosis (typically for the combination of radicular pain, sensory loss, and muscle weakness), whereas the remainder were treated medically.<sup>2</sup> Recurrence, defined as the reappearance of symptoms of radiculopathy after a symptom-free interval of at least 6 months, occurred in 32 percent of patients during a median follow-up of 4.9 years. At the last follow-up, 90 percent of the patients had normal findings or were only mildly incapacitated owing to cervical radiculopathy.

## CAUSES AND PATHOPHYSIOLOGICAL FEATURES

The most common cause of cervical radiculopathy (in 70 to 75 percent of cases) is foraminal encroachment of the spinal nerve due to a combination of factors, including decreased disc height and degenerative changes of the uncovertebral joints anteriorly and zygapophyseal joints posteriorly (i.e., cervical spondylosis) (Fig. 1). In contrast to disorders of the lumbar spine, herniation of the nucleus pulposus is responsible for only 20 to 25 percent of cases.<sup>2</sup> Other causes, including tumors of the spine and spinal infections, are infrequent.<sup>7</sup>

The mechanisms underlying radicular pain are poorly understood. Nerve-root compression by itself does not always lead to pain unless the dorsal-root ganglion is



**Figure 1. Causes of Cervical Radiculopathy.**

Foraminal encroachment of the spinal nerve from degenerative changes in the uncovertebral and zygapophyseal joints and herniation of the nucleus pulposus are the two most common causes of cervical radiculopathy (Panel A). T<sub>2</sub>-weighted magnetic resonance imaging in a sagittal view (Panel B) and axial view (Panel C) shows a herniated disk and an osteophytic spur at C6–C7 paracentral to the left side with compression of the exiting C7 nerve root. There is no evidence of spinal cord compression.

also compressed.<sup>8,9</sup> Hypoxia of the nerve root and dorsal ganglion can aggravate the effect of compression.<sup>10</sup> Evidence from the past decade indicates that inflammatory mediators — including matrix metalloproteinases, prostaglandin E<sub>2</sub>, interleukin-6, and nitric oxide — are released by herniated cervical intervertebral disks.<sup>11–13</sup> These observations provide a rationale for treatment with antiinflammatory agents.<sup>14</sup> In patients with disk herniation, the resolution of symptoms with non-surgical management correlates with attenuation of the herniation on imaging studies.<sup>15–18</sup>

#### STRATEGIES AND EVIDENCE

##### CLINICAL DIAGNOSIS

There are no universally accepted criteria for the diagnosis of cervical radiculopathy.<sup>19</sup> In most cases, the patient's history and physical examination

are sufficient to make the diagnosis.<sup>20</sup> Typically, patients present with severe neck and arm pain. Although the sensory symptoms (including burning, tingling, or both) typically follow a dermatomal distribution, the pain is more commonly referred in a myotomal pattern.<sup>2,21</sup> For example, radicular pain from C7 is usually perceived deeply through the shoulder girdle with extension to the arm and forearm, whereas numbness and paresthesias are more commonly restricted to the central portion of the hand, the third digit, and occasionally the forearm. Subjective weakness of the arm or hand is reported less frequently. Holding the affected arm on top of the head<sup>22</sup> or moving the head to look down and away from the symptomatic side often improves the pain, whereas rotation of the head or bending it toward the symptomatic side increases the pain.<sup>23</sup>

Guidelines developed by the Agency for Health Care Policy and Research for the assessment of

low back pain may be applied to the patient with neck pain and radiculopathy.<sup>24</sup> The presence of “red flags” in the patient’s history (including fever, chills, unexplained weight loss, unremitting night pain, previous cancer, immunosuppression, or intravenous drug use) should alert clinicians to the possibility of more serious disease, such as tumor or infection. Clinicians should also inquire about symptoms of myelopathy. These may occasionally be subtle (e.g., diffuse hand numbness and clumsiness, which are often attributed to peripheral neuropathy or carpal tunnel syndrome; difficulty with balance; and sphincter disturbances presenting initially as urinary urgency or frequency rather than as retention or incontinence).

Findings on physical examination vary depending on the level of radiculopathy and on whether there is myelopathy (Tables 1 and 2). In most series, the nerve root that is most frequently affected is the C7, followed by the C6.<sup>2</sup> Many provocative tests have been proposed for the diagnosis of cervical radiculopathy, but the reliability and diagnostic accuracy of these tests are poor.<sup>19,25</sup>

Several conditions can mimic cervical radiculopathy and should be ruled out by history taking and physical examination, occasionally supplemented by imaging, electrophysiological studies, or both<sup>26</sup> (Table 3).

**LABORATORY STUDIES**

Laboratory studies are of limited value and are not recommended. The erythrocyte sedimentation rate and C-reactive protein levels are elevated in many

patients with spinal infection or cancer, but these tests are not sufficiently sensitive or specific to guide further evaluation.

**IMAGING**

Conventional radiographs of the cervical spine are often obtained, but their usefulness is limited.<sup>31</sup> This is due to the low sensitivity of radiography for the detection of tumors or infections, as well as its inability to detect disk herniation and the limited value of the finding of cervical intervertebral narrowing in predicting nerve-root or cord compression.<sup>32</sup>

Magnetic resonance imaging (MRI) is the approach of choice when imaging is pursued in patients with cervical radiculopathy (Fig. 1),<sup>33</sup> but there are currently no clear guidelines regarding when such imaging is warranted. Reasonable indications include the presence of symptoms or signs of myelopathy, red flags suggestive of tumor or infection, or the presence of progressive neurologic deficits. For most other patients, it is appropriate to limit the use of MRI to those who remain symptomatic after four to six weeks of nonsurgical treatment, particularly given the high frequency of abnormalities detected in asymptomatic adults, including disk herniation or bulging (57 percent of cases), spinal cord impingement (26 percent), and cord compression (7 percent).<sup>34</sup>

Computed tomography (CT) alone is of limited value in assessing cervical radiculopathy,<sup>35</sup> but it can be useful in distinguishing the extent of bony spurs, foraminal encroachment, or the presence of

**Table 1. Physical Findings Associated with Cervical Radiculopathy.\***

Disk Level	Root	Pain Distribution	Weakness	Sensory Loss	Reflex Loss
C4–C5	C5	Medial scapular border, lateral upper arm to elbow	Deltoid, supraspinatus, infraspinatus	Lateral upper arm	Supinator reflex
C5–C6	C6	Lateral forearm, thumb and index finger	Biceps, brachioradialis, wrist extensors	Thumb and index finger	Biceps reflex
C6–C7	C7	Medial scapula, posterior arm, dorsum of forearm, third finger	Triceps, wrist flexors, finger extensors	Posterior forearm, third finger	Triceps reflex
C7–T1	C8	Shoulder, ulnar side of forearm, fifth finger	Thumb flexors, abductors, intrinsic hand muscles	Fifth finger	—

\* Provocative tests include the foraminal compression test (Spurling maneuver), in which the neck is passively bent toward the symptomatic side and the examiner applies pressure (approximately 7 kg) to the patient’s head (a positive test reproduces symptoms); the shoulder abduction test, in which the patient is asked to place the hand of the symptomatic arm on the head (a positive test reduces or eliminates symptoms); and the neck distraction test, in which the patient is supine and the examiner, holding the chin and occiput, applies a gradual pulling force (a positive test reduces or eliminates symptoms).<sup>25</sup>

ossification of the posterior longitudinal ligament. The combination of CT with the intrathecal administration of contrast material (CT myelography) provides accuracy similar to<sup>36</sup> and possibly superior to<sup>37</sup> that of MRI, but its invasive nature makes MRI preferable in most cases. Technetium and gallium bone scans are very seldom indicated, except in rare cases in which cancer or infection is suspected in multiple sites and MRI cannot be readily performed or is impractical.

#### ELECTRODIAGNOSTIC STUDIES

Needle electromyography and nerve-conduction studies can be helpful when the patient's history and physical examination are inadequate to distinguish cervical radiculopathy from other neurologic causes of neck and arm pain. Typically, abnormal insertional activity, including positive sharp-wave potentials and fibrillation potentials, is present in the limb muscles of the involved myotome within three weeks of the onset of nerve compression.<sup>38</sup> Examination of the paraspinal muscles increases the sensitivity of the test, since insertional activity can be seen as early as 10 days after the nerve injury. In addition, the presence of abnormal findings in paraspinal muscles differentiates cervical radiculopathy from brachial plexopathy.

#### TREATMENT

##### *Nonsurgical Management*

The main objectives of treatment are to relieve pain, improve neurologic function, and prevent recurrences.<sup>39</sup> None of the commonly recommended nonsurgical therapies for cervical radiculopathy has been tested in randomized, placebo-controlled trials. Thus, recommendations derive largely from case series and anecdotal experience. The preferences of patients should be taken into account in decision making.

On the basis of anecdotal experience, analgesic agents, including opioids and nonsteroidal antiinflammatory drugs, are often used as first-line therapy. In patients with acute pain, some physicians advocate a short course of prednisone (for example, starting at a dose of 70 mg per day and decreasing by 10 mg every day).<sup>39</sup> This practice is supported only by anecdotal evidence, however, and is associated with potential risks.

Retrospective<sup>40,41</sup> and prospective<sup>42,43</sup> cohort studies have reported favorable results with trans-laminar and transforaminal epidural injections of corticosteroids, with up to 60 percent of patients

**Table 2. Physical Findings Associated with Myelopathy.**

Findings	Hyperreflexia; hypertonia; clonus of the ankle, knee, or wrist; pathological reflexes or signs, such as the Babinski sign, Hoffmann's sign (flexion and adduction of the thumb when the examiner flexes the terminal phalanx of the long finger), and Lhermitte's sign (a sensation of electrical shock radiating down the spine, precipitated by neck flexion)
Clinical grading*	
Mild	Sensory symptoms; subjective weakness; hyperreflexia (with or without Hoffmann's sign or the Babinski sign); no functional impairment
Moderate	Objective motor or sensory signs (a score of >4 out of 5 on the Medical Research Council scale); either no or mild functional impairment (e.g., mild slowing of gait)
Severe	Objective motor or sensory signs with functional impairment (e.g., hand weakness, unsteady gait, sphincter disturbance)

\* Clinical grading is performed on the basis of the extent of symptoms, signs, and functional impairment.

reporting long-term relief of radicular and neck pain and a return to usual activities. However, complications from these injections, although rare, can be serious and include severe neurologic sequelae from spinal cord or brainstem infarction.<sup>44</sup> Given the potential for harm, placebo-controlled trials are urgently needed to assess both the safety and the efficacy of cervical epidural injections.

Some investigators have advocated the use of short-term immobilization (less than two weeks) with either a hard or a soft collar (either continuously or only at night) to aid in pain control.<sup>45</sup> Use of a cervical pillow during sleep has also been recommended. However, data are needed to assess the benefits of these approaches.

Cervical traction consists of administering a distracting force to the neck in order to separate the cervical segments and relieve compression of nerve roots by intervertebral disks. Various techniques (supine vs. sitting; intermittent vs. sustained; motorized or hydraulic vs. an over-the-door pulley with weights) and durations (minutes vs. up to an hour) have been recommended.<sup>46,47</sup> However, a systematic review stated that no conclusions could be drawn about the efficacy of cervical traction because of the poor methodologic quality of the available data.<sup>48</sup> Exercise therapy — including active range-of-motion exercises and aerobic conditioning (walking or use of a stationary bicycle), followed by isometric and progressive-resistive exercises — is typically recommended once pain has subsided

**Table 3. Conditions with Physical Findings Mimicking Those of Cervical Radiculopathy.**

Condition	Findings
Peripheral entrapment neuropathies (e.g., carpal tunnel syndrome)	Hypoesthesia and weakness in the distribution of the entrapped nerve (e.g., in carpal tunnel syndrome, medial three digits and opponens pollicis; in ulnar entrapment, fourth and fifth digits and thumb adductor); Tinel's sign and positive Phalen's maneuver often present in carpal tunnel syndrome; normal reflexes; nerve-conduction studies abnormal in carpal tunnel syndrome but normal in cervical radiculopathy
Disorders of the rotator cuff and shoulder	Pain in the shoulder or lateral arm region that only rarely radiates below the elbow and is aggravated by active and resisted shoulder movements, rather than by neck movements; normal sensory examination and reflexes
Acute brachial-plexus neuritis (neuralgic amyotrophy or Parsonage-Turner syndrome)	Typically causes severe pain in neck, shoulder, and arm, which is followed within days to a few weeks by marked arm weakness, typically in the C5-C6 region, as the pain recedes <sup>27,28</sup> (unlike in cervical radiculopathy, in which pain and neurologic findings occur simultaneously)
Thoracic outlet syndrome	Pain in shoulder and arm aggravated by use of the arm; intermittent paresthesia, most commonly in the C8-T1 region (rare in cervical radiculopathy); reproduction of symptoms by provocation tests, including Roo's test (the rapid flexion and extension of fingers while the arms are abducted at 90° and externally rotated 90°); neurologic examination usually normal; decreased radial pulse if associated with vascular compression (rare); nerve-conduction studies usually normal
Herpes zoster	Neuropathic pain in a dermatomal distribution, followed within several days by the appearance of the typical vesicular rash
Pancoast syndrome	Pain in shoulder and arm due to compression of the brachial plexus; paresthesia and weakness in the C8-T1 region (intrinsic hand muscles); ipsilateral ptosis, myosis, and anhidrosis (Horner's syndrome)
Sympathetically mediated syndromes	Diffuse pain and burning in arm and hand associated with swelling, hyperesthesia, allodynia, and vasomotor changes (temperature and color); neurologic examination usually normal
Referred somatic pain from the neck	Pain referred from cervical structures, including the intervertebral disks and zygapophyseal joints, that is usually felt in a segmental distribution (i.e., structures from the C5-C6 level, posterior neck, and supraspinatus fossa; C6-C7 level, supraspinatus fossa and scapula). Unlike in cervical radiculopathy, the pain is rarely felt below the elbow and the neurologic examination is normal <sup>29,30</sup>

in order to reduce the risk of recurrence, although this recommendation is not supported by evidence from clinical trials.<sup>39</sup>

#### **SURGERY**

In appropriate patients, surgery may effectively relieve otherwise intractable symptoms and signs related to cervical radiculopathy, although there are no data to guide the optimal timing of this intervention.<sup>4,5</sup> Commonly accepted indications for surgery differ depending on whether the patient has evidence of radiculopathy alone or whether there are also signs of spinal cord impairment, since the latter can lead to progressive and potentially irreversible neurologic deficits over time.

For cervical radiculopathy without evidence of myelopathy, surgery is typically recommended when all of the following are present: definite cervical-root compression visualized on MRI or CT myelog-

raphy; concordant symptoms and signs of cervical-root-related dysfunction, pain, or both; and persistence of pain despite nonsurgical treatment for at least 6 to 12 weeks or the presence of a progressive, functionally important motor deficit. Common surgical procedures for cervical radiculopathy are shown in Figure 2.<sup>49</sup> Randomized trials are lacking to compare these approaches.

Surgery is also recommended in cases in which imaging shows cervical compression of the spinal cord and there is clinical evidence of moderate-to-severe myelopathy (Table 2). For such patients, anterior approaches (preferred in patients with a cervical kyphosis) include cervical discectomy and corpectomy (removal of the central portion of the vertebral body) alone or in combination at single or multiple levels. Anterior decompression is generally combined with a strut reconstruction (bridging the space between the end plates of the verte-

bral bodies) with the use of bone (either autograft or allograft) or synthetic materials (carbon fiber or titanium cages) and plate fixation. Posterior options, which are often used in cases of multilevel decompressions in which there is preserved cervical lordosis, include laminectomy (with or without instrumented fusion) and laminoplasty (involving decompression and reconstruction of the laminae).

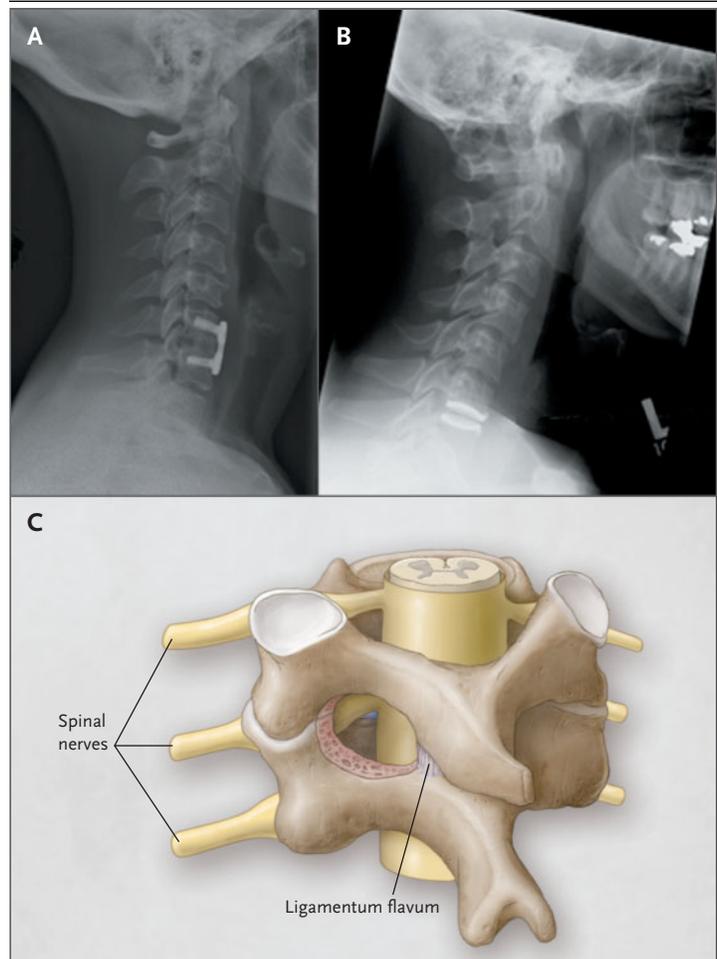
Data from prospective observational studies indicate that two years after surgery for cervical radiculopathy without myelopathy, 75 percent of patients have substantial relief from radicular symptoms (pain, numbness, and weakness).<sup>50,51</sup> Corresponding response rates for relief of radicular arm pain after surgery appear similar in patients treated for cervical myelopathy.<sup>52</sup>

Complications of surgery for cervical radiculopathy with or without myelopathy are uncommon but can include iatrogenic injury to the spinal cord (occurring in less than 1 percent of cases), nerve-root injury (2 to 3 percent), recurrent nerve palsy (hoarseness, 2 percent after anterior cervical surgery), esophageal perforation (less than 1 percent), and failure of instrumentation (breakage or loosening of a screw or plate or nonunion, less than 5 percent for single-level surgery).<sup>50-52</sup>

#### SURGICAL VS. NONSURGICAL MANAGEMENT

As summarized in a recent Cochrane review,<sup>53</sup> there are few good-quality studies comparing surgical and nonsurgical treatments for cervical radiculopathy. In one randomized trial comparing surgical and nonsurgical therapies among 81 patients with radiculopathy alone, the patients in the surgical group had a significantly greater reduction in pain at three months than the patients who were assigned to receive physiotherapy or who underwent immobilization in a hard collar (reductions in visual-analogue scores for pain: 42 percent, 18 percent, and 2 percent, respectively).<sup>54</sup> However, at one year, there was no difference among the three treatment groups in any of the outcomes measured, including pain, function, and mood.

In patients with mild signs of cervical myelopathy (not meeting the above criteria for surgery), nonsurgical treatment is reasonable. This recommendation is supported by the results of a small, but otherwise well-designed, randomized trial in-



**Figure 2. Surgical Approaches for the Treatment of Cervical Radiculopathy.**

Anterior cervical discectomy (Panel A) can be performed without spinal fusion, although more commonly a fusion (using a variety of biologic and synthetic materials) is performed to prevent disk collapse and kyphosis. As illustrated in the figure, this is commonly accompanied by anterior fixation of a plate to facilitate early return to normal activity. Anterior foraminotomy without fusion is a possible alternative, but there is less clinical experience with this option. In cervical arthroplasty (Panel B), an artificial disk made of various synthetic materials is inserted into the evacuated disk space after anterior cervical discectomy has been performed. This procedure (which is not approved by the Food and Drug Administration) is used outside the United States as an alternative to fusion in an effort to preserve motion and to minimize adjacent segment degeneration. Small prospective case series show results approximately equivalent to those with fusion at one-year follow-up, although randomized trials are lacking to show that arthroplasty results in less adjacent segment degeneration than does fusion.<sup>49</sup> Posterior laminoforaminotomy (Panel C) consists of a posterior decompression of the exiting cervical nerve root by partial removal of the lamina and medial facet and partial removal of the disk or osteophytic spurs. This procedure is indicated only for a condition that is laterally placed (not for central stenosis).

volving 51 patients, which showed that at two-year follow-up, no differences in neurologic outcomes were observed between patients treated medically and those treated surgically.<sup>55</sup>

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#### AREAS OF UNCERTAINTY

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The natural history of cervical radiculopathy remains uncertain. Data are needed from well-designed, randomized, controlled trials to guide nonsurgical management and decisions regarding whether and when to perform surgery.

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#### GUIDELINES

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There are no published guidelines by professional societies for the assessment and management of cervical radiculopathy.

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#### SUMMARY AND RECOMMENDATIONS

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Patients who present with acute neck and arm pain suggestive of cervical radiculopathy, such as the woman described in the vignette, should be assessed first by a careful history taking and physical

examination. In the absence of red flags suggesting infection or cancer or signs of myelopathy, it is reasonable to defer imaging and treat the patient's pain with analgesics (usually, nonsteroidal antiinflammatory drugs). MRI is indicated if substantial pain is still present four to six weeks after the initiation of treatment or if there are progressive neurologic deficits. Other options include cervical traction or transforaminal injections of corticosteroids, although the latter have potential risks, and neither approach has been well studied. It is reasonable to recommend a progressive exercise program once pain is under control, although it remains uncertain whether such a program reduces the risk of recurrence. Surgery should be reserved for patients who have persistent and disabling pain after at least 6 to 12 weeks of nonsurgical management, progression of neurologic deficits, or signs of moderate-to-severe myelopathy.

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