MAYO CLINIC

# Epidemiology, Diagnosis, and Treatment of Neck Pain

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**Learning Objectives:** On completion of this article, you should (1) be able to distinguish the different types (eg, neuropathic or nociceptive) of neck pain, (2) be able to identify "red flags" that may warrant advanced work-up, (3) be familiar with the risk factors for development of neck pain and its natural course, (4) know when and in whom advanced diagnostic testing may be helpful, and (5) be able to identify which patients to refer for specialty care (eg, injections or surgery).

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## Abstract

Neck pain is the fourth leading cause of disability, with an annual prevalence rate exceeding 30%. Most episodes of acute neck pain will resolve with or without treatment, but nearly 50% of individuals will continue to experience some degree of pain or frequent occurrences. History and physical examination can provide important clues as to whether the pain is neuropathic or mechanical and can also be used to identify "red flags" that may signify serious pathology, such as myelopathy, atlantoaxial subluxation, and metastases. Magnetic resonance imaging is characterized by a high prevalence of abnormal findings in asymptomatic individuals but should be considered for cases involving focal neurologic symptoms, pain refractory to conventional treatment, and when referring a patient for interventional treatment. Few clinical trials have evaluated treatments for neck pain. Exercise treatment appears to be beneficial in patients with neck pain. There is some evidence to support muscle relaxants in acute neck pain associated with muscle spasm, conflicting evidence for epidural corticosteroid injections for radiculopathy, and weak positive evidence for cervical facet joint radiofrequency denervation. In patients with radiculopathy or myelopathy, surgery appears to be more effective than nonsurgical therapy in the short term but not in the long term for most people.

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In the past few years, several reviews have been written on neck pain, although far fewer than on back pain, which often, but not always, involves similar mechanisms. Most of these reviews have targeted a specific specialty audience and have focused on one particular aspect of neck pain, rather than encompassing a broad overview aimed toward a general medical audience. The purpose of this review is to provide such an article, to



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include epidemiological aspects, classification, the natural course of neck pain, and an evidence-based, comprehensive guide to work-up, diagnosis, and treatment.

## METHODS

Databases on Medline via PubMed and Ovid, Embase, and the Cochrane Database of Systematic Reviews were searched using the key words *neck pain*, *cervical pain*, *cervical radiculopathy*, and *cervical myelopathy*, with no date restrictions. For individual sections, key words relating to specific topics (eg, *physical exam*, *history*, *radiological*, *surgery*, *epidural steroid injection*, *antidepressant*, *spinal manipulation*, *acupuncture*, *complementary and alternative medicine*) were identified and cross-referenced with the initial search terms using the aforementioned databases. Prime references and additional articles were obtained by cross-referencing all search terms with *review article* and manually searching through reference lists.

## OVERVIEW AND EPIDEMIOLOGY

The physical, psychological, and socioeconomic impact of neck pain is underappreciated. According to the Global Burden of Disease 2010 Study, neck pain is the fourth leading cause of years lost to disability, ranking behind back pain, depression, and arthralgias.[1] Approximately half of all individuals will experience a clinically important neck pain episode over the course of their lifetime.[2] There is substantial heterogeneity in the reported prevalence rates of neck pain; however, most epidemiological studies report an annual prevalence ranging between 15% and 50%,[2-5] with one systematic review reporting a mean rate of 37.2%.[2] The prevalence of neck pain is higher in females and peaks in middle age.[2-5] Neck pain is associated with several comorbidities including headache, back pain, arthralgias, and depression.[3,5]

### Who Gets Neck Pain?

The factors associated with the development and persistence of neck pain overlap considerably with those of other musculoskeletal conditions. The prevalence of neck pain is higher in females than in males, and the literature is mixed as to whether it peaks or plateaus in middle age.[2-6] Variables associated with neck pain that overlap with other rheumatologic conditions include genetics, psychopathology (eg, depression, anxiety, poor coping skills, somatization), sleep disorders, smoking, and sedentary lifestyle. For obesity, the results of epidemiological studies have usually but not always found a positive association between neck and shoulder pain and body mass index.[3,6-9] Some of the reasons why obese individuals may be predisposed to neck pain include elevated systemic inflammation, deleterious structural changes, increased mechanical stress and ground reaction force, diminished muscle strength, more psychosocial issues, and greater disability related to kinesiophobia compared with nonoverweight people.[10] Unique risk factors for neck pain include trauma (eg, traumatic brain and whiplash injuries) and certain sports injuries (eg, wrestling, ice hockey, football). Although certain occupations such as office and computer workers, manual laborers, and health care workers, have been found in some studies to have a higher incidence of neck pain, the major workplace factors associated with the condition are low job satisfaction and perceived poor workplace environment.[11]

### Classification of Neck Pain

There are many ways to categorize neck pain including duration (acute, <6 weeks; subacute, ≤3 months; chronic, >3 months), severity, etiology/structure, and type (ie, mechanical vs neuropathic). Among the various systems of categorization, duration is perhaps the best predictor of outcome. For a variety of different treatments, shorter duration has been found to be associated with a better prognosis than long-standing pain.[12-14] The association between longer duration of pain and poorer prognosis is consistent with the findings in cohort studies that greater disease burden in general (eg, higher baseline pain scores and disability) predicts poorer outcomes for spinal pain.[15-17]

Neck pain can also be categorized by mechanisms as mechanical, neuropathic, or secondary to another cause (eg, referred pain from the heart or vascular pathology). Mechanical pain refers to pain originating in the spine or its supporting structures, such as ligaments and muscles. Common examples of mechanical pain include pain arising from the facet joints (eg, arthritis), diskogenic pain, and myofascial pain. Neuropathic pain refers to pain resulting

primarily from injury or disease involving the peripheral nervous system, which generally involves mechanical or chemical irritation of nerve roots. The most common examples of peripheral neuropathic pain are radicular symptoms from a herniated disk or osteophyte and spinal stenosis. Myelopathy, or symptoms arising from spinal cord pathology, is a form of central neuropathic pain. Mixed neuropathic-nociceptive pain states include postlaminectomy (failed neck surgery) syndrome and degenerated disks that result in a combination of mechanical pain from annular disruption and radicular symptoms from herniated nucleus pulposus (Figures 1-3).

Differentiating neuropathic from mechanical pain is probably the most important clinical distinction to make, as it affects treatment decisions at every level (eg, which medications, injections, or surgical procedure). There are several instruments available that have been found to distinguish neuropathic from nociceptive or mechanical pain, with 2 of the most common being the painDETECT questionnaire and the S-LANSS (Self-report Leeds Assessment of Neuropathic Symptoms and Signs) pain scale.[18,19] For chronic low back pain, multiple studies have indicated a prevalence range of between 17% and 55% for predominantly neuropathic pain in a variety of cohorts, with a median of 41%.[20] No studies have examined the prevalence of neuropathic pain in a general neck pain population, but one study that aimed to validate S-LANSS and painDETECT in 152 individuals with cervical pain and a suspected nerve lesion found that 72% had definite or probable neuropathic pain, while another 18% had possible neuropathic pain according to the International Association for the Study of Pain Neuropathic Pain Special Interest Group grading system.[21] Among 6 patients with whiplash, one-third had probable neuropathic pain and two-thirds possible neuropathic pain. Of note, the authors found that both instruments suffered from low sensitivities in this population.

**FIGURE 1.** T2-weighted sagittal magnetic resonance image acquired slightly lateral to midline in a patient with unilateral radicular pain demonstrates a disk-osteophyte complex at C5-6 (arrow), which contributes to neural foraminal narrowing.

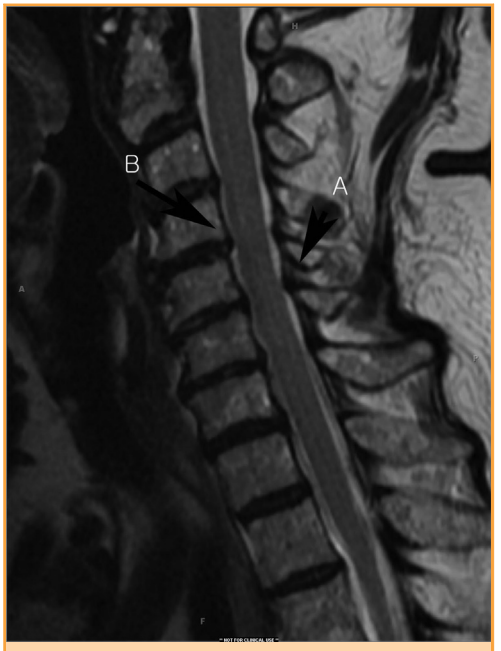


**FIGURE 2.** T2-weighted sagittal magnetic resonance image demonstrating multilevel disk bulging spanning levels C3-4 to C7-T1 causing central spinal stenosis in a patient with neuropathic pain extending into both arms. Ligamentum flavum hypertrophy at C5-6 (arrow A) and low-grade retrolisthesis of C4 on C5 (arrow B) contribute to central spinal stenosis. Note the absence of spinal cord signal hyperintensity, suggesting that there is no active cord edema.



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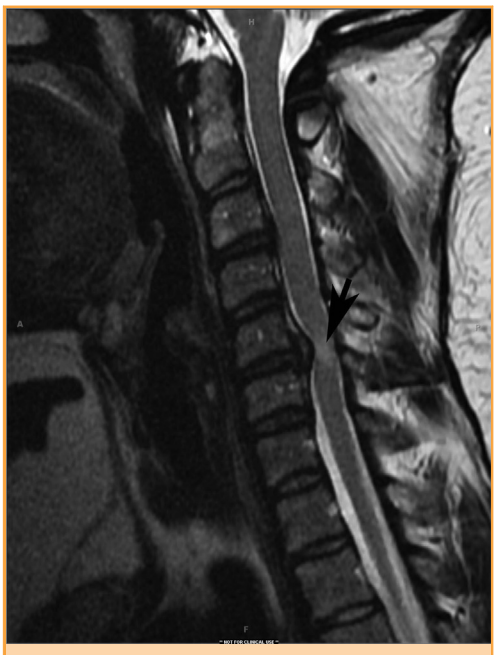

**FIGURE 3.** T2-weighted sagittal magnetic resonance image in a patient with signs of myelopathy demonstrating a large central disk extrusion at C5-6. The signal hyperintensity within the spinal cord (arrow) indicates edema.

### Natural Course of Neck Pain

Similar to back pain, most cases of acute (<6 weeks' duration) neck pain will resolve to a large extent within 2 months, but close to 50% of patients will continue to have some pain or frequent recurrences 1 year after occurrence.[22,23] For acute pain, treatment appears to have little effect on persistence.[23] Factors that may be associated with poorer prognosis include female sex, older age, coexisting psychosocial pathology, and radicular symptoms (Table 1).[22-26]

A study by Gore et al[27] performed in patients with long-standing or recurrent neck pain found that individuals with more severe pain following an injury and those with symptoms or signs of cervical radiculopathy had a greater likelihood of persistent pain, although a formal statistical analysis was not performed for evaluation of radiculopathy. No association was found between the degree of radiographic degeneration and satisfaction with treatment results. A large retrospective, epidemiological study conducted in patients with radicular pain evaluated at Mayo Clinic found that although recurrence was frequent (31.7%), at the mean follow-up of 5.9 years, 90.5% of patients experienced either no or only mild pain.[28] The finding that higher pain scores and radicular symptoms are associated with chronicity and poor outcome for neck pain is similar to what occurs with low back pain[29-32] and suggests that both subjective and objective factors play a role in prognosis.

The observation that most patients with cervical radiculopathy experience alleviation of symptoms with or without treatment is consistent with the results of small studies that revealed significant resorption in between 40% and 76% of cervical disk herniations.[33,34] These statistics are similar to those noted for lumbar disk herniations.[35] Although acute neuropathic symptoms in spinal stenosis will stabilize or improve in over half of individuals, the anatomic derangements do not generally improve without treatment.[36,37]

Cervical myelopathy involves pathology of the cervical spinal cord due to either trauma (spinal cord injury) or inflammation (myelitis), resulting in upper motor neuron signs. The natural course of nonsurgically treated myelopathy is highly variable. In a 1960s study that evaluated long-term follow-up in 28 patients treated nonoperatively, Lees and Turner[38] reported improvement in 17 patients, stable symptoms in 7, and progression in 4. Kadanka et al[39] conducted a randomized, 3-year study comparing surgical with nonsurgical treatment for mild to moderate spondylotic myelopathy. No differences were noted between treatment

**TABLE 1. Factors Associated With the Development or Persistence of Neck Pain**

| |
|---|
| Psychopathology |
| Low work satisfaction |
| Occupation/poor physical work environment |
| Female sex |
| Genetics |
| Concomitant back pain/other rheumatologic conditions |
| Poor coping skills |
| Catastrophization |
| Trauma/previous neck injury |
| Poor self-assessed health status |
| Sedentary lifestyle |
| Secondary gain |
| Smoking |
| Headache |

groups, with 80% of patients in both groups exhibiting improvement or no clinical deterioration. Shimomura et al[40] also reported a 20% deterioration rate at a mean follow-up of 3 years. A prospective study by Sampath et al[41] in 62 patients with cervical myelopathy found that equal proportions of medically and surgically treated patients (70%-75%) reported satisfaction with treatment, although the nonsurgically treated patients experienced worsened neurologic symptoms and a decreased ability to perform activities of daily living. Some investigators have reported more dire outcomes for spondylotic myelopathy. Matsumoto et al[42] reported that 10 of 27 patients treated conservatively over 6 months underwent surgery because of either neurologic deterioration or persistent disability. In another study by Sadasivan et al,[43] the authors reported deterioration in all 22 patients with cervical myelopathy, with 21 requiring surgery. In a consensus statement on the nonoperative treatment of spondylotic myelopathy, the authors concluded that between 20% and 62% of patients will have deterioration between 3-year and 6-year follow-up, with no patient or disease-specific factor being able to reliably predict progression of symptoms.[44]

## EVALUATION OF NECK PAIN

### History

A comprehensive history can provide important clues regarding etiology and help differentiate primary neck pain from shoulder pain, thoracic outlet syndrome, brachial plexopathy, upper extremity pain, vascular pathology, and referred pain from thoracic viscera (eg heart, lungs). Patients with neuropathic pain typically describe their symptoms as shooting, electrical-like, stabbing, and/or burning, whereas mechanical pain is more often described as throbbing or aching.[18,19] Neuropathic pain (eg, stenosis or herniated disk) is nearly always characterized by radiation into one or both upper extremities, usually in a single dermatomal or multidermatomal (eg, stenosis or a large or multilevel herniation) distribution. Because C7 and C6 are the most commonly affected nerve roots, radicular symptoms usually radiate into the middle or first 2 digits (eg, thumb and index finger), respectively.[28] Nonneuropathic pain arising from midlevel facet joints, disks (eg, C5-6), or even muscles may also occasionally extend into the upper arm, but referral patterns tend to be nondermatomal and more variable.[45-47] In pain stemming from the atlantoaxial, atlantooccipital, or upper facet joints or disks, radiation often extends into the occiput.[48]

Associated signs and symptoms can often distinguish neuropathic from nonneuropathic pain. Neuropathic pain is frequently accompanied by numbness, paresthesias, or dysesthesias. Sensory symptoms are unusual in patients with nonneuropathic neck pain, and when they occur, they tend to be nondermatomal. The presence of confirmed neurologic symptoms in a patient with normal imaging results warrants a search for other sources of neuropathic pain, such as brachial plexopathy, or carpal or cubital tunnel syndrome.

Aggravating and alleviating factors can provide information relevant to the decision to pursue further work-up. Mechanical pain of any origin is classically associated with a low-level baseline pain that tends to worsen with activity, while neuropathic pain is associated with less predictable bouts of more intense exacerbations. Pain exacerbated when turning or bending the head ipsilateral to the source may indicate radicular or facetogenic pain, whereas pain worsened by contralateral turning of the head could suggest myofascial orgin. Because the major cause of facet joint pain is arthritis, patients frequently report morning stiffness. Owing to a reduced spinal canal area, arm pain aggravated by neck extension is consistent with spinal stenosis; in contrast, pain worsened with forward flexion often signifies a diskogenic origin.

Cervical radiculopathy can often be distinguished from mechanical neck and shoulder pain by the abduction relief sign, in which abduction of the ipsilateral arm over the head alleviates symptoms.[49] This maneuver can distinguish radicular from certain types of shoulder pain, which may be worsened by shoulder abduction. One condition that is often mistaken for cervical radicular pain is thoracic outlet syndrome, which may be neurogenic (which comprises about 95% cases), arterial, and/or venous in origin. Thoracic outlet syndrome is classically unilateral, affects women more frequently than men, and peaks in prevalence in the fourth decade of life. In about half the cases, it is preceded by either trauma or


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repetitive stress. Imaging and Doppler analysis are most helpful for diagnosing vascular thoracic outlet syndrome but have low sensitivity for the neurogenic type. Several tests have been advocated to identify thoracic outlet syndrome including the elevated arm stress test, Adson test, and tenderness to palpation at the scalene triangle or insertion of the pectoralis minor, although none have high specificity.[50] Because neck pain is typically alleviated by rest and recumbency, severe unrelenting pain not affected by rest or position warrants consideration of "red flags" such as malignant neoplasms, primary neurologic conditions, and infection (Table 2, Figure 4).

Occasionally, the inciting event can facilitate identification of a pain generator. The most common precipitating event for neck pain is whiplash injury, which occurs when the neck and head continue to lurch forward after the trunk has ceased to move, resulting in shearing stress that involves the disks and facet joints that connect adjacent vertebrae. Although Bogduk and Yoganandan[51] reported that videoradiographic studies performed with and without headrests in cadavers in the 1970s indicated that rear-end collisions were most frequently associated with injuries to the intervertebral disks (90%), anterior spinal ligaments (80%), and facet joints (40%), more recent[52] and methodologically sound[53] studies have found no consistent relationship between pain and imaging abnormalities following motor vehicle collisions. In clinical studies performed by the Bogduk group using response to "double-blocks" as the reference standard, between 30% and 60% of patients with whiplash injury have predominantly facet joint pain.[54-56] For nontraumatic facetogenic and discogenic pain, the onset tends to be insidious because of the progressive strain on these structures from repetitive, low-level stress. For cervical radicular pain, particularly in younger individuals with robust disks, patients will sometimes report a specific antecedent event.

## Physical Examination

The physical examination is often used to confirm a historical finding, screen patients for serious or treatable pathology, and inform advanced imaging or further diagnostic work-

**TABLE 2. What Not to Miss: "Red Flags" Associated With Neck Pain**

| Red flag | Potential conditions | Associated signs and symptoms |
|---|---|---|
| Trauma (eg, fall, motor vehicle accident, whiplash injury) | Vertebral fractures, spinal cord injury/syrinx, ligamentous disruption | Loss of or alternating consciousness, cognitive deficits, traumatic brain injury, headaches, neurologic symptoms |
| Rheumatoid arthritis, Down syndrome, spondyloarthropathy | Atlantoaxial subluxation | Easy fatiguability, gait abnormalities, limited neck mobility, torticollis, clumsiness, spasticity, sensory deficits, upper motor neuron signs |
| Constitutional symptoms | Metastases, infectious process, systemic rheumatologic disease | Weight loss, unexplained fevers, anorexia, family or personal history of malignant neoplasm, diffuse joint pain and stiffness, abnormal laboratory test results |
| Infectious symptoms | Epidural abscess, spondylodiskitis, meningitis | Fever, neck stiffness, photophobia, elevated white blood cell count |
| Upper motor neuron lesion | Spinal cord compression, demyelinating disease | Hoffmann sign, hyperreflexia, Babinski sign, spasticity, incontinence, sexual dysfunction |
| Age <20 y | Congenital abnormalities (cervical spina bifida, Scheuermann disease), conditions associated with substance abuse such as infection | Congenital anomalies: birthmarks, overlying skin tags, patches of hair, family history, systemic disease (eg, diabetes, epilepsy for spina bifida)<br>Substance abuse: male sex, poor work or school performance, depression or other psychiatric morbidity |
| Concurrent chest pain, diaphoresis, or shortness of breath | Myocardial ischemia or infarction | Nausea, extension of pain into the left arm (especially medial upper arm) |
| Age >50 y | Metastases, vertebral fracture, carotid or vertebral artery dissection/bleeding | Family or personal history of malignant neoplasm, previous trauma<br>Arterial dissection: tearing sensation, headache, visual loss, or other neurologic sequelae |


**FIGURE 4.** T1-weighted sagittal magnetic resonance image in a patient with a known primary malignant neoplasm demonstrating hypointense lesions within the C3 (arrow A) and T3 (arrow B) vertebral bodies. At T3, there is an accompanying compression fracture with loss of vertebral body height. Breast, lung, prostate, renal cell, and gastrointestinal tract cancers, lymphoma, and melanoma are the primary malignant neoplasms most likely to metastasize to the vertebral bodies and should be considered in the differential diagnosis of a vertebral body infiltrative lesion in patients older than 40 years of age.

up but is rarely pathognomonic. Gait abnormalities, which can herald spinal cord (eg, myelopathy or syrinx) or brain injury, and major traumatic or developmental abnormalities should be noted. For example, doughy lipomata may indicate spina bifida or spinal cord abnormalities, and a prominent, palpable vertebral body can signify spondylolisthesis.

General appearance should be observed to identify facial expressions and behaviors indicative of pain. Patients who report severe pain in the absence of pain-related behaviors should be further evaluated for signs of nonorganic pathology. Abnormal lateral or forward flexion, or rotation, may indicate torticollis. Muscle atrophy, or winging or drooping of the shoulder, may be observed with radiculopathy, brachial plexopathy, or nerve entrapment.

True neurologic weakness should be distinguished from pain-induced weakness. In individuals with nerve injury, muscle wasting or asymmetric reflexes may be present, although 10% of asymptomatic individuals may have absent or asymmetric reflexes. In patients with poor effort or suspected malingering, reflexes may be the most (or only) objective examination tool. Signs of upper motor neuron lesions must be vigorously investigated.

Range of motion may be limited in all types of mechanical neck pain, but specific exacerbating movements may provide clues to the origin. For example, reproducible arm pain with neck flexion toward the affected side may indicate foraminal stenosis and/or radiculopathy. In one study conducted in whiplash patients, no difference in facet block responders and nonresponders was found for range of motion in any direction.[57] Provocative maneuvers may be more helpful in identifying potential sources of neuropathic pain. For cervical radiculopathy, the Spurling shoulder abduction and neck distraction tests have moderate sensitivity (approximately 50%) but high specificity (>80%).[58,59] For cervical myelopathy, the Hoffmann sign has been reported to have moderate sensitivity and specificity.[59,60] For facetogenic pain, one study found that paraspinal tenderness was weakly correlated with positive treatment response[61] (Tables 3 and 4).

## Diagnostic Work-up

In patients with suspected structural abnormalities (eg, scoliosis, spondylolisthesis, fractures), plain radiographs are generally sufficient. Magnetic resonance imaging (MRI) is the most sensitive test for detecting soft-tissue (eg, disk) abnormalities but is characterized by a high rate of abnormalities in asymptomatic individuals. The rates of abnormalities in people without symptoms varies from around 60% in individuals in their 40s to more than 80% in individuals older than 60 years, with the most common abnormalities being decreased signal intensity and disk protrusions.[62,63] Therefore, MRI is recommended to rule out red flags, in patients with serious or progressive neurologic deficits, and when referring patients for procedural interventions (eg, surgery); for individuals with persistent pain that does not


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**TABLE 3. Accuracy of Physical Examination Tests for Neck Pain**

| Test | Description | Diagnosis | Accuracy[a] |
|---|---|---|---|
| Spurling | Lateral flexion and rotation to the affected side with axial compression of the head reproduces radicular pain | Cervical radiculopathy | 40%-60% Sensitivity, 85%-95% specificity; moderate to substantial reliability |
| Shoulder abduction | Relief of ipsilateral cervical radicular symptoms with abduction of symptomatic arm (eg, placing it on head) | Cervical radiculopathy | 40%-50% Sensitivity, 80%-90% specificity; fair to moderate reliability |
| Neck distraction | Relief of radicular symptoms when examiner grasps patient's head under occiput and chin and lifts, applying axial traction | Cervical radiculopathy | 40%-50% Sensitivity, 90% specificity; moderate reliability |
| Valsalva | Reproduction of radicular pain with forced expiratory effort with mouth and nose closed | Cervical radiculopathy | Low sensitivity (22%), high specificity (94%) |
| Upper limb tension | Reproduction of radicular pain with scapular depression; shoulder abduction; forearm supination, wrist and finger extension; shoulder external rotation; elbow extension; contralateral followed by ipsilateral cervical lateral flexion | Cervical radiculopathy | 70%-90% Sensitivity, 15%-30% specificity |
| Lhermitte sign | Electrical-like sensations down spine or arms with passive flexion of neck | Cervical myelopathy | <20% Sensitivity, >90% specificity |
| Hoffmann sign | Flexion-adduction of thumb and index finger elicited with snapping flexion of middle or fourth finger distal phalanx | Cervical myelopathy | 50%-80% Sensitivity, 78% specificity |
| Babinski sign | Stimulation of the sole of the foot elicits dorsiflexion of hallux and sometimes dorsiflexion and abduction of other toes | Cervical myelopathy | 10%-75% Sensitivity, >90% specificity |
| Hyperreflexia | Overreactive or overresponsive deep tendon reflexes | Cervical myelopathy above level of muscle reflex innervation | >65% Sensitivity, high specificity |
| Clonus | >2 Repetitive beats during wrist or ankle dorsiflexion movements | Cervical myelopathy | <50% Sensitivity |
| Jackson compression | Downward pressure on head with lateral flexion. Localized pain may indicate facet joint pain; arm pain may indicate radiculopathy | Cervical radiculopathy/ myelopathy or facet joint pain | Not validated for facet joint pain. Low sensitivity, high specificity for myelopathy |
| Paraspinal tenderness | Paraspinal > midline pain with palpation | Cervical facet joint pain | Weak evidence for predicting a positive response to treatment |

[a]Ranges of accuracy are given when multiple studies were available.
Data from *Eur Spine J*,[58] *Pain Physician*,[59] and *Phys Ther*.[60]

respond to conservative treatment, radiologic evaluations can be considered.

Electrodiagnostic testing can be considered in patients with equivocal symptoms or imaging findings and to rule out peripheral neuropathy. The American Association of Electrodiagnostic Medicine reported 50% to 71% sensitivity in diagnosing cervical radiculopathy,[64] but a later study by Ashkan et al[65] found that compared with neurophysiologic studies, MRI was associated with a higher sensitivity (93% vs 42%) and negative predictive value (25% vs 7%) based on operative findings. Selective nerve root blocks have been used to identify painful nerve root(s) and have been reported to improve surgical outcomes, but randomized trials are lacking (see "Injections" section).[66-68]

## TREATMENT

### Conservative Therapy

Similar to back pain, cervical and scapular stretching and strengthening exercises have been found to provide intermediate-term relief for mechanical neck pain.[69-71] In one large randomized study of 206 patients with acute cervical radiculopathy, both physical therapy accompanied by home exercises and the use of a hard

**TABLE 4. Signs and Symptoms of Cervical Radiculopathy**

| Affected nerve root (frequency)[a] | Pain location | Sensory deficits | Muscle weakness | Reflex abnormalities |
|---|---|---|---|---|
| C4 (<10%) | Upper-mid neck | Capelike distribution, shoulder | None | None |
| C5 (10%) | Neck, shoulder, interscapular region, anterior arm | Lateral aspect of shoulder and arm | Shoulder abduction and external rotation, elbow flexion | Deltoid, biceps, and brachioradialis |
| C6 (20%-25%) | Neck, shoulder, interscapular region, lateral forearm, first and second digits | Lateral aspect of forearm and hand, first and second digits | Elbow flexion, shoulder external rotation, abduction and protraction, forearm supination and pronation, wrist extension | Biceps, brachioradialis |
| C7 (45%-60%) | Lower neck, shoulder, interscapular region, extensor surface of forearm, chest, third digit | Third digit, sometimes parts of first 4 digits | Elbow and finger extension, forearm pronation | Triceps |
| C8 (10%) | Lower neck, medial forearm and hand | Distal medial forearm to medial hand and fourth and fifth digits | Wrist flexion, finger and thumb abduction, adduction, extension and flexion | Finger flexors |

[a]Percentage data in part from *Brain*.[28]

cervical collar produced greater reductions in neck pain and disability over a 6-week period than a "wait and see" approach.[72] However, systematic reviews have concluded that cervical collars are no more effective than sham interventions for neck pain.[73] For complementary and alternative medical treatments, the strongest evidence supports a modest effect for spinal manipulation compared with no treatment or other noninterventional treatments. With regard to other complementary and alternative treatments, although they have generally been found to be superior to no treatment, the evidence that they are superior to sham treatments or other treatments is weak, negative, or conflicting (Table 5).

Few high-quality studies have evaluated pharmacotherapy for neck pain. Systemic nonsteroidal anti-inflammatory drugs (NSAIDs) have been found to be beneficial for spinal pain in general[82] but have not been formally studied in neck pain. Although NSAIDs are more efficacious than acetaminophen, the American College of Rheumatologists recommends acetaminophen as a first-line treatment, even for arthritis, because of its more favorable adverse effect profile.[83] In patients who present with predominantly mechanical neck pain, topical NSAIDs have proven efficacy.[84] In one randomized trial that compared spinal manipulation, home exercise and advice, and pharmacotherapy with NSAIDs or acetaminophen in acute and subacute neck pain, the manipulation and exercise groups fared better than medicinal treatment through 12-month follow-up.[81]

In 2 large (n=1405) randomized controlled trials evaluating the muscle relaxant cyclobenzaprine for acute neck (more than one-third of the patients) or low back pain associated with muscle spasm, the authors found both intermediate-dose (15 mg/d) and high-dose (30 mg/d) therapy to be more effective than placebo but no difference between low doses (7.5 mg/d) and placebo.[85] A double-blind crossover study comparing the stand-alone anti-inflammatory drug benorylate to benorylate plus the muscle relaxant chlormezanone found no benefit of add-on therapy for low back or joint pain but significantly better pain relief and sleep quality in patients with neck pain.[86] Muscle relaxants tend to be more effective for acute than chronic pain.[87] In light of their abuse potential and lack of greater efficacy compared with other muscle relaxants, many experts believe benzodiazepines should be prescribed only when other muscle relaxants have proven ineffective and with clearly defined goals, time frames, and appropriate surveillance.[88]


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**TABLE 5. Alternative and Complementary Medicine Treatments for Neck Pain**

| Treatment | Description | Evidence |
|---|---|---|
| Spinal manipulation | Manual therapy designed to maximize painless movement, reduce muscle tightness, improve joint mobility, and correct alignment problems | Superior to no treatment or sham treatment in the short term. Weak evidence for intermediate-term benefit and for superiority over pharmacotherapy and other alternative therapies |
| Acupuncture | Inserting needles into the skin at various anatomic locations to reduce pain or induce anesthesia. Needles may be manipulated manually or through electrical stimulation | Weak evidence that acupuncture is superior to no treatment in the short term. Strong evidence that acupuncture is not better than sham acupuncture or other treatments |
| Massage therapy | The manipulation of muscle and connective tissue to enhance function and promote relaxation and well-being | Superior to no treatment or sham treatment but not more effective than other active treatments in the short and intermediate term. No evidence for improved function |
| Exercise therapy | Active or passive physical exercises designed to strengthen or stabilize the spine that may reduce pain, prevent injuries, and improve posture and body mechanics | Strong evidence for intermediate-term relief for nonspecific neck pain and whiplash-type injuries. Conflicting evidence for improvement of disability. No clear evidence supporting one technique over another or that exercise can prevent the development of neck pain |
| Traction | Procedures designed to relieve pressure on the spine | There is low-quality evidence that traction is not superior to placebo treatments for neck pain with or without radiculopathy |
| Soft cervical collar | Orthopedic device used to immobilize the neck and support the head and neck, often after injury | There is low-quality evidence that a cervical collar is no more effective than physical therapy or other active therapies for cervical radiculopathy and whiplash |
| Electrotherapy | The use of electrical energy as a medical treatment to relieve pain, usually by interfering with nerve conduction | There is low-quality evidence that various forms of electrotherapy (eg, transcutaneous electrical nerve stimulation, pulsed electromagnetic field therapy) are better than placebo but not other treatments |
| Yoga | A series of physical, mental, and spiritual exercises designed to achieve a peaceful state of mind, improve conditioning, and attain self-actualization | There is weak evidence that yoga is more effective than home-based exercise treatment |

Data from references 69 through 81.

## Injections

The evidence supporting trigger point injections to treat myofascial pain is mixed. Part of the difficulty in evaluating clinical trials for trigger point injections is that the injection of any substance (or even dry needling) into taut bands of muscle may relieve pain, which makes it difficult to perform true placebo-controlled trials. In a systematic review by Scott et al[89] evaluating trigger point injections for chronic pain, the authors found no clear evidence for either benefit or ineffectiveness. With regard to the type of procedure, there is limited evidence that injections may be more effective and less painful than dry needling.[89,90] For botulinum toxin, there is mixed evidence for superiority over trigger point injections performed with saline or local anesthetic. A Cochrane review identified 4 studies that met inclusion criteria, 3 of which focused on myofascial pain in the neck and/or shoulder region.[91] Although all 3 studies favored botulinum toxin, in only 1 study did the results reach statistical significance.[92-94] A more recent study of 114 previous responders that used an enriched protocol design found modest benefit in some but not most outcome measures for some variables that persisted through 26 weeks.[95] In 2 controlled studies performed in patients with low back pain, the results were mixed regarding the effectiveness of botulinum toxin.[96,97] The authors found there was inconclusive evidence to support the use of botulinum toxin injections for myofascial pain syndrome. In a non-systematic review by Jabbari and Machado,[98] the authors concluded there was level A evidence for the use of botulinum toxin injections to treat cervical dystonia. One caveat that is important to

heed when interpreting studies on trigger point injections is that they are widely acknowledged to be more effective when used in patients in whom discrete, taut bands of muscle can be palpated (ie, trigger points) than in individuals with more diffuse symptoms.[47] In some primary studies, however, the methodology used to identify trigger points was unclear.

For cervical radiculopathy, the results of clinical trials evaluating epidural corticosteroid injections have been mixed. A small (n=40) randomized study found no significant differences at 3-week follow-up between transforaminal corticosteroids plus local anesthetic and transforaminal local anesthetic.[99] This is consistent with 3 randomized, double-blind studies by the same group that compared epidural corticosteroid plus local anesthetic to epidural local anesthetic alone in a variety of conditions (herniated disc, spinal stenosis, and failed neck surgery syndrome) and found no differences between treatment groups, with both groups experiencing improvement.[100-102] In a randomized, placebo-controlled, nonblinded study that compared a series of epidural corticosteroid and local anesthetic injections to intramuscular injections, Stav et al[103] reported significant benefit lasting up to 1 year. In a large, multicenter comparative effectiveness study, Cohen et al[104] found that combination treatment with a series of epidural corticosteroid injections plus conservative treatment with adjuvants and physical therapy was superior to either treatment alone. Of note, a systematic review and meta-analysis concluded that epidural local anesthetic and/or saline constituted an efficacious treatment intermediate in efficacy between epidural corticosteroids and a true intramuscular placebo injection.[105]

Cervical facet joint pain is estimated to account for between 40% and 60% of nonneuropathic neck pain based on controlled blocks.[55,106] The evidence for medial branch (facet joint nerve) radiofrequency ablation of cervical facet joint pain is weakly positive. In one small, placebo-controlled study performed in 24 meticulously selected patients with whiplash injury, the treatment group fared better than the sham group for pain relief and functional improvement, with the mean duration of benefit lasting about 9 months.[107] In a smaller study in 12 patients with cervicogenic headache that performed empirical radiofrequency denervation without diagnostic injections, 4 of 6 persons in the treatment group experienced success at 3 months, which favorably compared with 2 of 6 in the treatment group.[108] Although small uncontrolled studies have reported benefit with intra-articular corticosteroid injections,[109] the only placebo-controlled study reported no differences between the corticosteroid and local anesthetic control injections at 6-month follow-up.[110]

Injections in the form of selective nerve root blocks (SNRBs) have also been advocated as a tool to identify symptomatic spinal levels and select patients for surgery.[68] There is a strong correlation between the results of SNRB and single-level MRI pathology,[111] but the correlation between SNRBs, MRI findings, and neurologic examination results in individuals with multilevel pathology is much lower.[66] Although uncontrolled studies have found good surgical outcomes in patients who experience pain relief after diagnostic injections,[66,67,111] there have been no randomized studies evaluating their ability to improve treatment results.[68] One recent review concluded that adding SNRB to diagnostic work-ups in patients with lumbar radiculopathy being considered for surgery was not cost-effective.[112]

## Surgery

Few randomized studies have evaluated surgical treatment for neck pain, and none have done so for mechanical pain. In a randomized study comparing anterior decompression and fusion operations, physical therapy, and hard collar immobilization in 81 patients with cervical radiculopathy, Persson et al[113,114] found greater reductions in pain (29% for surgery, 19% for physical therapy, and 4% for cervical collar) and improvements in muscle strength and sensory loss in the surgical group than in the other treatment groups. Yet at 1-year follow-up, the differences favoring surgery were for the most part no longer statistically significant. A more recent randomized study that compared surgery and physical therapy to physical therapy alone for cervical radiculopathy found that surgery was associated with superior outcomes at 1 year, but by 2 years, the differences between groups were no longer statistically significant.[115] In a clinical trial


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performed in 120 patients with neck and/or arm pain secondary to a single, small contained disk herniation, plasma disk decompression was found to be superior to conservative treatment for pain and function throughout the 1-year follow-up.[116] Of note, conservative treatment had already failed in all patients.

In the only randomized study evaluating surgery for cervical myelopathy, Kadanka et al[117] compared operative therapy to conservative care consisting of immobilization with a soft collar, NSAIDs, and intermittent bed rest. Sixty-eight patients were randomized by coin flip, with discrepancies noted for some baseline variables. Overall, through the 10-year follow-up period, no significant differences were found for major outcome variables between treatment groups.[117,118] A subgroup analysis found that patients who were younger and had greater baseline disease burden and small spinal canal areas tended to fare better with surgery than those who were older and had greater function and transverse spinal canal diameter.[119]

There are no randomized controlled trials comparing surgical to nonsurgical therapies for mechanical neck pain associated with common degenerative changes, but extrapolated studies in the lumbar spine suggest that less than one-third of patients will experience clinically meaningful pain relief or functional improvement, with the results diminishing over time.[120,121] The results of systematic reviews comparing cervical disk replacement to anterior decompression and fusion operations are conflicting as to whether the former is associated with better outcomes for single-level spondylosis.[122,123] One study evaluating outcome predictors for anterior cervical decompression and fusion found that good functional capacity, male sex, and nonsmoking status were associated with successful long-term treatment results.[124]

## FUTURE DIRECTIONS

Compared with other leading causes of pain and disability, relatively few randomized controlled trials exist to guide treatment of neck pain, and the guidelines for neck pain are often extrapolated from those for other conditions. Clinical trials designed to determine efficacy and comparative effectiveness are needed for all types of treatments but particularly adjuvants for neuropathic pain and surgery for mechanical pain.

The use of biological therapies, including stem cell therapy, and nerve growth factor and cytokine inhibitors have been or are currently being studied for other chronic pain conditions such as low back pain but have yet to be critically evaluated for neck pain. Future research should be expanded to determine their efficacy for spinal pain in general or neck pain in particular.

The persistence of neck pain after whiplash and other types of injuries poses substantial physical, psychological, and economic consequences for patients and society. There is currently a very poor relationship between symptoms and imaging abnormalities in injured patients who continue to experience neck pain.[52] Finding ways to identify those individuals at increased risk for development of persistent pain, and preventing it, represents an important challenge to the medical community.

## CONCLUSION

Neck pain is one of the leading causes of disability in the world, yet the amount of research devoted to treatment is relatively low in comparison to the other leading causes. For acute neck pain, most cases will resolve spontaneously over a period of weeks to months, but a substantial proportion of individuals will be left with residual or recurrent symptoms. Treatment appears to have little effect on the course of acute neck pain. History and physical examination may provide important clues as to whether the pain is neuropathic or mechanical and are critical in determining who might benefit from advanced imaging or further diagnostic work-up. In patients with whiplash injuries, there is a poor correlation between pain and imaging results. Clinical trials have found that exercise may be beneficial, and for acute pain, muscle relaxants are effective. In individuals with chronic pain, there is conflicting evidence supporting epidural corticosteroid injections in patients with radiculopathy and spinal stenosis and weak evidence in favor of facet joint radiofrequency denervation for spinal arthritis.

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