Cervical Radiculopathy: Diagnosis and Management

ABSTRACT
Neck and arm pain are common reasons to seek medical attention, especially in the working population. However, there are several diagnostic pitfalls that must be avoided. Appropriate, conservative management will lead to improvement in a significant number of patients. Knowing when to refer a patient as well as what imaging modalities are indicated is crucial to managing cervical radiculopathy in the primary care setting. The purpose of this review is to help primary care physicians diagnose, investigate and treat cervical radiculopathy and to know when a surgical referral is appropriate.

KEYWORDS: Cervical radiculopathy, neurological exam, imaging, conservative treatment, surgery

Introduction
Cervical radiculopathy was first described by Parkinson in 1817. The first detailed description, however, was by Stookey in the 1920s. Later in 1949, Ruth Jackson used the term Cervical Syndrome to classify a group of cases where the cervical nerve roots were irritated by pathological narrowing the intervertebral foramen, causing pain, numbness and weakness in the upper extremity. In her paper, Jackson argued for conservative management using methods such as collar immobilisation and ergonomics. Presently there are more treatment options available; therefore, physicians must be able to recognize the symptoms/signs, institute appropriate first line treatment and know the indications for referral to further specialised care.
**Epidemiology**

The reported prevalence of disc degeneration is extremely variable in the literature and this may be due to inconsistencies in the definition of degeneration. Up to 95% of patients may have changes in their cervical spine by their seventh decade; however, most of these are asymptomatic.

The incidence of neck pain may be as high as 23.1 per 1000 people years and peaks around the fourth or fifth decade. However, incidence of pure cervical radiculopathy may be much lower, as the prevalence of this is only 3.3 cases per 1000 people years. Only around 0.6% of patients with neck pain describe truly incapacitating symptoms.

The estimated prevalence of combined neck and arm pain is around 83.2 per 100 000 people, and over half of all adults may experience these symptoms at least once in their lifetime. Risk factors include axial load bearing, prior lumbar radiculopathy, female sex, age above 40 and Caucasian race. However, some sources disagree with female sex being a risk factor and find men are affected slightly more often (1.6:1).

A cervical disc herniation usually affects the nerve root exiting at the transverse foramina closest to the disc. This is shown in Figure 1. For instance, a C6-7 disc herniation often affects the C7 nerve root (Figure 4) as the roots exit above their corresponding vertebral bodies. Approximately two thirds of patients with degenerative cervical radiculopathy present with symptoms related to the C7 root, while one fifth present with C6 symptoms. Findings at C8 and C5 are much less frequent. The C5-6 disc shows the highest incidence of degeneration but this is not usually associated with nerve root irritation. The C5-6 level is also the most common site for foraminal stenosis.

![Figure 4](image)

T2 weighted sagittal (A) and axial (B) MRI views showing disc herniation at the C6-7 level compressing the exiting left C7 nerve root.
Pathophysiology

The normal intervertebral disc contains the nucleus pulposus, which is rich in hydrophilic proteoglycans and hyaluronic long chains which attract water and keep the disc hydrated. The nucleus pulposus is surrounded by 15-25 layers of collagen fibers which, collectively, are referred to as the annulus fibrosus. The degenerative process begins in the second decade with a breakdown of the proteoglycan composition, which often results in disc desiccation and degradation, leading to decrease in the disc height and narrowing of the intervertebral foramen. The development of radial and circumferential annular tears can lead to disc extrusion. The facet joints and posterior elements, having lost anterior support from the disc, respond to the increased strain by developing hypertrophic changes (Figures 2 and 3), which further narrows the canal.8

Cervical radiculopathy is caused by nerve root irritation, which may be caused by cervical disc herniation (Figure 2).5 Cervical disc herniation often occurs in the early stages of degenerative disc disease when the annulus fibrosus is susceptible to tears and usually happens in the most mobile cervical segments.5

Neural foraminal stenosis is another common cause of cervical radiculopathy.10 Cervical disc protrusion, posterior osteophytes, hypertrophied facets and/or ossi-
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The clinician must rule out cervical myelopathy in patients presenting with neck and arm pain. Patients often complain of progressive limb weakness, generalised hypoesthesia, hypertonia, clumsiness of upper extremities (dropping objects), falls and in the later stages urinary retention, incontinence and sexual dysfunction.

The patient’s arm symptoms and can help distinguish a radicular pain from a purely mechanical one.

Patients with C5 radiculopathy can have a diminished biceps reflex, along with deltoid or biceps weakness, and numbness over the shoulder and anterolateral aspect of the arm. Those with a C6 radiculopathy may also have biceps weakness along with diminished biceps and brachioradialis reflexes, weakness of the shoulder flexors, wrist extensors, and numbness of the thumb and index finger and along the radial side of the forearm. Subjects with C7 radiculopathy may present with a diminished triceps reflex, weakness of elbow extension, wrist flexion and finger extensors. There is also numbness of the second and third digits and perhaps the tips of all the fingers. A C8 radiculopathy can cause weak intrinsic hand muscles and numbness of the fourth and fifth digits extending to the ulnar side of the forearm. The different clinical presentations of patients with nerve root irritation are summarized in Table 1.

Clinical presentation

A patient presenting with cervical radiculopathy has symptoms that differ depending on the nerve root affected. Because of the associated mechanical problems many patients will complain of pain limiting movements of the head. A common manoeuvre to detect cervical radiculopathy and separate it from the much more frequent structural referred pain is the Spurling manoeuvre. Although several variations have been described, we prefer extension and lateral bending of the cervical spine followed by axial compression. A positive test reproduces radicular pain down the affected arm. It may be beneficial to stage the provocative manoeuvres, such that extension and lateral bending are initiated first, and then axial compression is then added as a reinforcement (to avoid excessive pain during examination). Adding an element of rotation to these manoeuvres increases the probability of provoking the patient’s numbness. TheValsalva manoeuvre may also reproduce cervical radiculopathy symptoms. Applying manual traction by pulling on the patient’s head may reduce the patient’s arm symptoms and can help distinguish a radicular pain from a purely mechanical one.

Decreased disc height, degenerative changes of the uncovertebral joints or of the zygapophyseal joints may also contribute to nerve root compression.
Examination may reveal hyperreflexia, spasticity or increased tone, positive Babinski’s reflex (extensor cutaneous plantar reflex), Hoffmann’s sign, a wide based gait or L’hermitte’s sign (electric-like pain on neck flexion). Musculoskeletal disorders of the shoulder girdle can also mimic the pain seen in cervical radiculopathy and as such need to be considered.

### Differential Diagnosis

Although the great majority of cases of cervical radiculopathy are the result of disc herniations or foraminal stenosis the other causes of cervical radiculopathy range from inflammatory nerve disorders to coronary vessel disease. Rarer causes include neoplasms such as a neurofibroma, schwannoma or meningioma which may exert mass effect on a cervical nerve root, much like a herniated disc. Intradural extramedullary or intradural intramedullary neoplasms may also cause similar symptoms as can a syrinx associated with a Chiari malformation. Pancoast tumors, thyroid tumors, esophageal tumors, lymphomas and carcinomatous meningitis are also included in the differential.

Inflammatory disorders like brachial neuritis (often due to herpes zoster), or lateral amyotrophic sclerosis can also cause neck and arm pain.

Trauma may cause fractures of cervical vertebra or avulsion of nerve roots. Rupture of rotator cuff muscles or suprascapularis nerve impingement can mimic the deltoid weakness seen in C5 radiculopathy. Carpal tunnel syndrome may cause numbness in the thumb much like C6 radiculopathy.

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**Table 1: Cervical Nerve Roots and the Typical Physical Findings in the Setting of Cervical Radiculopathy**

<table>
<thead>
<tr>
<th>Sensory</th>
<th>Motor</th>
<th>Reflex</th>
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<tr>
<td>C5 Over the shoulder and anterolateral aspect of arm</td>
<td>Deltoid or biceps weakness</td>
<td>Decreased biceps reflex</td>
</tr>
<tr>
<td>C6 Thumb, index and radial side of forearm</td>
<td>Weakness of biceps and wrist extensors (radial aspect)</td>
<td>Decreased brachioradialis reflex</td>
</tr>
<tr>
<td>C7 Second and third digit, may affect tips of all fingers</td>
<td>Weakness of triceps and finger extensors, weakness of wrist flexion (ulnar aspect)</td>
<td>Diminished triceps reflex</td>
</tr>
<tr>
<td>C8 Ulnar side of forearm, and fourth and fifth digits</td>
<td>Weak intrinsic hand muscles, finger flexors</td>
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Investigations
History and physical examination are generally sufficient to diagnose cervical radiculopathy. As a result, imaging is necessary only when a patient requires surgery. Plain radiographs may show loss of disc height, loss of cervical lordosis, neuroforaminal narrowing, end plate sclerosis or osteophyte formation but often add little to the management. Computed tomography scans are capable of showing bony foramina stenosis but are poor at visualizing the spinal cord and nerve roots. Due to its ability to demonstrate soft tissue and neural tissue compression as well as degenerative changes, T2 weighted Magnetic Resonance Imaging is the test of choice for cervical spine conditions. CT myelogram may be used in patients with MRI contraindications. EMG may be used in patients where a multiple nerve roots seem involved or when the clinical exam is inconclusive. However, the results only become abnormal after three weeks of significant radicular compression. If the EMG is done six months after the onset of radiculopathy, fibrillations from the denervated muscle may disappear. EMG is limited because it targets motor axons and may not detect predominantly sensory radiculopathies.

A retrospective descriptive study showed degenerative disc disease is present in 76% of patients with chronic neck pain and/or radiculopathy in the upper limbs. However, 14% of these patients had a completely normal MRI and 16% had a non-degenerative pathology. Common degenerative cervical changes include degenerative disc, disc bulge, neural foramina stenosis, disc herniation and myelomalacia. Cervical disc herniation is rare in old age.

Management
Over 90% of patients improve with conservative management including analgesics, NSAIDS, posture modification, activity restriction and physiotherapy including modalities and cervical traction. In a few cases of intense or prolonged pain muscle relaxants or corticosteroids may be used. Interestingly, patients with cervical radiculopathy have been shown to have altered endurance of the trapezius and sternocleidomastoid muscles when compared with healthy subjects; physiotherapy may help to address these deficiencies. Currently there is insufficient evidence to recommend neck manipulation for cervical radiculopathy; these manoeuvres may yield complications such as worsening radiculopathy, development of myelopathy and, potentially, spinal cord injury. Used sparingly and usually at night when complex daily activities are not required muscle relaxants like cyclobenzaprine and tizanidine may help
alleviate neck pain caused by increased muscle tension at insertion sites. Opioids may be beneficial in patients with acute pain but patients using opioids have lower rates of compliance to other conservative therapy and undergo surgery more frequently than other groups. Chronic opioid use for musculoskeletal disease is increasing with a raising rate of significant opioid side effects. For these reasons we do not favour the routine use of opioids for patients with radiculopathic pain. Patients who fail to improve within six weeks to three months of conservative management or who experience progressive neurologic deficit or suffer intolerable pain unmanageable by conservative means or patients with findings suggestive of cervical myelopathy all warrant referral for surgical consideration.

Non-radicular axial pain referred from other structures in the cervical spine are not good surgical candidates. In spite of the highly favorable natural history, surgery remains a popular choice for the management of cervical radiculopathy. The rate of surgical treatment for degenerative disc disease associated with cervical radiculopathy (80%) or cervical myelopathy (20%) in Norway increased by 74.1% from 2008 to 2014. This increase in surgery rates may result from a combination of an aging population and increased safety and availability of surgery.

The most common surgical approach is the anterior cervical discectomy and fusion (Figure 5), an approach popularised by Cloward, and then refined by Smith and Robinson. About two percent of patients undergoing anterior cervical approach will have a complication. Patients often complain of hoarseness which lasts 24-48h postoperatively (11%); persistent hoarseness might be the sign of recurrent laryngeal nerve injury (around 2%). Horner’s syndrome is seen in 0.1-3.6%. A dural tear (0.2-0.5%) or worsening of the radiculopathy (0.2-3.3%) can occur. Dysphagia (2-60%) is relatively common and underreported. It is probably multifactorial due to the complex innervation of the pharynx. Smoking, female sex and postoperative pain have been recognised as risk factors. Rarely difficulty swallowing may be caused by hardware migration and failure (0.4%) or pharyngeal/esophageal perforation (0.2-0.3%). Surgical site infection occurs in 0.2-1.6% of cases and a post-operative hematoma compromising the airway is seen in 0.2-5.6%. Mortality and spinal cord injury are rare at less than 1%.

Adjacent segment disease is a concern following surgery for cervical radiculopathy, particularly operations including fusion. This has been reported to occur at a rate of 2.4% per year. The same study found that smoking (odds ratio...
1.9), the female sex (odds ratio 1.7) and having less than 3 discs included in the fusion (odds ratio 1.8) were risk factors for adjacent segment disease.22

Up to 90% of patients are satisfied with anterior cervical discectomy and fusion results.5 In the immediate post-operative period patients should avoid sudden rotation of the neck. They can gradually resume normal activity but should wait for full recovery of cervical motion to start driving.5

Cervical disc replacement is another option (Figure 6).5 Motion preservation has been shown in some studies to reduce adjacent segment disease compared with fusion, presumably by decreasing the stress on adjacent discs.5,23 Patients who undergo single level cervical disc replacement with satisfactory neural decompression have outcomes comparable to those with a single level fusion.23 A multicenter five year prospective, randomised controlled trial compared disc replacement with ACDF for management of 2-level symptomatic degenerative disc disease in otherwise healthy patients with either cervical radiculopathy of cervical myelopathy from two adjacent diseased discs. The study showed slightly increased patient satisfaction (96.4% VS 89.5% at five years) as well as lower reoperation rates in those treated with disc replacement (4.3% reoperation for disc replacement VS 16.2% for ACDF; p-value = 0.0003).23 There were also more adjacent level surgeries in patients who underwent ACDF (11.4%) than in those who underwent disc replacement (3.1%).26 Although some studies have shown superior results with cervical disc replacement compared to fusion not all the trials have shown positive results and this technology requires further study.24-27

Some disc herniations and cases of foraminal stenosis can be treated by posterior foraminotomy and sequestrectomy.5,28 A retrospective case control study showed similar reoperation rates for ACDF and posterior cervical foraminotomy.28

Nerve root injection with a mixture of corticosteroids and local analgesics may decrease pain in up to 60% of patients.5 In one study 33 surgical candidates who failed appropriate conservative management were treated with epidural corticosteroid injections. Only two patients came to surgery during the subsequent year.29 Complications following these injections are not common but there have been reports of nerve root and brainstem toxicity (particularly associated with particulate agents like triamcinolone hexacetonide) and as a result these injections are generally not recommended.5,29

**Improving patient outcomes**

It is impossible to predict who will fail conservative management...
and ultimately require surgery. Operative management is generally reserved for patients who have unmanageable pain or fail to improve after at least three months of non-operative care. Even patients presenting with severe arm dominant pain usually gain substantial improvement within the first four to six months. About 83% of patients recover completely within two to three years. A study comparing surgical to conservative management of cervical radiculopathy found surgery to be superior at three months post-op but showed no significant differences between groups at one year follow up. A post hoc analysis of the two cohorts showed that patients who received surgical treatment before six months had significantly more improvement in arm pain than those patients who received surgical treatment after six months. Surgery should be considered when there is no improvement in the first several month of non-operative management.

Preoperative mental distress significantly associated with duration of preoperative pain has been associated with poorer postoperative outcomes. Receiving worker’s compensation has also been associated with a poorer prognosis. Clearly addressing a patient’s mental health and compensation status before referral may help improve outcomes.

Opioid dependant patients have been shown to have higher complaints of disability and higher rates of noncompliance. Although a recent post hoc analysis of two randomised controlled trials (both comparing ACDF and total cervical disc arthroplasty) did not show statistically significant differences in postoperative outcomes between strong opioid users, weak opioid users and non-opioid users previous studies have shown opioid users have lower rates of good surgical outcomes. Prescribing narcotics for cervical radicular pain must be approached cautiously and long term opioid use is not appropriate.

**Summary**

1. Cervical pain is a common clinical problem; pure cervical radiculopathy is much less frequent.
2. The natural history of cervical radiculopathy is favorable; most patients improve within 3 months.
3. Imaging is only required if there are indications of sinister, non-mechanical pathology or when surgery is being contemplated.
4. Surgery produces beneficial results in 85-90% of cases.
Mechanical neck pain is a common problem among the working population. The clinician must recognize the small subset with constant arm dominant radicular pain caused by cervical disc herniation or foraminal stenosis while excluding other more sinister diagnoses including cervical myelopathy. Conservative management will result in improvement in up to 90% of patients but a lack of improvement within the first three or four months warrants a surgical consultation. Imaging is needed only when surgery is considered and MRI is the modality of choice. The surgical option should be tailored to the individual patient and the expertise of the treating surgeon. Surgical outcomes can be enhanced by stressing the high rate of operative success, improving the patient’s mental state, resolving psychosocial conflicts, encouraging smoking cessation, using opioids sparingly and emphasizing a rapid return to normal activity including a prompt return to work.

References

CLINICAL PEARLS
1. A well-constructed musculoskeletal and neurological history and physical examination can distinguish between mechanical neck pain, cervical radiculopathy, cervical myelopathy or shoulder pathology.
2. C5-6 and C6-7 are the most common levels affected.
3. C6 radiculopathy leads to numbness in the thumb and weakness in wrist extension.
4. C7 radiculopathy leads to numbness in the middle finger and triceps weakness.
5. Spurling’s manoeuver can be used to reproduce radicular symptoms. It should not be used when myelopathy is suspected.