

# Radicular arm pain

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## Abstract

Cervical radiculopathy is a neurological condition caused by dysfunction or compression of a cervical nerve root. Patients often report unilateral neck pain with radiation to the ipsilateral arm, often with sensory changes in a dermatomal distribution. Weakness and reflex changes are also commonly found and can be very troubling for patients. Careful history and examination is important to identify any more concerning features such as progressive symptoms and features of myelopathy, which could prompt surgical management. Although the majority of patients will see an improvement in their symptoms over time with conservative management, surgery is indicated in patients with debilitating pain, progressive neurology, significant weakness, instability or myelopathy. Advancements in surgical techniques offer a range of potential operations that should be considered carefully for each patient. This article outlines the clinical approach to presentation, pathophysiology, diagnosis and management.

**Key words:** Cervical radiculopathy, Facet joints, Neck pain, Radiculopathy, Stenosis

Received: 26 June 2020; accepted following double-blind peer review: 22 September 2020

## Introduction

Cervical radiculopathy is a neurological condition arising from dysfunction or compression of a cervical nerve root. This can manifest as electrical pain in the upper limbs with weakness, numbness and reduced reflexes on the affected side (Carette and Fehlings, 2005). Studies have demonstrated an annual incidence of 107 per 100 000 in men and 63 per 100 000 in women (Radhakrishnan et al, 1994), with a relatively low proportion of cases (15%) associated with trauma or physical exertion. The two most common causes of cervical radiculopathy are spondylosis of the facet joints and herniation of the intervertebral disc (Caridi et al, 2011). Given the large clinical overlap between cervical radiculopathy and compression of peripheral nerves, understanding the pathophysiology and clinically differentiating these is crucial.

## Clinical history and examination

The clinical presentation of a patient largely depends on the underlying cause of their symptoms. Patients with spondylosis and chronic herniations of the intervertebral discs have a more insidious history than those with an acute disc herniation (Caridi et al, 2011). Early epidemiological studies described risk factors such as male gender, cigarette smoking and heavy lifting in the development of cervical disc herniations. Other causes such as spinal tumours and infections are rare but important and symptoms must be clinically correlated to avoid missing these potentially devastating diagnoses. Any red flags identified during history taking, such as night pain, fever, previous cancer, past or present intravenous drug use, or immunosuppression, should lead the clinician to consider a more serious cause for the symptoms.

Patients with cervical radiculopathy tend to report unilateral neck pain with radiation to the ipsilateral arm (Rhee et al, 2007). This is in contrast to patients with axial neck pain, where pain is confined to the neck and nearby structures with no dysfunction in the upper limbs. Sensory symptoms such as numbness and paraesthesia tend to follow a dermatomal distribution, although referred pain is typically felt in a myotomal pattern (Wong et al, 2014). However, absence of referred pain does not rule out nerve root compression (Rhee et al, 2007).

When taking a history from any patient with cervical radiculopathy, it is very important to ask about symptoms pertaining to cord compression, or myelopathy. Patients presenting with cord compression may give a history of clumsiness, progressive weakness, gait disturbance and reduced fine motor function suggestive of myelopathy (McCartney et al,

### How to cite this article:

Patnaik S, Carr A, Inaparthi P, Kieffer WKM. Radicular arm pain. *Br J Hosp Med*. 2021. <https://doi.org/10.12968/hmed.2020.0365>

2018). Bladder or bowel dysfunction can also be present both separately or together, although these are very late signs. Myelopathy is a progressive and debilitating condition, and identification of symptoms requires urgent management.

Examination of patients with cervical radiculopathy should follow the 'look, feel move' formula. Patients often show a reduced range of spontaneous head movement, as well as a reduced head tilt (Devereaux, 2009). This is most pronounced in extension because of the narrowing of the foramen. Pain in the trapezius and interscapular region are common findings regardless of the root level affected and patients may complain of tenderness when this area is examined (Rhee et al, 2007).

Careful history may help to determine the affected level, as a patient will often accurately describe the area in which they feel pain or numbness. Examination of the affected side may also demonstrate objective weakness in a particular myotome, as well as reduced reflexes. Patterns of neurological deficits will point the clinician to the affected level (Figure 1 and Table 1). Other conditions can imitate cervical radiculopathy, and it is important that these are excluded, with or without further investigations. For example, C6 radiculopathy can mimic carpal tunnel syndrome. However, provocative tests for radiculopathy such as Spurling's manoeuvre will not worsen symptoms of carpal tunnel syndrome, and likewise tests at the wrist such as Durkan's or Phalen's test will not exacerbate a radiculopathy.

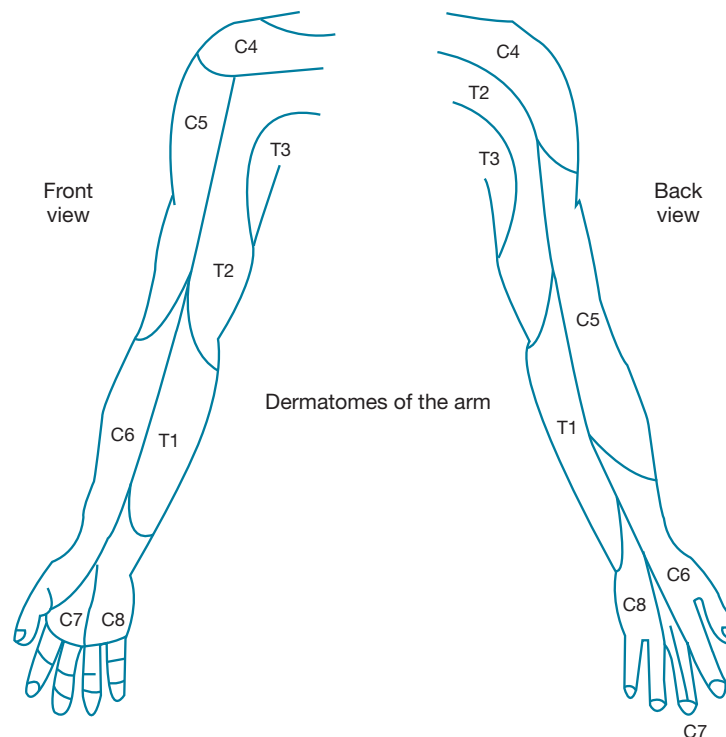
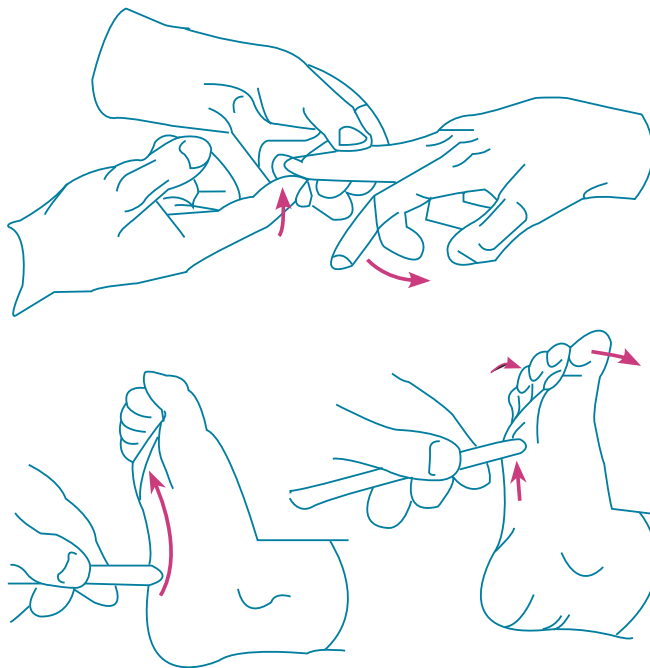


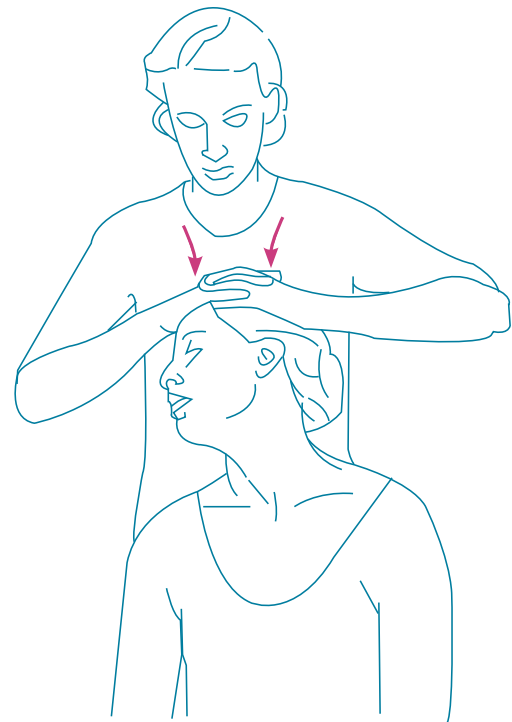
Figure 1. Dermatomes of the upper limb.

Table 1. Patterns of cervical radiculopathy with corresponding spinal level					
Disc 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	

From Carette and Fehlings (2005)



**Figure 2.** a. Hoffman's sign: the examiner holds the middle finger of the patient in extension, and gently flicks the fingernail of the finger towards the palm. If there is any flexion of the ipsilateral thumb or finger, this is a positive test. b. Babinski's sign: the examiner rubs the lateral aspect of the planar surface of the patient's foot, starting at the heel along a curve towards the toes. A test is positive when there is extension of the hallux or a fanning of the other toes.



**Figure 3.** Spurling's test, used to reproduce radiculopathy.



**Figure 4.** Shoulder abduction test.

Patients should also be examined for upper motor neurone signs such as hyperreflexia, Hoffman's sign (Figure 2a), clonus, impaired heel-toe gait or Babinski's sign (Figure 2b). Fine motor function can also be assessed by asking the patient to undo and button up a shirt. Positive findings make the diagnosis of myelopathy more likely and should be taken very seriously. Patients with myelopathic signs should have expedited investigations and surgical management if indicated, because of the progressive nature of the condition. Before any operative intervention, patients with myelopathy should be counselled that surgery is to prevent any further deterioration, and will not reverse the symptoms they already have.

### Special tests

Spurling's test (Figure 3) is one of a collection of provocative tests that may reproduce the symptoms of radiculopathy. Other tests include the shoulder abduction test (Figure 4), Valsalva manoeuvre, upper limb tension test and neck distraction. Spurling's test is performed with the patient sitting down, and the clinician standing behind the patient. The

neck is then extended and rotated to the side of pain while the examiner applies downward pressure onto the head. In patients with severe radiculopathy axial pressure is not required as this can cause significant pain and distress.

## Pathology

Compression of the cervical nerve root may occur as a result of herniation of intervertebral disc material or bony osteophytes that impinge on the cervical nerve root. Cervical spondylosis usually occurs between levels C5–C7, although higher levels can also be involved (Binder, 2007). Disc herniations at C7–T1 are rare, accounting for only 4–8% of cervical disc herniations (Lee et al, 2016). Note should be made of the mismatch in root numbering as the C8 root passes through the C7–T1 foramen.

Disc herniations are categorised as ‘soft’ and ‘hard’, the former being ruptured nucleus pulposus and the latter being cervical spondylosis where degeneration of the facet joints and loss of disc height causes compression. Spondylosis causes approximately 75% of cases of cervical radiculopathy, in contrast to the lumbar spine where soft herniation is more commonly seen (Radhakrishnan et al, 1994).

Nerve root impingement by disc material can lead to nerve damage by mechanical or chemical pathways. Mechanical compression of the spinal nerve is likely to lead to local ischaemia and nerve damage. However, direct pressure on the nerve root does not necessarily cause pain. A proposed mechanism for radiculopathy is the chemical pro-inflammatory cascade mediated by prostaglandin E2, interleukin factor 6, tumour necrosis factor alpha and matrix metalloproteinases (Kang et al, 1995).

Referred somatic pain from the neck arises from cervical structures including the intervertebral disc and zygapophyseal joint, which is usually felt in a segmental distribution. However, unlike in cervical radiculopathy, the pain is rarely felt below the elbow and the neurological examination is normal.

Primary tumours involving the spine are rare, while spinal column metastases are present in up to 70% of cancer patients. Radicular signs are frequently present in patients with spine tumours. The vertebral column is the most common site of metastases in the skeletal system and 8–15% of vertebral metastases are in the cervical spine consisting of the occipitocervical junction, subaxial spine, and cervicothoracic junction (Mesfin et al, 2015). Radicular signs results from the invasion or compression of the nerve root by the tumour itself or by pathological fractures causing root irritation.

## Differential diagnoses

### Brachial neuritis

Brachial neuritis (also known as neuralgic amyotrophy or Parsonage Turner syndrome) is one of the more common causes of brachial plexopathy, primarily affecting the upper trunk. The pathophysiology of brachial neuritis has not yet been fully described but risk factors include viral infection and rheumatic disease, as well as developing neuritis post surgery, immunisation or trauma (Feinberg and Radecki, 2010).

In contrast to cervical radiculopathy, brachial neuritis has a rapid onset of intense arm pain which is not exacerbated by neck movements, and provocative tests (Spurling’s manoeuvre) are negative. Sensory changes are non-dermatomal, typically subside within days to weeks and may be followed by weakness and/or paralysis of the upper extremity muscles. The majority (89%) of patients make a full motor recovery by 3 years (Tsairis et al, 1972). A diagnosis of brachial neuritis should be considered in patients who do not respond to conventional therapy and have progression of upper extremity muscle weakness irrespective of the reduction in pain.

### Thoracic outlet syndrome

Thoracic outlet syndrome is another cause of unilateral upper extremity pain and weakness and sensory changes over the medial forearm and ulnar digits caused by compression of the brachial plexus by a cervical rib or a fibrous band from an elongated C7 transverse process (McGillicuddy and Sullivan, 2003).

Presentation includes mild, deep, aching upper extremity pain, hand weakness and clumsiness, Tinel's sign in the supraclavicular fossa, weakness of the hand intrinsic muscles and wasting of the thenar ('guttering sign') and hypothenar eminence.

### Mononeuritis multiplex

Mononeuritis multiplex is a painful, asymmetrical, asynchronous sensory and motor peripheral neuropathy involving isolated damage to at least two non-contiguous nerve systems. However, multiple nerves in random locations of the body can be affected and, as the condition deteriorates, it becomes less multifocal and more symmetrical (Vial and Bouhour, 2008).

It is mostly associated with systemic disorders such as diabetes, vasculitis, amyloidosis, systemic lupus erythematosus, paraneoplastic syndromes and some viral infections including AIDS (Lenglet et al, 2011).

### Musculoskeletal pain

Patients with shoulder joint dysfunction, including rotator cuff injuries and frozen shoulder, may complain of pain in the shoulder and lateral aspect of the upper arm occasionally radiating down the elbow. These disorders can be distinguished from a radiculopathy as pain is exacerbated by shoulder movement rather than neck movement, and patients will have normal reflexes and a normal sensory examination.

### Pancoast tumour

Pancoast tumour is a rare bronchogenic carcinoma, accounting for less than 5% of cases of lung cancer (Foroulis et al, 2013). They involve the apices of the lung, infiltrating the chest wall and also the thoracic inlet. As the tumour grows, patients experience severe pain in the shoulder that radiates to the axilla, neck and scapula. Pain also radiates down the ipsilateral medial aspect of the arm and forearm along the distribution of the ulnar nerve, and is associated with wasting of the intrinsic muscles of the hand. Infiltration of the sympathetic chain and stellate ganglion cause the classic Horner syndrome including ptosis, miosis, ipsilateral anhidrosis of the face and enophthalmos.

### Double crush syndrome

Double crush syndrome is a distinct compression at two or more locations (proximal in cervical spine and distal in cubital tunnel, carpal tunnel or elsewhere) along the course of a peripheral nerve that can coexist and synergistically increase symptom intensity. The exact mechanism of this phenomenon is controversial and fiercely debated.

Clinical examination combined with electrodiagnostic studies can help the clinician in the diagnosis of double crush syndrome. Injection therapy can also be used as a diagnostic tool; both nerve root and peripheral injections are used to help distinguish the predominant area of symptomatic compression.

In patients with a strong suspicion of double crush syndrome and failure of conservative measures, surgical decompression of the peripheral site is usually addressed first and the patient counselled about the possibility of incomplete relief.

## Investigations

Imaging and electrophysiological testing play key roles in investigating cervical radiculopathy. Although commonly ordered in primary care, plain radiographs are of limited use as they do not show disc herniations or intervertebral narrowing, and have low sensitivity in diagnosing tumour or infection (Carette and Fehlings, 2005).

Computed tomography scanning is the most sensitive form of imaging to assess the bony structures of the spine, identifying osteophyte formation, evidence of foraminal encroachment and ossification of the posterior longitudinal ligament which could be causing cervical pain. However, a computed tomography scan alone has poor sensitivity in visualising soft tissue structures.

Magnetic resonance imaging scanning is the imaging modality of choice given the ability to assess soft tissue structures as well as show the course of the nerve exiting the foramen (Caridi et al, 2011). In patients who have an indwelling magnetic resonance imaging

incompatible device or any other contraindications to a magnetic resonance imaging scan, a computed tomography combined with a myelogram may allow delineation of the affected level but is more invasive and carries more risks including meningitis, infection or damage to the spinal nerves.

If a patient has had symptoms for 4–6 weeks without resolution, as well as any objective neurological signs, National Institute for Health and Care Excellence (2018) guidelines recommend referral for a magnetic resonance imaging scan. This includes progressive symptoms, as well as the presence of myelopathy or red flag symptoms.

Electrodiagnostic studies can be useful in patients where there is difficulty differentiating between a peripheral nerve entrapment and cervical radiculopathy. However, they should never be the only determinant for diagnosis or future management because of the relatively high level of false positive and negative results (Rhee et al, 2007).

## Management

### Non-operative treatment

The primary aim of conservative treatment is to relieve pain, improve neurological function, and prevent recurrence. Non-steroidal anti-inflammatory drugs are often the mainstay of pharmacological management. Use of oral steroids is controversial, and dosing should be short term if at all. Tricyclic antidepressants and drugs such as gabapentin can be a useful adjunct in the treatment of radicular arm pain.

Ancillary treatments such as bracing, traction and electrical stimulation are associated with improvements in patient-reported pain in some uncontrolled cases series. Physical therapies beginning with gentle range of motion exercises, and then progressing to strength and conditioning activities provide a short term benefit of neck pain and grip strength without altering the natural course of radiculopathy (Rhee et al, 2007).

Cervical nerve root blockade in the form of transforaminal epidural steroid injection using fluoroscopic guidance achieves good pain relief in around 60% of cases (Lin et al, 2006), but due consideration should be given to potential complications ranging from minor to more severe, such as epidural haematomas and spinal cord infarction with severe neurological sequelae.

In the vast majority of patients (75–90%) with radiculopathy, signs and symptoms will improve with non-operative management over a variable length of time without specific treatment (Sampath et al, 1999).

### Operative treatment

As most patients improve without surgical treatment, surgical intervention should be carefully considered. Surgery is indicated for the rapid relief of symptoms when there is debilitating pain that is resistant to conservative measures, progressive neurological deficits, clinically significant motor deficits, signs of cervical instability or myelopathy with magnetic resonance imaging evidence of nerve root compression.

The timing of surgical intervention is unclear. Most patients who respond to conservative treatment do so within 4–6 months (Wong et al, 2014). Worse outcomes from surgery have been found with longer duration of symptoms (Burneikiene et al, 2015). A cut-off period of 6 months of non-operative treatment is recommended as significant better pain scores were seen in patients who underwent decompression within 6 months of onset of symptoms (Burneikiene et al, 2015).

When planning surgery, the chosen operation will depend on factors including the location of the pathology, previous surgery, single or multi-level disease, congenital factors, spinal alignment and comorbidities. There are multiple surgical techniques to treat cervical radiculopathy, all of which rely on decompression of the affected nerve root(s) either directly or indirectly. These include anterior cervical discectomy with or without fusion or instrumentation, posterior cervical foraminolaminotomy and the newer anterior cervical disc replacement.

Most surgeons currently choose to perform anterior cervical discectomy with fusion rather than anterior cervical discectomy alone (Arrojas et al, 2017). Fusion involves introducing a strut graft between the vertebral bodies using bone or synthetic materials such as a titanium

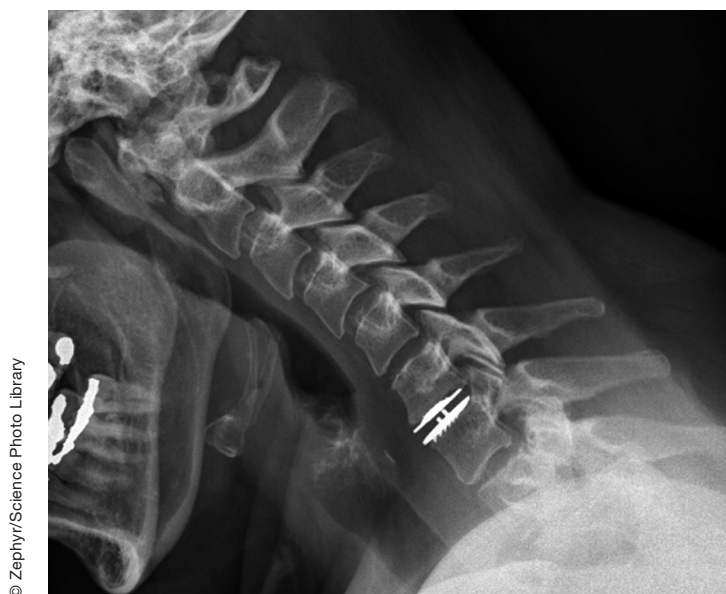
age (Figure 5). Studies point to anterior cervical discectomy with fusion as a superior option, allowing a more predictable functional outcome and protection against disc space collapse with successful fusion (Fraser and Hartl, 2007; Peolsson and Peolsson, 2008). Inserting a graft increases the rate of fusion and allows indirect decompression of the neural foramen by increasing the cephalocaudal height of the space without destabilising the posterior elements of the cervical spine (Samartzis et al, 2004; Fraser and Hartl, 2007). Plating with anterior cervical discectomy with fusion is generally reserved for patients with more than two level pathology and in whom the fusion rate is expected to be low, such as those with a history of smoking, osteoporosis and advanced age (Bose, 2001). In patients with a kyphotic cervical spine, this procedure allows the cervical lordosis to be restored through decompression and fusion (Galbraith et al, 2012).

Research has focused on anterior cervical disc replacement (Figure 6) as it potentially offers the benefit of ‘motion-preserving’ surgery, avoiding the risks of adjacent segment degeneration. A systematic review reported greater clinical success and consistently lower re-operation rates in comparison to anterior cervical discectomy with fusion (Hu et al, 2016).

In patients with foraminal stenosis and anterolateral disc herniation, posterior cervical foraminolaminotomy via a midline posterior approach to the spine is often used (Rhee



**Figure 5.** Lateral cervical spine X-ray demonstrating anterior cervical disc fusion.



**Figure 6.** Lateral cervical spine X-ray demonstrating a spinal disc implant.

## Key points

- Cervical radiculopathy causes acute neck and arm pain that can be particularly debilitating and requires careful history and examination to ascertain the cause and location of pathology.
- Red flag signs indicating infection, malignancy and myelopathy should be acted upon as a matter of urgency.
- Imaging and electrophysiological studies comprise the mainstay of investigations, with magnetic resonance imaging scanning being the preferred method of imaging.
- Although the majority of patients will have resolution of their symptoms without surgical intervention, surgery is indicated in patients who have unmanageable pain, progressive neurological deficit and signs of myelopathy.
- The approach to surgery should be considered for each patient, depending on pathology and patient factors.

et al, 2007). This exposes and decompresses the affected nerve through a window in the lamina, at the junction with the facet joint. It is an excellent technique in patients with a single level radiculopathy although it can be useful in addressing multi-level pathology (Galbraith et al, 2012) and is best applied to soft disc fragments causing neural foraminal stenosis without degenerative changes. Posterior cervical foraminolaminotomy can preserve motion in the spine and avoid morbidity associated with the anterior approach, such as dysphagia and implant-related complications. It also has the benefit of maintaining spinal alignment and not requiring a fusion. However, this does not allow easy decompression of anterior pathology and the patient is at risk of continued degeneration of the involved segment, which may require a revision procedure (Iyer and Kim, 2016). Despite the higher re-operation rate of posterior cervical foraminolaminotomy compared to anterior cervical discectomy with fusion surgery, in patients with single level unilateral cervical radiculopathy these two methods show comparable results in terms of clinical outcome, patient satisfaction and complication rates (Fang et al, 2020).

## Conclusions

Patients presenting with neck and arm pain should have a thorough history and examination to elicit the potential cause. Those with symptoms suggestive of cervical radiculopathy with or without myelopathy should have a prompt workup to establish the cause, whereby correct referral and management by appropriate clinicians will be possible. Depending on the patient's circumstances as well as symptoms, treatment could be conservative or interventional.

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### Conflicts of interest

The authors declare that there are no conflicts of interest.

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## Curriculum checklist

This article addresses the following requirements from the general internal medicine training curriculum:

- Is focused on patient safety and delivers effective quality improvement in patient care
- Managing patients in an outpatient clinic, ambulatory or community setting, including management of long-term conditions
- Managing medical problems in patients in other specialties and special cases.

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