Incidence
Neck pain is a common condition that affects adults of all ages and sexes. It is slightly more common in males. Sixty-seven per cent of adults will experience pain during their lifetime, but only 5% will become disabled because of this pain.1

Pathophysiology
The pathophysiology is the same as for the lumbar spine.1 The three stages described by Kirkaldy-Willis2, describe this process:
1. Initial dysfunction: characterised by circumferential and radial tears in the annulus and synovitis of the uncovertebral and facet joints
2. Instability: characterised by internal disc disruption, resorption, and degeneration of the facet joint, with capsular laxity, subluxation and joint erosion, and finally
3. Stability: where hypertrophic bone around the discs and facet joints lead to segmental stiffening or ankylosis.

Kang et al identified increased levels of metalloproteinases, nitrous oxide, prostaglandin E2 and interleukin 6 in retrieved disc material, suggesting that these substances are intimately involved in the degenerative process as well as in axial pain production. This biochemical process results in mechanical change with loss of disc height, subsequent disc bulging posteriorly, accompanied by infolding of the ligamentum flavum. Combined with osteophyte formation, there are decreased canal and foraminal dimensions, reducing the area available for the neurological structures.

A canal diameter on lateral X-ray of less than 14 mm is defined as stenotic. With increased utilisation of MRI, cord compression is directly visualised either anteriorly by disc pathology or posteriorly by ligamentous hypertrophy. Cord signal changes and cord deformation confirm myelopathy. In addition to the mechanical compression on the cord, there is also an alteration of the blood supply causing destruction of both grey and white matter. This may cause ascending and descending demyelination above and below the level of the compression.1

Clinical picture
Patients with cervical spine-related problems can be systematically approached by dividing their presentations into axial neck pain, radiculopathy or myelopathy syndromes. It is essential to remain cognisant of non-cervical causes of the complaint.

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Axial neck pain
The spondylotic pain associated with degenerative disc disease is typically episodic, with the chief complaints being of neck, scapular and shoulder pain. Probable sources include the discs, facets, extensor muscles and greater occipital nerve. There may be symptoms of vertebral artery compression with dizziness, tinnitus and occasional retro-ocular pain. Symptoms are exacerbated by neck range of motion, especially extension.

Dwyer, April and Bogduk injected contrast media into the facet joints of the C-spine of normal individuals and produced a topographical map of pain (Figure 1). The pattern of pain distribution is sclerotomal, i.e. involving an area of common embryological origin. The branches of the dorsal rami, which innervate the posterior musculature and skin, together with the sinu-vertebral nerve are responsible for the transmission of pain to these specific areas. This differs from the dermatomal pain distribution of radiculopathy, where the pathology involves the nerve root.

Figure 1: Areas of pain experienced on facet joint provocation

Radiculopathy
Usually presents as pain and neurological dysfunction along a nerve root distribution, with pain radiating down the arm or into the chest. There may be associated paraesthesia or weakness of the affected myotome. The pain is usually intermittent and associated with neck and shoulder pain and may be aggravated by neck extension and lateral flexion to the side of the pathology, i.e. Spurling’s sign. The arm pain is typically worse than the neck pain. The level of the lesion can be localised according to the neurological findings.

The shoulder abduction relief sign may be present. This test has been equated to the straight-leg raise in the lower limb, where pain is relieved with positioning the arm behind the head, with the shoulder abducted and elbow flexed. Patients may spontaneously adopt to this posture to ameliorate their symptoms. Axial compression and distraction tests have low sensitivity.

Myelopathy
Myelopathy is often multi-segmental in the patient over 60 years, with stiff segments contributing to both static and dynamic stenosis. As a result, there is often a spectrum of symptoms and signs, often with poor correlation between neurology and the level of maximal compression.

There is “no pathognomonic symptom or physical sign”. The course of the disease is often prolonged and the patient can present with very subtle and poorly localised and vague pain (which may only be a minor complaint) or tingling on neck extension. They often present initially with subtle gait disturbances, with subjective instability, loss of balance or stiffness with ambulation. At the other end of the spectrum, they may present with an atactic gait, spasticity, motor weakness of the legs and hyper-reflexia.

They may present with the “myelopathy hand”. This can be as subtle as weakness of grip strength, inability to grasp and release rapidly, weak abduction and extension of the ulnar digits, to overt signs of such as a positive Hoffmann and inverted radial reflex, the finger-escape and grasp-release signs. A positive scapulo-humeral reflex is indicative of stenosis above C3.

Less commonly there may be autonomic dysfunction, viz. the Barre-Lieou syndrome. First described by Barre in 1926, patients present with a variety of symptoms such as occipital headaches, tinnitus, nystagmus, temporary deafness, blurred vision, corneal hyperaesthesia and ulcers. It has been attributed to trauma or degenerative disc disease at C3 and C4, causing a disturbance of the cervical sympathetic nerves and vascular disturbance of the fifth and eight cranial nuclei.

In a study done by Good et al, less than 50% of patients with myelopathy had the correct diagnosis made at initial presentation to a physician, with a minimum average delay to diagnosis of six months.

Differential diagnosis
Non-cervical causes must be considered. These would include:

• tumours of thorax, mediastinal pathology, Pancoast tumour
• nerve compression syndromes, thoracic outlet syndrome
• degenerative processes or rotator cuff tears of the shoulder.
Classification of cervical disc disease

(Odom)
1. Unilateral soft disc protrusion with nerve root compression *(Figures 2 and 3)*
2. Foraminal spur/hard disc with nerve root compression
3. Medial soft disc protrusion with spinal cord compression *(Figure 4)*
4. Transverse ridge or cervical spondylosis with spinal cord compression

Soft discs (disc extrusion) usually affect one level, whereas hard disc (osteophyte/disc complex) pathology usually affects multiple levels. The C5/6 level is affected in the majority of cases.

Natural history

Axial pain and radiculopathy

The natural history of cervical degenerative disc disease is not entirely benign with 25-30% continuing to have chronic symptomatology warranting consideration for surgical work-up. There is good evidence to show that acute disc herniations usually decrease in size over time and that most patients with symptomatic disc herniations and non-progressive radicular symptoms respond well to non-operative treatment. It is rare for patients with radiculopathy to progress to a myelopathy.

Myelopathy

There are few studies and little consensus defining the natural history of myelopathy. There is some debate as to what percentage of patients will actually deteriorate neurologically, but it seems apparent that spontaneous improvement is unlikely. Sampath et al performed a prospective outcome analysis study, comparing medical versus surgical treatment in patients with myelopathy. Medical treatment did not significantly affect neurological outcome, functional status or pain but had a significant detrimental effect on the ability to perform activities of daily living. There was a significant improvement in pain and functional status in the surgically treated group, though no significant improvement in neurological outcome was shown. When the two groups were compared, the surgically treated group had better outcomes, despite having worse pre-operative functional disability. Nurick followed up 36 patients with myelopathy who were treated conservatively, and found that patients who presented with mild symptoms rarely progressed. Deterioration in functional status seemed to be worse in patients over 60 years. In Epstein’s clinical review of 1355 patients, 36% improved, while 64% did not, and of the latter group, 26% experienced neurological deterioration. Clark and Robinson, in their study showed that the majority of the symptomatic patients (66%) experienced deterioration, and none reverted to a normal neurological state when symptoms had been present for longer than two years.

Figure 2: Sagittal MRI of patient with left arm and peri-scapula pain demonstrating C6/7 disc herniation

Figure 3: Axial MRI of same patient showing compression on left C7 root
Natural history studies have failed to establish prognostic indicators that could predict which patients in the mild group would progress. However, it seems unlikely that patients with moderate to severe symptoms will improve without surgical intervention.

**Investigations**

**X-ray**
Standard antero-posterior and lateral views of the cervical spine are a good starting point, but not particularly useful in non-traumatic cervical pathology due to the high incidence of asymptomatic degenerative changes in the population. Oblique views may assist with assessment of the foramina.

**Magnetic Resonance Imaging (MRI)**
MRI is the definitive diagnostic procedure due to the ability to visualise the soft tissue component. It is of course only an adjunct to a clear history and careful clinical examination. With the sensitivity of MRI many clinically irrelevant findings may be present, especially in the older patient. This may create a diagnostic dilemma as to which disc is causing symptoms. There are also a myriad other sources of the patient’s pain – the degenerative disc may just be part of the natural ageing process and not necessarily the major source of the patient’s pain.

**Discography**
The use of discography is controversial. It may be indicated in axial neck pain, without neurological findings where MRI is not diagnostic or shows multiple level disease. The aim of this investigation is to record reproduction of the patient’s pain at the affected level with little or no pain in a control level. When there is no validated level, or if pain is not elicited, then surgery is unlikely to be successful.

**Management**

**Non-operative management**

**Axial neck pain and radiculopathy**
The best initial treatment consists of short-term periods of rest, non-steroidal anti-inflammatory medication (NSAIDs) and positioning the neck in a position of comfort.

**Medication**
Simple NSAIDs or the new Cox II inhibitors, with fewer GIT side-effects, are usually effective. Narcotics and muscle relaxants are a good choice for acute exacerbations, but with long-term use can independently lead to depression, especially diazepam, and have significant potential for abuse. Amitryptaline is a better long-term alternative.

**Rest and splinting**
A 48-hour period of rest is the recommended maximum for any patient with acute pain before the rest also contributes to the patient’s pain. Soft cervical collars are useful, especially when worn back to front, to avoid cervical extension which usually aggravates the pain. Bracing causes rapid atrophy and loss of tone of the paraspinal muscles and should be used continuously for short periods only, and thereafter only at night. For this reason rigid collars are contraindicated in this patient group.

**Traction**
Traction has not been shown to be of any clinical benefit in the patient with axial pain. It may be helpful in the short-term in the patient with acute radicular pain secondary to an acute herniated disc.

**Exercise**
Most studies support exercise targeted at improvement in overall general fitness with active *supervised* aerobic exercises. It is important that the patient attend a physiotherapist initially to supervise this programme. Exercises should be targeted at improving strength and endurance of the neck, and as important, the shoulder and scapular stabilisers. Passive exercises of the neck should be avoided. There have been no studies proving any benefit from ultrasound, massage or manipulation.

**Surgical management**

**Indications for surgery**
- **Axial pain:** Failure of 6-12 months of non-operative treatment, despite active rehabilitation, increasing axial pain severe enough to interfere with desired activities of daily living in a patient with no psychosocial contra-indications.
• **Radiculopathy**: Persistent or recurrent arm pain unresponsive to a 6-12 week trial of conservative therapy or an increasing neurological deficit.

• **Myelopathy**: Unclear indications in mild disease, but no delay in progressive scenario.

**Surgical management of axial neck pain and radiculopathy**

Neural compression is managed primarily by decompression and may be augmented by stabilisation (fusion). Surgery for axial pain is less established but enthusiasts would utilise motion segment fusion or more recently arthroplasty techniques.

**Anterior cervical discectomy and fusion (ACDF)**

The treatment of disc herniations by anterior cervical discectomy was first popularised by Robinson and Smith in 1958. ACDF is preferred for most cases as the pathology is predominantly anterior to the cord and can be removed without having to manipulate the cord with all the associated risks. Insertion of bone graft facilitates fusion, but more importantly, distracts the bodies and indirectly decompresses the neural foramina.

The side of approach depends on surgeon preference. A right-sided approach is more comfortable for the right-handed surgeon, while others prefer a left-sided approach, to decrease the risk of inadvertent recurrent laryngeal nerve injury. The disc is removed in its entirety, the endplates are curetted until bleeding bone is exposed and a tricortical graft inserted. More recently instrumentation (anterior plates and interbody cages – Figure 5) have been added to improve fusion rates and reduce subsidence but improved outcomes are not easily demonstrable.

The patient is immobilised in a firm collar for 6-8 weeks until bony union, and most patients can expect full return to normal activity by 6-12 weeks.

**Results**

There is weak support in the literature for ACDF in the management of axial neck pain. Some studies report a 70-80% good/excellent outcome in well-selected patients. More critical to a successful outcome in axial neck pain however, is that the objective findings of disease correlate with the clinical picture, MRI or discography.

ACDF is a highly reliable surgical procedure for radiculopathy in well-selected patients, with statistically significant improvements in postoperative scores for both pain and function.

Due to concerns about adjacent segment degeneration following fusion, interbody arthroplasty is advocated. Although motion is maintained post-operatively, spontaneous ankylosis in the medium term is common, and long-term outcome is still not available. Ongoing axial pain is a risk to facet degeneration and this procedure will probably be limited to the young patient with radiculopathy who is unsuitable for a posterior decompression.

**Posterior approach**

The posterior approach may be utilised for lateral disc herniations. Foraminotomy is contraindicated in central stenosis where there are large central disc herniations with myelopathy and instability, as excessive cord manipulation would be required. The approach affords limited ability to correct any deformity and it is inadvisable in severe kyphotic deformity, as the decompressed nerve root will continue to be draped over the anterior pathology with ongoing symptoms. As it does not restore disc height, there is a risk of long-term deterioration in results as the disease progresses at that level.

The approach requires quite extensive muscle dissection with postoperative pain. Significant epidural bleeding is also an obstacle. As a result, microscopic approaches are becoming more popular claiming reduced operating time, less bleeding and shorter hospital stays with earlier return to function. Despite this an 84-98% success rate in relief of radicular symptoms is reported. Fessler and Khoo showed no significant difference in long-term outcome when comparing open versus endoscopic techniques. Hard discs have less successful outcomes.

![Figure 5: Postoperative X-ray demonstrating C6/7 interbody cage](image-url)
Management of cervical cyclopa thy
The options are ACDF, anterior corpectomy and fusion, and the posterior procedures of laminectomy or lamino- plasty.

The anterior approach affords direct visualisation and decompression of the offending structures such as the disc and uncovertebral osteophytes. It decompresses the anterior spinal artery, which supplies the anterior 80% of the cord thereby alleviating any ischaemic component of the neurology. It allows concomitant deformity correction in the instance of kyphotic deformity or instability, which is common and often contributes to the myelopa thy, to restore the normal sagittal profile and undrape the cord off the kyphotic segment. The stabilising effect of fusion protects the cord from repetitive movement and microtrauma, affording the best environment for healing and functional recovery.

There is still controversy regarding the best treatment for patients with multi-level spondylosis. Successful fusion and clinical outcomes diminish with multilevel procedures. Pseudoarthrosis rates after single level surgery is 0-20%, compared to that of 50% for multi-level surgery. Emery et al, showed an unacceptably high pseudoarthrosis rate (44%) in three or more level ACDF procedures. Boles and colleagues report an only 47% solid fusion in patients undergoing 3- or 4-level ACDF despite the addition of anterior instrumentation. Smoking had a significant negative impact on healing and clinical recovery.

Hillebrand in a retrospective review of patients treated with multi-level disease, compared results of ACDF to that of corpectomy and strut grafting. Arthrodesis was 64% in single level surgery versus 100% for that of corpectomy and strut grafting. They concluded that strut grafting requires union across only two sites compared with four or six surfaces with multi-level ACDF, making the former a better option particularly in smokers or patients at high risk of non-union.

Posterior decompression allows for indirect decompression of the canal, by expanding the posterior arch, either by removal of the arch (laminectomy) or by increasing the “girth” of the arch as with laminoplasty. This allows the cord to shift posteriorly and away from the anterior pathology.

Posterior options are considered in congenital stenosis, cord compression secondary to posterior pathology or multilevel disease in the absence of kyphosis. Theoretically, spinal stability and motion are preserved despite laminectomy, and fusion is not necessary, avoiding graft related complications. In the well-selected patient, results and neurological recovery is similar to that of anterior procedures. This procedure should only be considered in the patient with a normal lordotic cervical spine with no degenerative instability, as the cord will remain tethered over the kyphotic segment despite posterior expansion of the canal in this instance.

Laminectomy alone is adequate for decompressing the cord in the absence of instability. If there is any instability, posterior stabilisation should be performed concomitantly, such as with for example, lateral mass screw and rod fixation (Figures 6 and 7). In order to obtain adequate decompression, the level above and below the stenotic segment needs to be included, necessitating quite an extensive surgical exposure in the multilevel stenotic spine.

Posterior surgery has the disadvantage of an associated increased axial neck pain (up to 30%), a tendency to progressive loss of lordosis with time and progressive loss of motion despite no concomitant fusion having been performed. Radiculopathy can occur as the cord moves dorsally impinging the nerve root, with C5 being the commonest root involved.

Yonenobou et al, looking at cervical myelopathy, found the anterior approaches have a 76% good to excellent result, compared to that of only 65% for laminectomy.
There is a tendency for patients treated with laminoplasty or laminectomy to deteriorate with time, despite their initial clinical outcomes being comparable to that of anterior approaches. Ten per cent of patients develop recurrence of symptoms, mainly because of post-laminectomy kyphosis and adjacent segment degeneration. Outcomes for laminectomy vs. laminoplasty are also slightly worse, with Herkowitz reporting a good to excellent result in only 66% of laminectomy patients compared to 82% with laminoplasty.

Conclusion

Cervical degeneration is common and age-related making it imperative that special investigations are interpreted in light of the history and clinical findings. Radiculopathy is frequently self-limiting and an expectant approach can be maintained. Myelopathy, however, is frequently progressive and seldom improves spontaneously, mandating a more aggressive approach.

There are many surgical options and an even greater number of instrumentation options available, each with its own specific indications, advantages and disadvantages. Patients therefore require an individualised management plan.

In our expanding elderly population, cervical degenerative disease is a growing burden. Although outcomes for radiculopathy and myelopathy treated operatively are good, the results of surgery in axial neck pain are not as promising, and we should be proactive in offering our patients a more comprehensive and supervised conservative management programme.

References


Bibliography