SURGICAL DISORDERS OF THE CERVICAL SPINE: PRESENTATION AND MANAGEMENT OF COMMON DISORDERS

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"This man needs to see a Doctor!" So wrote an exasperated neurologist after reviewing a patient on the neurosurgical ward. Unfortunately this comment still springs to mind when one considers the clinical management of some cervical spine problems.

Magnetic resonance imaging (MRI) scanning has led to a tidal wave of referrals of cervical spine problems to neurosurgeons. However, in many cases, the problem is more apparent on the scan than clinical assessment. MRI scanning cannot replace thoughtful history taking and clinical examination, and does not provide the necessary information for diagnosis and treatment. As a rule of thumb appropriate management depends in equal part on history, examination, and investigations.

SPINAL DEGENERATIVE DISEASE

Cervical degenerative disease is common and it is often difficult to distinguish pathological changes from the normal aging process. Neck, shoulder, and brachial pain is frequently encountered and the majority of patients presenting with these symptoms do not need consideration for surgery. Patients and doctors may feel that there is "something" that should be done although, in fact, this is rarely the case. MRI scans may well reinforce this delusion by demonstrating abnormalities. Such findings must, however, be put into perspective. Cervical disc degeneration reaches a prevalence of nearly 95% by the age of 65 years, so it is hardly surprising if the majority of patients have some abnormality on their scan.

Surgery is generally used in degenerative disease for decompression of spinal cord or nerve roots. The decompression itself may lead to a relative destabilisation of the cervical spine by interference with muscle, ligament or bone. This can result in worsened (and potentially disabling) postoperative neck pain, and to avoid this complication decompression procedures may be combined with a simultaneous fusion. However, the resultant loss of spinal movement following such a fusion may result in accelerated degeneration at adjacent spinal levels. Thus, as with all surgical procedures, a careful consideration of the benefit from surgery must be balanced against risk. To do this we need to understand both the natural history of cervical spondylosis and the expected outcomes with surgery. Unfortunately, such information is not available as randomised clinical studies have not addressed this issue.

CERVICAL ANATOMY

The upper surface of a typical cervical vertebral body is concave from side to side and convex in an anterior posterior direction (fig 1). The upper projection of the lateral superior surface is known as the uncus and articulates with the vertebral body above at the uncovertebral joint of Luschka. The pedicle is attached below the uncovertebral joint on the body of the vertebra. Thus an intervertebral foramen is bounded in front by both vertebral bodies, the uncovertebral joint, and the lateral disc. Posteriorly the foramen is bounded by the facet joint (figs 1, 2, and 3). Root compression may occur secondary to osteophyte formation arising from the uncovertebral joint medial to the root or the facet joint lateral to the root. These bony abnormalities are particularly well seen on computed tomography (CT) (fig 3). A lateral disc prolapse may also compress the root.

The laminae enclose a relatively large spinal canal which is triangular in cross section and nicely defined on axial MRI (fig 1). Cord compression may occur anteriorly, secondary to midline disc prolapse, osteophyte or more rarely ossified posterior longitudinal ligament (fig 4). The cord may be compressed posteriorly by a hypertrophied ligamentum flavum.

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CERVICAL SPONDYLOSIS

Cervical spondylosis describes a non-specific degenerative process of the spine, which may result in varying degrees of stenosis of both the central spinal canal and root canals. Factors contributing to this narrowing include degenerate disc, osteophyte, and hypertrophy of lamina, articular facets, ligamentum flavum, and posterior longitudinal ligament. Other relevant pathological processes

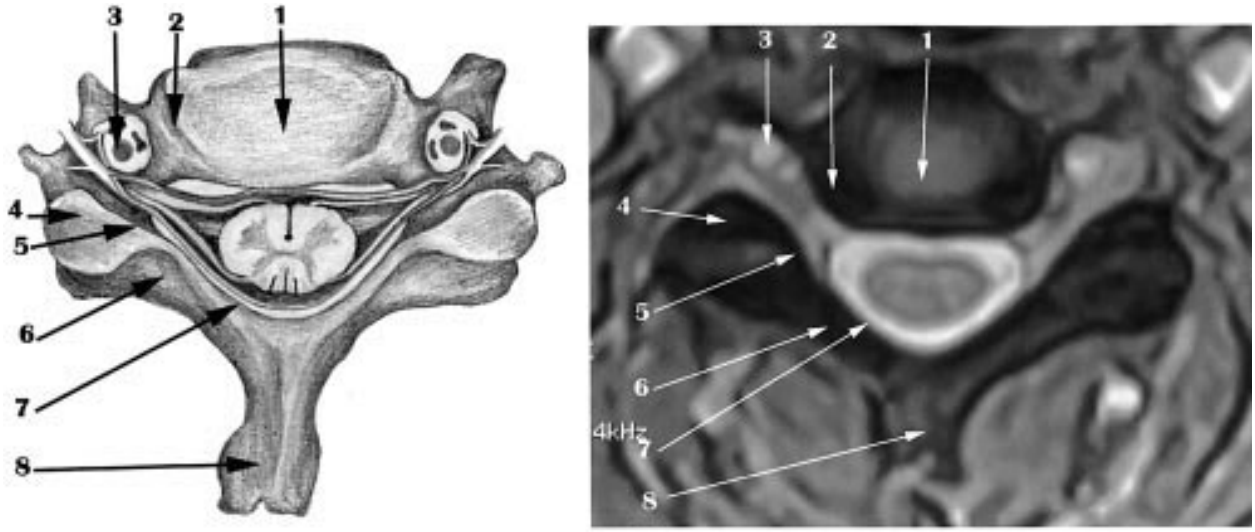

Figure 1 Axial cervical spine anatomy. The key on the illustration (left) corresponds to the key on the MRI image (right). (1) Anterior vertebral body endplate. (2) Uncus (constituting one side of uncovertebral joint). (3) Vertebral artery within foramen transversarium. (4) Lower facet. (5) Medial aspect of facet joint. (6) Lamina. (7) Site of attachment ligamentum flavum. (8) Spinous process.

include loss of the cervical lordosis and vertebral body subluxation. A congenitally narrow canal will precipitate the early development of symptoms.

In the first two decades of life few changes occur within the spine, but from the third decade onwards degeneration is apparent. This tends to start at the level of the disc and is most common at C5/C6 and C6/C7. The majority of individuals over 50 years have radiological evidence of degenerative disease, but only a small proportion will have neurological symptoms or signs.

CLINICAL PRESENTATION OF CERVICAL DEGENERATIVE DISEASE

Radiculopathies

Referred pain in the arm from nerve root irritation is often referred to as brachalgia and can be severe. Root compression occurs secondary to:

- disc prolapse
- osteophyte
- instability of a spinal segment

Symptoms most commonly begin on waking in the morning without any precipitating event. In the earliest stages paraesthesia may be prominent with the more typical radicular pain following at an interval. Many patients will present with symptoms and signs of a monoradiculopathy, although functional overlap between nerve roots and multiple root entrapment means that symptoms and signs are not always clear cut. Nonetheless, it is important to try to establish the level of a suspected entrapment by history and examination to allow appropriate interpretation of MRI findings. Congruence between history, examination, and MRI results is the key to appropriate selection of patients for surgery. Henderson and colleagues[1] noted in a large series of operated cases of cervical radiculopathy that just over 50% of all cases had dermatomal symptoms, whereas the majority of patients with C6 and C7 radiculopathies had diagnostic motor, reflex, and sensory changes. In this series more than three quarters of patients had neck pain, over a half had scapular pain, and nearly a fifth anterior chest pain.

Most herniated discs cause painful limitation of neck motion, particularly neck extension or rotation to the side of the pain. Some patients gain relief of symptoms by raising an arm or resting the hand on the back of the head. Worsening of symptoms with Valsalva activities is common.

The most common levels of disc herniation are C5/C6 and C6/C7 leading to compression of the C6 and C7 roots, respectively. C3 root compression is very rare and may present with pain and numbness around the mastoid and pinna. C4 root compression may cause pain and numbness in the back of the neck, over the scapula, and sometimes the anterior chest. The symptoms and signs of lower cervical root compression are shown in table 1.

C5 radiculopathy may be confused with shoulder pathology, and left C6 radiculopathy may be mistaken for angina. C8 and T1 nerve root involvement may rarely produce a partial Horner's syndrome.

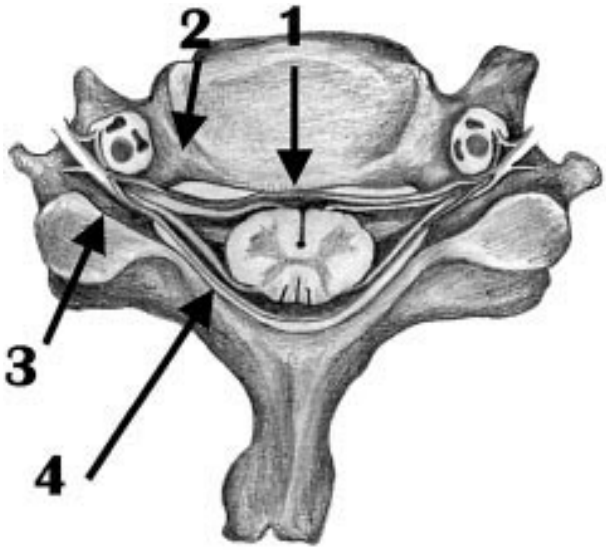

Figure 2 Potential sites of pathology causing compression of the spinal cord or spinal root in cervical spondylosis. (1) Central disc prolapse or osteophyte. (2) Lateral disc prolapse or osteophyte of uncovertebral joint. (3) Medial facet joint osteophyte. (4) Ligamentum flavum hypertrophy.

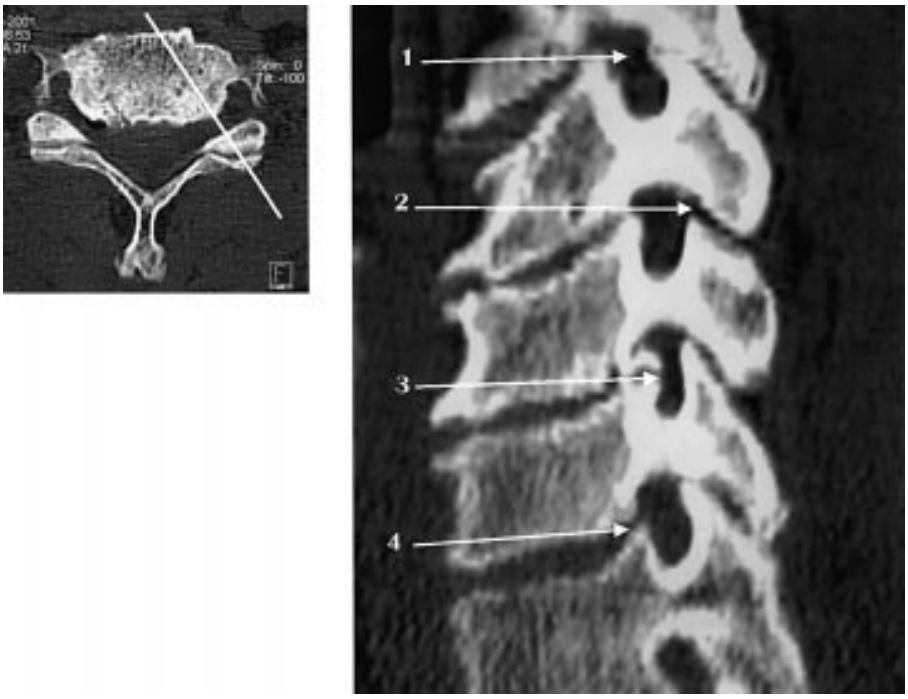

Figure 3 Axial (left) and oblique (right) CT scans of the cervical spine. White line on axial image corresponds to plane of oblique image through root canal. (1) Root canal. (2) Facet joint. (3) Uncovertebral osteophyte causing root canal stenosis. (4) Lateral disc space.

MRI is the investigation of choice. Plain cervical *x* rays in flexion and extension are performed if there is a question of instability. CT scanning is occasionally used to look at bony anatomy when planning surgical approaches.

Most patients with acute cervical radiculopathy caused by cervical disc herniation will improve spontaneously. Anti-inflammatories, analgesia, and a cervical collar will speed recovery. If surgery can be avoided the long term prognosis is good. Lees and Turner[2] described 51 patients with cervical radiculopathy followed up for 19 years—45% had only one episode of radicular pain without recurrence, 30% had mild symptoms, and 25% had persistent or worsening symptoms.

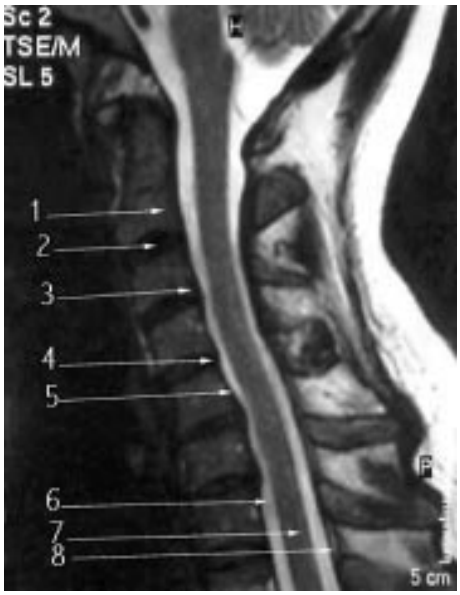

Figure 4 T2 weighted sagittal MRI scans of the cervical spine. (1) C2 vertebral body. (2) Intervertebral disc. (3) Posterior body edge adjacent to disc space (site of potential osteophyte formation). (4) Posterior disc margin (site of potential disc prolapse). (5) Posterior longitudinal ligament (site of potential ossification and cord compression). (6) Cerebrospinal fluid in front of cord. (7) Spinal cord. (8) Ligamentum flavum (site of potential hypertrophy and cord compression).

Treatment

Indications for surgery to decompress cervical roots include:

- disabling motor deficit such as loss of deltoid function (C5) or profound weakness of wrist extension (C7)
- uncontrollable brachalgia (rare)
- failure of conservative management of brachalgia for six weeks.

It is important to ensure adequate analgesia during conservative treatment, with opiates as necessary. Hospital admission is sometimes necessary.

It is common to have minor weakness related to root entrapment, especially when the patient has severe pain. With appropriate analgesia and encouragement most patients with apparent loss of power do in fact have reasonable strength but are limited in their effort by pain. It is important to examine these patients carefully so as not to miss the occasional case who has genuine loss of motor function. Such cases should be considered for urgent surgery.

Surgery works well for relief of severe brachalgia, but is less effective in the treatment of established weakness particularly when present for more than a few weeks. Surgery for sensory disturbances is unrewarding and in general should be avoided.

Surgery involves an anterior or posterior approach depending on the site of root compression. The anterior approach is used whenever pathology extends in front of the root and cord, as with an osteophytic bar or a disc prolapse with a central component. Posterior approaches are useful for laterally placed disc herniations and root canal stenosis, secondary osteophyte of the uncovertebral joint or facet joint. All commonly used anterior approaches involve working through the disc space with removal of varying amounts of adjacent bone (osteophyte) above and below the disc space. A bone graft is placed into the defect left by removal of the disc. A minority of surgeons will perform discectomy without fusion in younger patients. There is, however, a relatively high

Table 1 Clinical presentation of lower cervical radiculopathies

Nerve root (disc level)	Symptoms	Signs		
		Motor weakness	Diminished reflexes	Sensory disturbance
C5 (C4/C5)	Pain from side of neck to shoulder. Numbness over deltoid	Deltoid	Biceps	Shoulder and lateral arm
C6 (C5/C6)	Pain over lateral arm and forearm. Sensory disturbance in lateral forearm, thumb and index finger	Biceps and brachioradialis	Biceps and supinator	Lateral forearm, hand and thumb
C7 (C6/C7)	Pain radiating down middle forearm to middle and sometimes ring finger. Sensory disturbance of middle finger	Elbow, wrist and finger extensors	Triceps	Predominantly middle finger
C8 (C7/T1)	Pain radiating to medial forearm and hand. Sensory disturbance medial border hand, ring and little finger	Hand grip and intrinsic muscles		Medial hand and little and ring finger

incidence of a radiological kyphotic deformity postoperatively at the level of the fusion, and this approach has not gained widespread acceptance. The theoretical disadvantage of fusion is accelerated degeneration of the discs above and below the fused segments, and trials of artificial joints and discs are in progress. Single level fusion does not usually lead to any noticeable loss of neck movement.

Posterior approaches are useful for root decompression and avoid the need for discectomy. Disadvantages include the need for dissection of the posterior cervical musculature with increased risk of postoperative neck pain.

Outcome

There is a significant morbidity attached to all cervical surgery. Therefore, due consideration must be given to the relative risks and expected benefit before embarking on surgery for problems other than persisting severe pain or progressive motor deficit. The published results of surgery for cervical radiculopathy are surprisingly good, with many series reporting good or excellent outcome in more than 90% of patients. Although such figures can undoubtedly be achieved in well selected patient groups, it is unrealistic to expect such a high rate of success in general neurosurgical practice.

Cervical spondylotic myelopathy

Chronic disc degeneration with osteophytes is the most common cause of spinal cord compression in patients over 55 years of age (figs 5 and 6).

Cervical spondylotic myelopathy (CSM) can present in a number of ways and five different syndromes are described; the transverse lesion syndrome, the motor system syndrome, the central cord syndrome, the Brown Sequard syndrome, and the brachalgia and cord syndrome. These syndromes simply reflect varying patterns of myelopathy and radiculopathy. Cervical pain is uncommon. The typical presentation in the upper limbs is numb, clumsy hands with difficulties with buttons, coins, and fine manipulation. Patients will typically complain of tingling in the hands and feet. Weakness of the small muscles of the hands is commonly seen. Legs are often unsteady with a tendency to "jump" at night. Patients can have a surprisingly good exercise tolerance, and spastic weakness tends to occur in more advanced cases. Bladder disturbance is generally seen with more advanced disease. Sensory signs are less common than might be expected from the frequency of symptoms.

At least 10% of patients initially diagnosed as having CSM will turn out to have another disease process such as motor neurone disease, multiple sclerosis or subacute combined degeneration of the cord. The shuffling gait of spastic myelopathy may also be misdiagnosed as Parkinson's disease.

The natural history of CSM is not well defined. Lees and Turner[2] reported 44 patients, noting that the patients with a mild disability had the best prognosis. Fifteen patients had severe disability and, of these, 14 remained moderately or severely disabled on long term follow up. In this series long

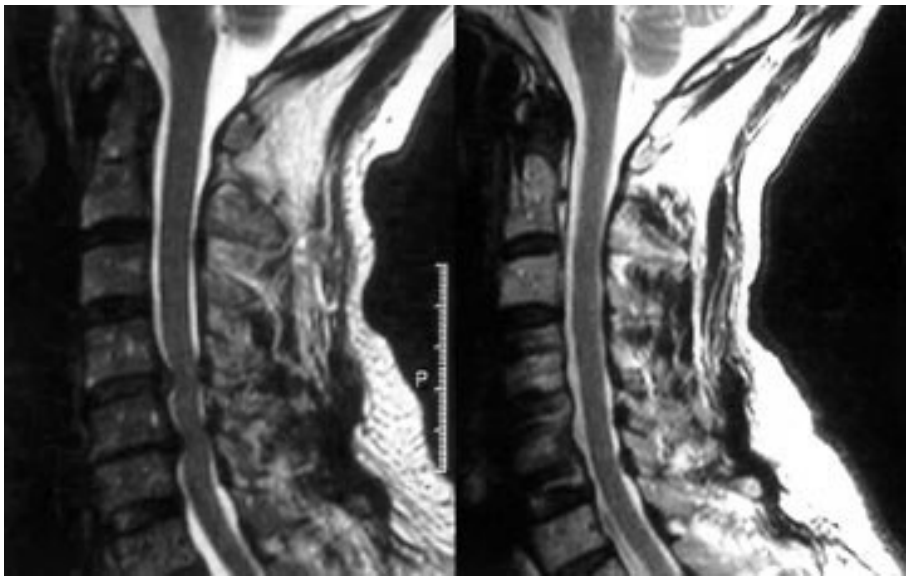

Figure 5 MRI scans of a patient with cervical spondylosis. Left: preoperative image—cord compression at two levels from disc and osteophyte. Right: postoperative image following level 2 anterior cervical discectomy, iliac crest graft, and plating.

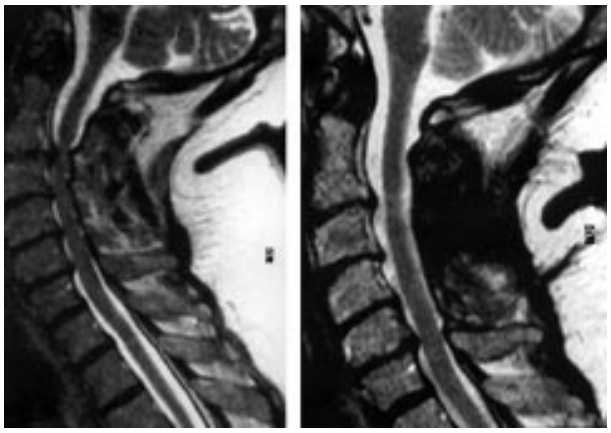

Figure 6 MRI scans of a patient with cervical spondylosis. Left: preoperative image—cord compression at several levels from disc and osteophyte. Right: postoperative image following cervical laminectomy.

periods of non-progressive disease were noted with only rare instances of steady deterioration. Myelopathy infrequently developed in patients with spondylosis if it was not present when the patient initially sought treatment. Nurick[3] supported these findings, noting that disability was established early in the disease. Another much quoted series followed 24 patients for six and a half years.[4] Approximately one third improved while equal proportions remained the same or deteriorated. The factor most often associated with deterioration is the age of the patient at presentation, with patients over 60 years old having the poorest prognosis.

Plain cervical *x* rays will often show evidence of degenerative change, with abnormalities being most prominent at C5/C6 and C6/C7. Loss of disc height and formation of prominent osteophytes is a common finding in older patients and provides limited useful information for patient management. Similarly measurements of anteroposterior canal diameter correlate with risk of myelopathy but are rarely used in planning treatment. MRI, which shows the relation of spinal cord and roots to encircling structures, remains the single most important investigation. There is controversy over the significance of signal change within the cord noted on preoperative MRI scan. Low signal intensity changes on T1 weighted sequences are thought to represent a poor prognosis. The significance of T2 signal change is uncertain. These changes appear to represent a spectrum of pathologies and encompass a range of potential for spinal cord recovery. In general, surgeons regard such signal change as a relative indication for early decompression.

Treatment

There is no specific conservative management available except perhaps wearing a cervical collar to avoid repetitive cord injury. This is said to benefit no more than a third of patients. However, as with other aspects of management there are no randomised controlled trials.

Indications for surgery to decompress the cervical cord in the presence of cervical spondylosis include:

- progressive myelopathy
- stable myelopathy (as prophylaxis against further deterioration).

Surgery is performed by an anterior or posterior approach. Anterior surgery may involve discectomy with resection of associated osteophytes if compression is localised to the discs and adjacent structures. If compression extends behind vertebral bodies these may also be resected (corpectomy). Posterior decompression generally involves resection of the laminae (laminectomy) or displacement of the laminae away from the spinal cord to increase the cross sectional area of the spinal canal (laminoplasty). Controversy exists as to the appropriate technique for decompression, and ultimately will largely reflect an individual surgeon's training. In general, decompression is carried out from the approach most likely to remove the offending structure compressing the cord. Cervical discs or osteophytes indenting the cord anteriorly will therefore be removed by anterior cervical discectomy, whereas a narrow cervical canal secondary to hypertrophied posterior ligaments or a congenitally narrow canal will be treated by a posterior decompression.

Outcome

The outcome from surgery for CSM is variable. Once myelopathy is established, improvement may occur but pronounced recovery should not be expected. The longer the duration of preoperative symptoms and the worse the severity of these preoperative symptoms, the less the benefit from surgery. In one series[5] 48% of patients were improved if operated on within one year of symptom onset. Only 16% improved after a year or more of symptoms.

In general, surgery for CSM aims to arrest decline in neurological function rather than reverse it. Some surgical series suggest that surgery makes little difference when compared with the natural history of CSM, whereas in others a definite advantage is seen over conservative management. The lack of good quality prospective data means that the exact role of decompressive surgery remains undefined. Patients showing a steady decline in neurological function, operated on early after the onset of symptoms and in whom the disease has not progressed to an advanced stage, would seem most likely to benefit from intervention. Patients with advanced disease rarely recover useful function and need to be counselled fully about the risks and benefits of surgery. A proportion of patients will show a perioperative decline in neurological function and a further number may develop late deterioration, despite a radiologically adequate decompression. Any patient who deteriorates following decompressive surgery should undergo a repeat cervical MRI to confirm that an adequate decompression has been achieved. Intraoperative assessment of the adequacy of decompression is unreliable. Radiological proof of adequate decompression is essential before a patient is informed that their disease has failed to respond to surgery. It is not necessary to ask the neurosurgeon's permission to perform such an investigation!

Late deterioration in neurological function may occur as a result of degeneration of spinal levels adjacent to a fused segment. The question as to whether this process is accelerated by the fusion is still unclear. In one series symptomatic adjacent segment disease occurred at an incidence of 2.9% per year during the 10 year follow up after an anterior cervical arthrodesis.[6] This may, however, be little different to the natural history of spinal aging. Spontaneous late deterioration is also known to occur several years after adequate decompression without obvious explanation. An MRI is important to distinguish between these two problems.

Neck pain

Neck pain from degenerative disease may arise from a variety of structures in the neck including discs, facet joints, joint capsules, ligaments, and muscular structures. Establishing the exact site of pain is not possible in the majority of cases.

Axial neck pain without radicular features may reflect conditions other than cervical spondylosis. These include cervical sprain (whiplash), fracture (pathological or traumatic), occipital neuralgia, disc prolapse, atlantoaxial subluxation, and possibly Chiari 1 malformation or fibromyalgia. A detailed history may suggest a cause for the pain—for example, occipital pain with atlantoaxial instability or prominent nocturnal pain with malignancy.

Neck pain associated with headache is said to occur with atlantoaxial lateral mass osteoarthritis, although headache is also common with lower cervical root entrapment. Unilateral headache with facial pain has been described in C2/C3 facet joint degeneration, but again tends to be a non-specific symptom. Patients with lower cervical spine disc degeneration complain of differing patterns of symptoms, with neck pain and stiffness sometimes eased and sometimes increased by activity. Specific patterns of posterior neck pain referred from zygoapophyseal joints are well recognised and maps of pain referral are available.[7]

Plain *x* rays are often performed, though treatable pathology is infrequently detected. Cervical disc degeneration has a prevalence of 10% in the mid 20s increasing to nearly 95% by age 65 years. Plain films will show degenerative change with loss of disc height, formation of osteophytes, and degenerative changes in the facet joints. The presence of degenerative change does not indicate that a patient will have pain, though symptoms usually correspond with the degenerative change seen on *x* ray.[8] In the presence of neck pain alone, degenerative changes on plain films do not warrant further investigation.

Most episodes of neck pain are short lived and respond to non-operative measures. Gore[9] reported a series of 205 patients with neck pain treated with non-operative measures. After 10 years 79% were improved or asymptomatic, 13% remained unchanged, and only 8% were worse. However, 32% still rated their pain as moderate to severe. Another series found that only a quarter of the patients with neck pain were disabled by their symptoms at five year follow up.

In Europe and North America cervical spine fusion is sometimes performed for neck pain with cervical spondylosis. There are, however, no randomised controlled studies to support this practice. One series found 70% of patients who underwent cervical arthrodesis on the basis of positive cervical discography had a good result. However, these results are exceptional and relief of neck pain with cervical fusion is more commonly within the expected rate for the natural history of the disease process. In the UK there is no tradition of surgery for axial neck pain, although some surgeons will consider the procedure for severe single level disease. The natural history of neck pain, the uncertain outcome of cervical fusion, and the associated short and long term complications of a cervical arthrodesis would not, however, seem to justify such surgery. Treatment should initially involve physiotherapy and a rehabilitation programme, with referral to a multidisciplinary pain team in resistant cases.

RHEUMATOID ARTHRITIS

A significant proportion of patients with rheumatoid arthritis will develop cervical spine problems. The examination of these patients is complicated by their widespread joint disease, but a careful history should establish a diagnosis. Patients with rheumatoid arthritis have a good understanding of their disease and will often say when they have symptoms unrelated to a flare up of their arthritis. The cervical spine complications in rheumatoid arthritis are often relatively easy to diagnose as, in contrast to spondylitic myelopathy, plain cervical *x* rays provide much useful information.

The history should enquire into all symptoms relevant to cervical myelopathy. In more advanced cases basilar impression (vertical migration of C2 into the foramen magnum) may cause symptoms due to brainstem compression. In one series of patients with radiological basilar impression 22% had cranial nerve dysfunction (trigeminal, glossopharyngeal, vagus, and hypoglossal). Other findings included internuclear ophthalmoplegia, vertigo, diplopia, downbeat nystagmus, and sleep apnoea.

The examination will be limited by joint disease, but it is usually possible to assess for upper motor neurone signs such as hyperreflexia and, within the added constraints of possible peripheral neuropathy, gain some measure of preservation or loss of vibration and proprioception.

Cervical *x* rays are performed in flexion and extension. MRI is performed if any significant abnormality is noted on the plain films or if neurological signs are present. A relatively normal *x* ray does not exclude an inflammatory mass at the odontoid peg.

The figures quoted with respect to the cervical complications of rheumatoid arthritis vary greatly according to the series reviewed. What is clear, however, is that neck pain is common (40–88%), cervical subluxations are common (43–86%), but neurological deficit less frequent (7–34%). The challenge is to decide which patients need surgical intervention and which do not. This is a critical question as it is now clearly established that patients with more advanced disease respond less well to surgery than those with milder disease.

The most common problem encountered is atlantoaxial subluxation (figs 7 and 8). In advanced cases basilar impression may occur. Subaxial subluxations are more frequent than in spondylotic disease, and in more advanced cases subluxation may occur at many levels, giving rise to a so called "stair case" deformity.

Atlantoaxial subluxation

The single most important problem to be aware of is atlantoaxial subluxation. This is the most common cervical manifestation of rheumatoid arthritis, being present in 25% of patients in one series. In this study the mean time between onset of rheumatoid arthritis and diagnosis of atlantoaxial subluxation was 14 years.

C1 most commonly subluxes anteriorly on C2, this movement usually occurring in flexion. If such a subluxation is "mobile" C1 will return to its normal reduced position on extension. In time a fixed subluxation may develop with an enlarging inflammatory mass around C2, such that C1 does not regain its normal position in relation to C2 irrespective of the position of the neck. These so called "fixed" subluxations tend to occur in more advanced rheumatoid arthritis as well as in association with basilar impression, when degeneration of the C1 ring allows vertical migration of C2 towards the foramen magnum.

Atlantoaxial instability is commonly diagnosed in asymptomatic patients having flexion and extension views performed before elective orthopaedic surgery. It may also be diagnosed because of cervical pain (C2 pain with occipital radiation) or be detected as part of the investigation of myelopathy.

The most difficult group to manage are asymptomatic patients with a mobile atlantoaxial subluxation. Is it justified to perform a "pre-emptive surgical strike"[10] to avoid the development of myelopathy? The answer to this question is unclear, although various measures of the degree of atlantoaxial subluxation have been suggested to identify individuals in whom

Figure 7 Cervical spine *x* rays in rheumatoid arthritis. Left: anterior atlantoaxial subluxation in flexion. Middle: reduction of atlantoaxial subluxation in extension. Right: postoperative view following C1/C2 fusion with transarticular screws. Bone graft is placed in the facet joints as well as between the C1 and C2 laminae.

cord compression (and consequent myelopathy) is most likely to occur. Traditionally the most popular measure has been the anterior atlantodental interval, and operative intervention has, according to differing authors, been recommended when the figure has been above 8, 9 or 10 mm. The predictive value of these figures in terms of onset of paralysis has been disappointing. The use of the posterior atlantodental interval (PADI)—the distance between the posterior aspect of the dens to the anterior aspect of the C1 lamina—has been recommended as an alternative. One series[11] claimed that using a PADI of $\leqslant 14$ mm yielded a sensitivity (ability to detect patients with paralysis) of 97%. The negative predictive value of 94% was perhaps of even more significance—that is, if the PADI is > 14 mm the chance that the patient will not have paralysis is 94%. When all is said and done, these figures are undoubtedly useful in informing any decision about surgical fixation but are rarely used as the final arbiter. "A surgeon with a ruler is a surgeon in trouble!"

Indications for surgical treatment of atlantoaxial subluxation include:

- myelopathy
- severe occipital pain (C2 root compression)
- excessive subluxation without symptoms (see above).

Treatment

Patients with myelopathy and C1/C2 subluxation require urgent fusion. Patients with myelopathy and fixed subluxation or basilar impression also need early treatment.

Patients with severe occipital (C2) pain and instability are good candidates for C1/C2 fusion. Even if the degree of subluxation is minor, these patients should be referred for surgical assessment as fusion can lead to a dramatic improvement in quality of life.

Asymptomatic patients with a limited subluxation should probably undergo *x* rays once or twice a year, but not be treated unless there is progression.

Asymptomatic patients with more major subluxation should be referred for neurosurgical assessment. The theoretical risks of sudden death or neurological deficit, as well as the reluctance of surgeons and anaesthetists to perform joint or tendon procedures on such patients, means in practical terms that an increasing number of these patients are coming to surgery.

Surgery for atlantoaxial subluxation is performed by a posterior approach. The most popular procedure involves placement of screws across the C1/C2 facet joint with simultaneous bone grafting. This is a highly effective procedure, which can lead to a significant improvement in pain, myelopathy, and quality of life.

If basilar impression is present a period of preoperative traction is employed to try and disimpact the vertically migrated C2 from the foramen magnum and ring of C1. If this is not possible it may be necessary to perform a transoral excision of the odontoid peg before a posterior fixation procedure.

Outcome

The most important predictor of postoperative outcome seems to be the patient's preoperative neurological condition. It is important that the patient receives appropriate investigation and treatment before becoming bed bound, as the prognosis at

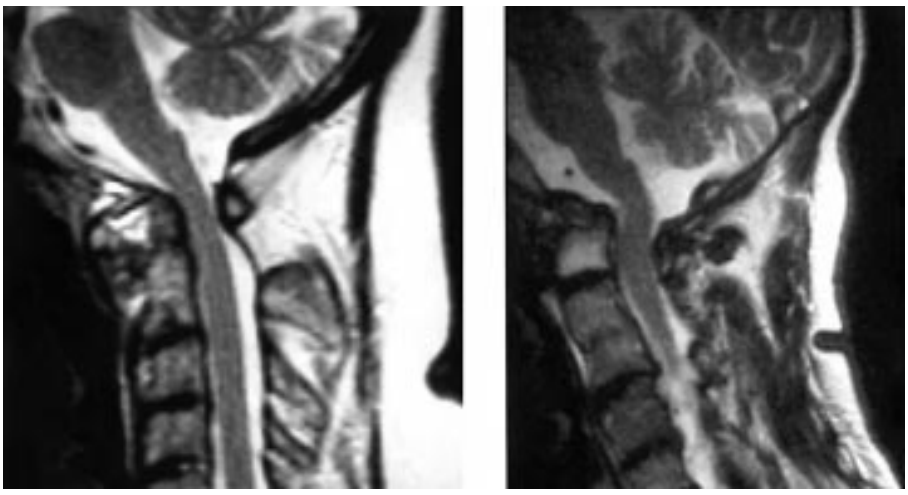

Figure 8 MRI scans in rheumatoid arthritis. Left: mobile atlantoaxial subluxation. Note restriction of cord at craniocervical junction caused by subluxation of C1. This subluxation reduced in extension. Treatment was by C1/C2 screws (same patient as fig 3). Right: patient presenting with spastic quadraparesis. Note basilar impression with translocation of eroded body of C2 into foramen magnum. Treatment was by transoral decompression of C2 and posterior fusion.

this stage is extremely poor. It is, however, never too late to investigate these patients; even those who are immobile can gain benefit from operative intervention.

SYRINGOMYELIA

In this condition there is cystic cavitation of the spinal cord. In communicating syringomyelia there is primary dilatation of the central canal which is more accurately described as hydromyelia. This is almost always associated with abnormalities at the foramen magnum such as tonsillar herniation (Chiari malformation) or basal arachnoiditis. In non-communicating syringomyelia a cyst arises in the cord substance and does not communicate with the central canal or subarachnoid space. Common causes include trauma, neoplasm or arachnoiditis.

Communicating syringomyelia presents with dissociated sensory loss in a cape distribution, cervical or occipital pain, wasting in the hands, and painless arthropathies (Charcot joints). MRI is the investigation of choice and treatment aims to re-establish normal flow of cerebrospinal fluid (CSF) across the foramen magnum. If this fails then direct drainage of the cyst into the subarachnoid space or pleural cavity may be appropriate.

The most common form of non-communicating syringomyelia is post-traumatic, which often has a late presentation following spinal cord injuries. It should be the first diagnosis considered in patients showing a late deterioration in spinal cord function following a spinal cord injury. Treatment aims to re-establish normal CSF flow across the site of the injury.

Obstruction of CSF flow should always be suspected in patients with apparently idiopathic syringomyelia, and CSF flow studies or myelography may need to be considered. In a proportion of patients subarachnoid obstruction will be secondary to an arachnoid web which may well be amenable to surgical excision.

CERVICAL SPRAIN

Whiplash is currently defined as a traumatic injury to the soft tissue structures in the region of the cervical spine caused by hyperflexion, hyperextension or rotation injury in the absence of fractures, dislocations or intervertebral disc herniations. Symptoms may start immediately or be delayed. Associated complaints of uncertain pathophysiology include headaches, cognitive problems, and back pain.

Patients with neck pain and stiffness should undergo cervical spine flexion and extension views. Provided a satisfactory range of movement is achieved further investigations are not indicated. If neurological symptoms or signs are present an MRI scan should be performed.

Treatment in all patients (except those with fractures and dislocations) involves early mobilisation with neck exercises and return to normal activities as tolerated. Cervical collars are discouraged except for the first few days after the injury. Therapies such as TENS (transcutaneous electrical nerve stimulation) and acupuncture are recommended if symptoms persist for more than three weeks. Short courses of anti-inflammatory medication may also be appropriate. Patients with neurological symptoms and signs should undergo MRI scanning and treatment as for cervical spondylotic disease.

The majority of patients with a whiplash associated disorder complain of predominant neck pain with varying radicular symptoms. As previously emphasised no surgical treatment is appropriate for this neck pain.

CONCLUSION

The management of cervical spine problems has been revolutionised by the introduction of MRI scanning which allows precise visualisation of the cord, the spinal roots, and the surrounding structures. Appropriate interpretation of this information will always depend on the history and neurological examination. Perhaps more than any other specialist, the neurologist should have the skills required for the assessment of patients with spinal disease.

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RECOMMENDED READING

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