

Cervical Kyphosis

A patient guide

In brief: Cervical kyphosis is the loss of the normal gentle forward curve of the neck, the cervical lordosis, and its replacement by a backward, or kyphotic, bend so that the neck curves the wrong way. In health the neck arches gently forwards, a shape that balances the head economically over the shoulders and keeps the eyes level with the horizon. When that curve flattens and then reverses, the head is carried forward of the body, the muscles at the back of the neck must work harder to hold the gaze up, and in the most severe cases the chin can come to rest towards or against the chest, the so-called chin-on-chest deformity. Cervical kyphosis is not a single disease but the final common shape produced by many different processes, including wear of the discs, previous surgery on the back of the neck, inflammatory conditions such as ankylosing spondylitis, injury, and disorders that weaken the neck muscles. It ranges from a mild, symptomless straightening seen on a scan to a fixed, disabling deformity that interferes with looking ahead, swallowing and, where the spinal cord is draped over the apex of the curve, with the function of the cord itself.

What cervical kyphosis is, and the normal curve it departs from

The neck, or cervical spine, is made up of seven vertebrae stacked one upon another, cushioned by intervertebral discs and bound together by ligaments and muscles. Viewed from the side, the healthy neck does not run straight but arches gently forwards in a curve called the cervical lordosis. This forward curve is the counterpart to the gentle backward curves of the chest and the forward curve of the lower back, and together these alternating curves allow the spine to carry the weight of the head and trunk with the least possible effort while keeping the eyes looking level at the horizon.

In the neck this forward arch is created chiefly by the shape of the discs, which are taller at the front than at the back, wedging the vertebrae into a lordotic stack. Measured on a side-on X-ray between the second and seventh vertebrae, the lordosis in young, symptom-free adults averages somewhere in the region of seventeen to twenty-one degrees, although there is a wide normal range. The angle of the first thoracic vertebra at the base of the neck, the T1 slope, sets the platform on which the cervical curve must balance, and the head is normally carried so that a plumb line from the upper neck falls within about four centimetres of the base of the neck.

Cervical kyphosis is the departure from this arrangement. The forward curve first flattens, so that the neck becomes straight, and may then reverse into a backward bend, so that the vertebrae are wedged the wrong way and the head is carried forward of the trunk. The deformity is described by where its apex, the most sharply angled point, lies, and by how severe and how flexible it is. A mild kyphosis may be no more than a straightening visible only on a scan; a severe one may fix the head in a permanent downward stare.

How the neck loses its curve: the biomechanical cycle

Much of the understanding of cervical kyphosis rests on a single mechanical idea, which is that the front and back of the neck work as a balanced pair. The discs and vertebral bodies at the front bear the compressive weight of the head, while the muscles and ligaments at the back act as a tension band, a guy-rope that holds the curve up against the constant forward pull of gravity. The forward arch is maintained only so long as this front-to-back balance is preserved.

In degenerative kyphosis the cycle characteristically begins at the front. As the discs wear and dry out they lose height, and because they tend to collapse more at the front than the back, the front of the neck shortens and the weight-bearing axis of the head shifts forwards. This forward shift throws extra tensile load onto the structures at

the back, which over time stretch and weaken. As the posterior tension band attenuates, the curve straightens and then reverses, which shifts the weight further forwards still, which loads the front discs more heavily and drives further degeneration. In this way a self-perpetuating, vicious cycle is set up in which disc collapse and posterior failure feed one another, and the kyphosis gradually advances.

The same logic explains why anything that damages the structures at the back of the neck can produce kyphosis. The muscles of the neck contribute the large majority of its mechanical stability, and when the posterior tension band is cut, stretched or paralysed, the front of the neck is left to collapse forwards unopposed.

The causes of cervical kyphosis

Cervical kyphosis is best thought of as a shape with many causes rather than a single disease. The principal groups are these.

****Iatrogenic and post-surgical.**** The single commonest identifiable cause is previous surgery on the back of the neck. Operations that remove the bony arches to take pressure off the spinal cord, particularly multilevel laminectomy, divide the posterior ligaments and detach or weaken the extensor muscles, disrupting the tension band. Reported rates of kyphosis after cervical laminectomy alone vary widely, with figures across the literature ranging from roughly six per cent to nearly half of cases, and the risk is higher in younger patients, where the spine is more mobile, and where the facet joints have been extensively removed. This is one of the reasons laminoplasty, which reconstructs rather than removes the bony arch and preserves more of the posterior tension band, is often favoured where it is suitable, since it is associated with markedly less catastrophic kyphosis than laminectomy alone.

****Degenerative.**** Age-related wear of the discs, the process described above, is a major cause, and the proportion attributable to degeneration is rising as populations age.

****Inflammatory, especially ankylosing spondylitis.**** In ankylosing spondylitis the spine becomes inflamed and then progressively fuses into a rigid column, which not infrequently sets into a fixed forward bend. When this involves the neck or the junction between the neck and chest it can produce the severe chin-on-chest deformity, in which the fused spine holds the head locked towards the breastbone.

****Traumatic.**** Injuries that damage the discs, ligaments or bony elements at the back of the neck can leave a post-traumatic kyphosis, and in children in particular a kyphotic deformity may progress after even relatively minor flexion injuries.

****Neuromuscular.**** Conditions that weaken the neck extensor muscles allow the head to drop forwards. These include motor neurone disease, Parkinson's disease, myasthenia gravis, the inflammatory muscle diseases and various genetic myopathies, as well as the effects of previous radiotherapy to the neck.

****Congenital.**** Rarely the neck is malformed from birth, with vertebrae that have failed to form or to separate properly, producing a kyphosis present from early life.

****Infective and neoplastic.**** Infections such as spinal tuberculosis, and tumours that destroy the vertebral bodies, can collapse the front of the neck and tip it into kyphosis.

Why cervical kyphosis can cause pain and disability

A flattened or reversed neck does not always cause symptoms, and a mild kyphosis discovered on a scan may produce none at all. Where symptoms do arise, they tend to follow from the altered mechanics of the deformed neck.

The commonest complaint is pain, and much of it is muscular in origin. When the head is carried forward of the body, the extensor muscles at the back of the neck must work continuously simply to hold the gaze level, much as the arm aches when a weight is held out in front rather than close to the body. This sustained effort produces fatigue, aching and pain across the back of the neck and shoulders, which characteristically worsens through the

day and with activities that demand a forward head posture. Because the kyphosis throws the rest of the spine out of balance, the muscles of the upper back can be drawn into the same compensatory effort.

In more severe and fixed deformities the problems extend beyond pain. A neck locked in flexion tilts the natural line of sight downwards, so that looking ahead becomes difficult or impossible, interfering with walking, driving and social interaction. The same posture can compress the food passage and tilt the throat, producing difficulty in swallowing, and in the most extreme cases can affect breathing. These functional difficulties, taken together, can be profoundly disabling and are among the principal reasons severe cervical kyphosis is considered for correction.

Myelopathy: when the deformity affects the spinal cord

The most serious consequence of cervical kyphosis arises when the spinal cord itself is affected, a condition called myelopathy. The mechanism is partly one of geometry. The spinal cord runs down the front of the spinal canal, and when the neck bends forwards into kyphosis the cord is drawn tight and pressed forwards against the backs of the vertebral bodies and any bony spurs projecting from them. In effect the cord is draped over the apex of the curve like a rope pulled taut over a beam.

This draping does two things. It compresses the front of the cord directly against the bone, and it stretches the cord lengthwise, because the cord is tethered at intervals by the nerve roots and by small ligaments and cannot freely slide away from the pressure. Laboratory and imaging studies show that both the compression and this longitudinal tension rise as the kyphosis worsens, and that the most sharply angled, apical part of the curve tends to coincide with the most compressed part of the cord. The result is an injury to the cord that can produce the features of cervical myelopathy: clumsiness of the hands, difficulty with fine tasks such as buttons and writing, unsteadiness of gait, and altered sensation.

The same geometry explains an important point about treating cord compression in a kyphotic neck. Operations performed from behind rely in part on the cord drifting backwards away from the front of the canal once it is decompressed; but when the neck is kyphotic the cord remains draped forwards over the apex and cannot drift back, which is one reason kyphotic alignment is associated, in the published series, with poorer neurological recovery after posterior decompression alone, and why correcting the curve is often considered alongside relieving the pressure.

Horizontal gaze and the chin-brow vertical angle

One of the defining problems of severe cervical kyphosis is the loss of horizontal gaze, the ability to look straight ahead. Human beings are strongly adapted to hold the eyes level with the horizon, and a neck fixed in flexion forces the gaze downwards towards the floor, which is both disabling and, for many, distressing.

The standard way of capturing this is the chin-brow vertical angle. With the person standing and the neck in its fixed, natural position, a line is drawn from the chin to the brow, and the angle this line makes with the true vertical is measured. A value near zero means the gaze is roughly level; a large positive value means the chin is dropped and the gaze is driven downwards. In the literature on deformity correction a chin-brow vertical angle within about ten degrees either side of vertical is generally associated with good horizontal gaze, while larger angles correspond to progressively worse forward vision. Because direct measurement can be awkward, related measures taken from X-rays, such as the slope of a line drawn across the base of the skull, are sometimes used as surrogates.

This angle is more than a description. Where a deformity is to be corrected surgically, the chin-brow vertical angle is used to plan how much correction is needed to restore a level, comfortable gaze, and to judge the result afterwards. Interestingly, the published experience suggests that aiming for a small downward tilt rather than perfectly level can suit some people better, because a degree of downward gaze helps with tasks performed at table height such as eating, reading and working; the planning of correction is therefore a balance rather than a single ideal number.

How cervical kyphosis is assessed

The assessment of cervical kyphosis rests on standing imaging, because the deformity is one of overall posture and balance and is best understood with the head carried in its natural position against gravity.

Standing side-on X-rays of the whole spine are the foundation. They allow the curve to be measured, most often as the angle between the second and seventh cervical vertebrae, and they show how the head is balanced over the shoulders and pelvis. Long-cassette films that include the chest and pelvis are used because the neck does not balance in isolation: a kyphotic neck is frequently a compensation for, or is compensated by, curves elsewhere in the spine.

Dynamic X-rays, taken with the neck bent forwards and backwards, are particularly important because they reveal whether the deformity is flexible, correcting at least in part when the neck is extended, or rigid and fixed. This distinction is central to understanding the deformity, as a flexible curve and a fixed one behave quite differently.

Cross-sectional imaging adds detail. Magnetic resonance imaging, the MRI scan, shows the spinal cord and whether it is compressed or stretched over the apex of the curve, while computed tomography, the CT scan, shows the bony anatomy, any previous fusion, and the detail needed where bony correction is contemplated.

Measurement and classification. Several measurements are drawn from these images, including the cervical curve angle, the forward position of the head, the T1 slope and the chin-brow vertical angle. Formal classification systems, of which the most widely cited groups deformities by the location of their apex and by a set of severity modifiers, provide a common language for describing the deformity and have been related to the degree of disability a person reports.

What the evidence shows about management — in principle

It is important to be clear that the evidence base in cervical deformity is built largely on case series, biomechanical studies and expert review rather than on large randomised trials, and that the descriptions which follow report what the literature observes in groups of patients, not guidance for any individual. Decisions in practice are highly individualised and depend on the cause, the severity and flexibility of the curve, the state of the spinal cord, the general health of the person and their own priorities.

Non-operative measures are described for milder, flexible and non-progressive kyphosis, and for people in whom surgery would carry undue risk. The literature discusses posture-directed physiotherapy and strengthening of the neck extensor muscles, pain management, and observation with periodic imaging to watch for progression. These measures are aimed at symptoms and at supporting the posterior musculature rather than at reversing an established structural curve.

Surgical correction is reserved in the literature for deformities that are severe, progressive or fixed, that interfere with gaze, swallowing or balance, or that are accompanied by compression of the spinal cord. The aim of surgery is to relieve any pressure on the cord, to restore alignment so the head is balanced and the gaze level, and to fuse the corrected spine so that the new shape is held. The published approaches fall into recognisable groups.

An **anterior approach**, from the front of the neck, removes the worn discs or part of a vertebral body and rebuilds the front column, opening the front of a kyphotic curve; it is often suitable for flexible deformities where the front column has collapsed. A **posterior approach**, from the back, allows the spine to be instrumented with screws and rods, releases tight structures and, where necessary, performs bony cuts called osteotomies to swing a rigid curve back into alignment. **Combined front-and-back approaches**, sometimes in the sequence front, then back, then front again, are described for rigid, severe deformities, particularly the fused spine of ankylosing spondylitis, where releases on both sides are needed before the curve will move.

Osteotomies, controlled cuts through the bone that allow a fused or rigid spine to be re-angled, are the means by which fixed deformities are corrected. A range is described in the literature, from cuts through the back

elements that hinge the spine open, to larger wedge resections that remove part of a vertebral body. These are demanding procedures, performed close to the spinal cord, the nerve roots and the vertebral arteries, and the literature is candid that they carry significant risks; the threshold for undertaking them is therefore weighed carefully against the severity of the deformity and its consequences.

Outlook

The outlook in cervical kyphosis spans a very wide range, because the term covers everything from a trivial straightening of the neck seen incidentally on a scan to a rigid, disabling chin-on-chest deformity. For the milder, flexible forms the picture is generally reassuring; many cause few or no symptoms, and where symptoms are muscular they are often managed without surgery.

The concern lies with deformities that are severe, progressive or fixed, and especially those that affect the spinal cord. Here the published experience is that thoughtful correction can restore a level gaze, relieve pressure on the cord and improve the ability to carry out everyday tasks, but that this comes through major surgery whose risks are real and must be set against its benefits. Across the whole field, the recurring themes are that the balance between the front and back of the neck governs the deformity, that flexibility and the state of the spinal cord matter as much as the raw angle of the curve, and that any individual outlook is a matter for careful assessment by the treating team rather than something that can be read from a single measurement.