

Hangman's Fracture

A patient guide

In brief: A hangman's fracture is a break through the bony ring at the back of the second bone in the neck (the axis, or C2), usually accompanied by a degree of forward slip of that bone on the one below it. Despite its alarming name, it is fundamentally different from a fracture of the peg-shaped dens, and most people who sustain it have no damage to the spinal cord. This page explains, in plain and impersonal terms, what the injury is, how it differs from an odontoid fracture, why the spinal cord is usually spared, and what the published evidence says about how it is assessed and managed.

What a hangman's fracture is (and the name)

A hangman's fracture is a fracture that runs through the slender bridges of bone at the back of the axis — the second vertebra in the neck — on both sides. In the medical literature it is given the more precise name of **traumatic spondylolisthesis of the axis**. "Traumatic" because it follows an injury; "spondylolisthesis" because the body of the axis tends to slide forward on the vertebra beneath it (the third cervical vertebra, C3). The combination of a bilateral break in the bony ring and a forward shift of the bone in front of it is what defines the pattern.

The name itself is historical and, in modern practice, somewhat misleading. It dates from an era when the injury was associated with judicial hanging, in which a calculated drop with a particular position of the rope knot tended to produce a break in this exact region. The term was popularised in 1965 by Schneider and colleagues, who observed that the bilateral neural-arch fracture seen after road-traffic collisions resembled, on radiographs, the lesion described in the judicial-hanging literature. The resemblance was anatomical, not causal: the everyday injury arises in an entirely different way and carries a far better outlook than the dramatic name suggests.

The crucial point for anyone trying to make sense of this diagnosis is that a hangman's fracture today is overwhelmingly a civilian injury caused by accidents, and that the great majority of people who have one walk away neurologically intact. The name has endured for historical reasons, but it should not be read as a description of how the injury usually happens now, nor of its likely consequences.

The C2 anatomy and where it breaks

The neck is supported by seven cervical vertebrae, stacked one upon another, with the spinal cord running down a protected channel — the spinal canal — formed by their bony rings. The first two of these vertebrae are unusual in shape because they have a specialised job: they allow the head to nod and to rotate.

The first cervical vertebra, the atlas (C1), is a ring of bone that cradles the base of the skull. The second, the axis (C2), is the focus of a hangman's fracture. The axis has several distinctive features. Projecting upwards from its body is a stout, peg-shaped process of bone called the **odontoid process**, or **dens**. This peg sits within the ring of the atlas above and acts as a pivot, so that the head and atlas can turn from side to side around it. Between the body of the axis at the front and the bony arch at the back lie two narrow bridges of bone, one on each side, known as the **pars interarticularis** (sometimes the pedicles, depending on the precise line of the break). These bridges connect the front and back of the vertebra and carry the small joint surfaces (facets) that link the axis to the vertebrae above and below.

In a hangman's fracture, it is these slender bridges of bone — the pars interarticularis or pedicles on both sides — that break. The fracture line runs through the posterior part of the bony ring, separating the body of the axis at the front from the arch at the back. Characteristically, the odontoid peg remains intact, and the joint between the atlas and the axis is left undisturbed. The break is, in effect, behind and to either side of the body, not through the peg

that rises from it.

This precise location explains almost everything that follows: why the injury behaves as it does, why the spinal cord is usually spared, how it is classified, and how it differs from the other well-known fracture of the second neck bone.

The modern mechanism vs the historical one

Understanding how a hangman's fracture happens means separating two quite different stories that share a name.

The *historical* mechanism is that of judicial hanging. In a carefully arranged long drop, with the knot positioned beneath the chin, the body fell a calculated distance and was then arrested sharply by the rope. The forces involved were a violent combination of *distraction* — a lengthwise pulling apart of the neck — and *hyperextension*, in which the head is thrown backwards. The anatomist Wood-Jones described this as the "ideal lesion" of judicial hanging in 1913: a bilateral fracture of the neural arch produced by these distractive forces. In that setting the forces were extreme and the consequences usually fatal, because the lengthwise distraction tended to tear the spinal cord apart even as the bones separated.

The *modern* mechanism is altogether different. The everyday hangman's fracture is a civilian injury, arising most often from road-traffic collisions and falls, and also from diving accidents and sport. Here the dominant forces are *hyperextension combined with axial loading* — that is, the head is forced backwards at the same time as a compressive load is driven down through the top of the head and neck, as may happen when the forehead or crown strikes a windscreen, a dashboard or the ground. This is frequently followed by a rebound into flexion, in which the head whips forward; the degree of that flexion rebound influences how far the bone displaces and whether the disc between C2 and C3 is disrupted.

The contrast matters because the two mechanisms produce very different outcomes. Distraction pulls the neck apart and endangers the cord; compression with hyperextension tends to crack the bony ring while leaving the cord room to escape harm. The shared name disguises the fact that the historical lesion and the modern injury, although they look similar on an X-ray, are driven by opposite forces and carry opposite prognoses.

Why the spinal cord is usually spared

One of the most reassuring features of a typical hangman's fracture, and one of the most counter-intuitive given its name, is that the spinal cord is usually undamaged. There are two main reasons for this.

The first is the nature of the break itself. When the bony ring fractures on both sides, the posterior arch becomes separated from the body of the axis. Instead of the canal being crushed inwards, the front and back portions of the vertebra spring apart, and the space available for the spinal cord effectively *widens* at the moment of impact. This phenomenon is often described as "auto-decompression" or "self-decompression": the very act of breaking creates more room, rather than less, around the cord. A fracture pattern that in other parts of the spine might threaten the cord here tends to protect it.

The second reason is the natural roominess of the spinal canal at this level. The canal is at its widest in the upper part of the neck, so there is a generous margin of space surrounding the cord at the axis to begin with. That built-in reserve, combined with the widening produced by the bilateral fracture, means the cord is usually left untroubled even when radiographs show a dramatic separation of the bone.

There is, however, an important exception. In a less common pattern known as the *atypical* hangman's fracture, the fracture line runs not cleanly through both bridges of bone but instead enters the back of the body of the axis itself. When the break takes this course, the canal does not widen in the protective way described above, and the back wall of the vertebral body can be displaced towards the cord. For this reason the atypical variant carries a materially higher risk of neurological injury than the typical fracture, and it is recognised as a distinct and more serious entity. The general rule that the cord is usually spared applies to the typical pattern; the atypical pattern is

the exception that proves it.

The Levine-Edwards / Effendi types

Because hangman's fractures vary considerably in how far the bone has shifted and how unstable the injury is, doctors use classification systems to describe them. The most widely used grew out of work by Effendi and colleagues in 1981 and was refined by Levine and Edwards in 1985. This system sorts the injury into types according to the amount of forward translation (slip), the degree of angulation (tilt), and the resulting stability.

Type I describes a fracture through the bony bridges with minimal displacement — by convention, less than about 3 mm of forward translation and no significant angulation. These fractures are regarded as stable, because the ligaments and the disc between C2 and C3 remain largely intact.

Type II describes a fracture with greater forward translation (more than about 3 mm) together with significant angulation, and disruption of the disc between C2 and C3. The mechanism here is thought to be hyperextension and axial loading followed by a flexion rebound. These fractures are unstable.

Type IIa is a particular variant marked by severe angulation but relatively little translation, with a more oblique fracture line. It is singled out because its mechanism is one of flexion-distraction rather than compression. This distinction has a practical consequence that is well established in the literature: a Type IIa injury must not be placed in lengthwise traction, because pulling the neck apart in this pattern worsens the angulation rather than correcting it.

Type III is the most severe pattern. Here a Type II fracture is combined with dislocation of the small facet joints between C2 and C3 on both sides, so that the posterior elements are also displaced. These are markedly unstable injuries.

A separate system devised by Francis in 1981 grades the injury across five categories according to the precise degree of angulation and displacement, and is sometimes used alongside the Levine-Edwards classification to quantify severity. In contemporary practice, the AO Spine Upper Cervical Injury Classification, introduced and refined in 2020 and 2022, provides a modern, reliability-tested framework for describing injuries of the axis and the upper neck.

How it differs from an odontoid fracture

A great deal of confusion arises because there are two well-known fractures of the second neck bone, and they are easily mistaken for one another. Distinguishing them is perhaps the single most useful thing for a patient to understand.

An **odontoid fracture** (also called a dens fracture) is a break of the peg-shaped process that rises from the body of the axis — the very pivot around which the head rotates. A **hangman's fracture**, by contrast, leaves the peg entirely intact and breaks the bony bridges behind and to either side of the body. In other words, the two injuries occur in different parts of the same bone: the odontoid fracture is at the front and centre, through the upstanding peg; the hangman's fracture is at the back, through the paired bridges of the ring.

This difference is not merely anatomical pedantry, because it governs how each injury behaves. In a hangman's fracture the joint between the atlas and the axis is typically undisturbed, and the bilateral break tends to widen the spinal canal, which is why the cord is usually spared. An odontoid fracture involves the pivot of rotation itself and the structures that hold the atlas to the axis, and its behaviour, healing tendencies and management considerations are quite distinct. The two injuries also tend to differ in their classification systems, their patterns of healing and the factors that influence stability.

For these reasons, although both are described loosely as "C2 fractures", they are separate diagnoses with separate literatures. A hangman's fracture is defined precisely by what it spares — the dens and the atlanto-axial joint — as much as by what it breaks.

How it tends to present

A hangman's fracture characteristically follows a significant injury to the head and neck: a road-traffic collision, a fall from height, a diving accident or a sporting impact. Because the forces required are considerable, the injury rarely occurs in isolation from a clear traumatic event.

The most common features described in the literature are neck pain and stiffness, tenderness over the upper part of the back of the neck, and a reluctance to move the head. Some people instinctively support the head with the hands. Because the upper neck is involved, there may be pain referred towards the back of the skull. Despite the severity of the underlying break, and in keeping with the tendency of the spinal canal to widen rather than narrow, the majority of people are neurologically intact at presentation — that is, without weakness, numbness or other signs of cord involvement. This relative absence of neurological signs is one of the reasons the injury can occasionally be underestimated on first assessment.

It is worth noting that hangman's fractures frequently accompany other injuries sustained in the same event, including injuries elsewhere in the spine, to the head, or to the chest and limbs. In the setting of major trauma, the neck is one of several regions that receive careful attention.

How it is assessed (CT, MRI)

The assessment of a suspected hangman's fracture rests principally on imaging, supported by clinical examination.

After blunt trauma, recognised clinical decision rules — such as the NEXUS criteria and the Canadian C-spine Rule — are used to determine who requires imaging of the neck at all. Where a significant injury is suspected, computed tomography (a CT scan) of the cervical spine is the modern standard. CT produces detailed cross-sectional images of bone and is well suited to detecting and characterising fractures of the bony ring of the axis, to measuring the degree of translation and angulation, and to planning any surgery. It is more sensitive than plain X-rays and is particularly valuable for identifying the atypical pattern, in which the fracture line extends into the back of the vertebral body and which can be difficult to appreciate by other means.

Plain radiographs — the traditional side-on X-ray of the neck — historically formed the basis of the classification systems, because translation and angulation were originally measured on them. They retain a role but have largely been superseded by CT for definitive characterisation.

Magnetic resonance imaging (an MRI scan) is used to assess the soft tissues that CT cannot show well: the disc between C2 and C3, the ligaments at the back of the spine, and the spinal cord itself. MRI can reveal disruption of the disc or ligaments that bears on the stability of the injury, and can show any change in signal within the cord. It is especially relevant where the pattern is atypical or where stability is in question.

What the evidence shows about management (collar vs halo vs surgery) — impersonal

The management of a hangman's fracture depends heavily on the type of fracture and on its stability, and the published literature describes a spectrum of approaches rather than a single route. What follows is a general, impersonal summary of that evidence and does not constitute advice for any individual.

For stable injuries — broadly, the Type I pattern with minimal displacement — non-operative management with an external orthosis is well supported. A rigid collar is commonly described, and in at least one substantial case series even non-rigid immobilisation produced good rates of bony union. Stable fractures of this kind generally heal with external support alone.

For unstable injuries with greater displacement — broadly the Type II pattern — the literature describes reduction (restoring the alignment of the bone) followed by a period of immobilisation in a collar or a halo-vest, with many such fractures going on to unite. Surgery is generally reserved for fractures that cannot be adequately reduced, that show marked instability, or that fail to heal. The conservative route carries a recognised rate of complications,

including kyphotic deformity (forward angulation) and non-union, quoted across series at a wide range for the more unstable patterns, and the halo-vest in particular is described as poorly tolerated by older people. For the Type IIa variant, the literature is consistent that lengthwise traction should be avoided, and reduction is instead achieved by extension and compression before immobilisation, or by surgery.

For the most unstable injuries — the Type III pattern with associated facet dislocation — surgical stabilisation, by open reduction and fixation, is generally described. A range of surgical techniques exists, including fusion of C2 to C3 from the front (anterior cervical discectomy and fusion), fixation from the back (posterior fixation), and direct repair of the broken bridges with screws (transpedicular osteosynthesis), the last of which can preserve the natural rotation between the atlas and the axis. Systematic reviews report that solid fusion is achievable by all of these routes, with no single approach shown to be universally superior; the choice is tailored to the fracture type, the individual and the operating surgeon's experience. Across the literature there has been a general shift towards earlier surgery for clearly unstable patterns, rather than attempting to salvage failed conservative treatment.

Outlook

The outlook for a typical hangman's fracture is, on the whole, considerably better than the injury's name might suggest. Because the spinal cord is usually spared, the central concern is bony healing and the restoration of stable, well-aligned neck mechanics, rather than recovery from cord injury.

Stable fractures treated with external support generally have a favourable healing record. Unstable fractures may require more prolonged immobilisation or surgery, and the literature documents that a proportion of conservatively treated unstable injuries develop angulation or fail to unite, which is one reason surgical stabilisation is sometimes chosen. Where surgery is undertaken, solid fusion is reported to be achievable through several different approaches. The atypical pattern, in which the fracture enters the back of the vertebral body, stands apart in carrying a higher risk of neurological injury, and its outlook is correspondingly more guarded than that of the typical fracture.

These are general observations drawn from the published literature and from the natural history of the injury. The course of any particular fracture depends on its type, its stability, the presence of other injuries, and a range of individual factors that fall outside the scope of a general description.