

Butterfly Vertebra

A patient guide

In brief: A butterfly vertebra is a congenital variation in the shape of a single vertebra, in which the two side-by-side halves of the vertebral body fail to join completely in the midline during early development. The result is a vertebra split by a vertical (sagittal) cleft, with each half tapering inwards towards the centre, so that on a front-on image the bone resembles the two wings of a butterfly. It is also called a sagittal cleft vertebra. The single most important idea to hold on to is that, in the great majority of cases, a butterfly vertebra is an incidental and harmless anatomical variant — a quirk of how the spine formed before birth rather than an injury, an infection or a tumour. It is most often discovered by chance on an X-ray, CT or MRI scan performed for some unrelated reason, frequently causes no symptoms at all, and usually requires nothing more than being correctly recognised for what it is. Its chief clinical importance is precisely that it can be mistaken on imaging for something more serious, such as a fracture or a deposit of cancer, when in fact it is a benign shape the person has carried since birth.

What a butterfly vertebra is

The spine is built from a stack of building blocks called vertebrae. The main weight-bearing part of each vertebra is its body, the broad block of bone at the front, separated from its neighbours above and below by the cushioning intervertebral discs. In a typical vertebra, this body is a single, solid, roughly cylindrical piece of bone.

In a butterfly vertebra, that body is divided down the middle by a cleft that runs from front to back in the vertical, front-to-back plane — the sagittal plane — leaving two triangular halves, one on the left and one on the right. Each half is wider at its outer edge and tapers towards the midline, so the two halves meet, or almost meet, at a narrow waist in the centre. Seen from the front, the two wedge-shaped halves with their tapering inner points look strikingly like a butterfly with its wings spread, which is how the variant earned its common name. The older anatomical term for the same appearance is a sagittal cleft vertebra, and a complete midline split is sometimes described as anterior rachischisis.

It is worth being clear about what a butterfly vertebra is not. It is not a broken bone that has split apart, and it is not a bone that has been eaten away by disease. It is a vertebra that simply formed in two halves rather than one, and then grew that way. The bone is fully formed, fully calcified and structurally continuous across the cleft in most cases; it is the outline and internal architecture that differ from the usual single block, not the substance of the bone.

How it forms: the embryology of the sagittal cleft

To understand a butterfly vertebra it helps to look back at how the spine is laid down in the first weeks of life before birth. Very early in development, a rod-like structure called the notochord runs down the midline of the embryo. The notochord acts as a kind of central scaffold and chemical signal around which the future vertebrae organise themselves. As development proceeds, blocks of tissue on either side of the notochord, derived from structures called somites, condense to form the cartilage models of the vertebral bodies, which later turn to bone.

Each developing vertebral body forms from paired centres, one on the left and one on the right, that grow towards each other and normally fuse seamlessly in the midline to create a single solid body. A butterfly vertebra arises when this midline fusion fails to complete. The two lateral halves do not fully unite, and a cleft persists between them. The most widely cited explanation is that a portion of notochordal tissue persists in the midline where it should have receded, physically keeping the two halves apart and preventing them from joining. In the normal course of events, notochordal tissue is squeezed out of the vertebral body and contributes instead to the soft central

core of the disc, the nucleus pulposus; in a butterfly vertebra, a remnant lingers in the wrong place at the wrong time, and the body is left divided.

This is a defect of formation that occurs very early, during the period when the vertebral bodies are first taking shape, generally considered to fall within the first several weeks of embryonic development. Because the cleft runs in the sagittal plane, the two halves end up arranged side by side, in contrast to other cleft variants where the split runs across the body in the coronal plane. The funnel-shaped tapering of each half, narrowing towards the centre, is the direct anatomical consequence of two halves that grew inwards but never met.

What it looks like on imaging

The classic appearance of a butterfly vertebra depends heavily on the view and the type of scan, and this is central to why the variant is both easily recognised by those familiar with it and easily mistaken by those who are not.

On a front-on (anteroposterior) X-ray, the appearance is at its most characteristic and gives the variant its name. The two triangular halves of the vertebral body, each tapering towards the midline, produce the symmetrical butterfly-wing pattern. The discs and the adjacent vertebrae often adapt to the unusual shape, with the neighbouring vertebral bodies sometimes moulded to fit the funnel of the cleft.

On a side-on (lateral) X-ray, the picture is quite different and far more deceptive. From the side, the cleft is not seen as a midline split; instead the vertebra tends to look short and wedge-shaped at the front, with reduced height anteriorly. This wedged profile is exactly the appearance that a wedge compression fracture produces, which is one of the main reasons a butterfly vertebra can be misread as an injury if only the side view is considered.

On CT, which provides detailed cross-sectional images of bone, the sagittal cleft is shown directly and unambiguously. The two halves are seen separated by a defect that often has smooth, well-defined, sometimes sclerotic (dense) margins, and the funnel-shaped or wedge-shaped contour of each half is clearly demonstrated. The smoothness and symmetry of the margins, and the absence of the jagged, irregular edges of a fresh break, help mark the appearance as a developmental one.

On MRI, which shows soft tissues as well as bone, the cleft is typically filled with material that follows the signal of disc tissue rather than bone, often connecting the discs above and below through the funnel of the defect. Importantly, the bone marrow on either side of the cleft usually shows normal signal, without the swelling (oedema) that would accompany a recent fracture, and without the abnormal soft-tissue mass or marrow replacement that would suggest a tumour or infection. This absence of any aggressive or inflammatory change is one of the most reassuring features that points firmly towards a benign, congenital cause.

Usually incidental and without symptoms

The defining clinical feature of a butterfly vertebra, repeated throughout the literature, is that it is usually asymptomatic and is most often found by chance. A great many cases come to light only because a scan was performed for some unrelated reason — an X-ray after a minor knock, a CT of the abdomen for a stomach complaint, an MRI for back pain that turns out to arise from quite separate causes — and the butterfly shape is noticed incidentally on the images.

Where symptoms such as back pain are present alongside a butterfly vertebra, the relationship between the two is generally uncertain. Back pain is extremely common in the general population and has many causes, so finding a butterfly vertebra in someone with back pain does not establish that the variant is the source of the pain. The published case reports describing back pain in people with a butterfly vertebra are careful to note that the association remains unproven, since pain of that kind is so frequent regardless of whether a butterfly vertebra is present. In short, the variant is frequently a bystander rather than a culprit.

A butterfly vertebra can occur at any level of the spine. It is reported most often in the lumbar region of the lower back and the thoracic region of the chest, and is encountered only rarely in the sacrum at the base of the spine. A

person may have a single butterfly vertebra or, less commonly, more than one. Cases with a single isolated butterfly vertebra and no other abnormality are particularly likely to behave as a silent, lifelong variant.

Why it can be mistaken for something serious

The greatest practical significance of a butterfly vertebra lies not in any harm it does, but in the harm that can follow from misinterpreting it. Because of its unusual shape, it can mimic several more worrying conditions on imaging, and a number of distinct mistakes are described.

The first and commonest is mistaking it for a fracture. On a side-on view the wedged, shortened appearance closely resembles a wedge compression fracture, and in the setting of trauma — where someone has had an accident and a scan is being scrutinised for injury — there is a recognised tendency to over-diagnose a break. The literature specifically warns that butterfly and related congenital vertebral variants are a cause of over-diagnosis in trauma patients, and that awareness of the entity is needed so that a benign, long-standing shape is not labelled as an acute injury.

The second is mistaking it for a tumour, particularly a deposit of cancer that has spread to bone, known as a metastasis, or for a destructive lytic lesion that eats away at bone. The cleft and the unusual contour can superficially suggest that part of the bone has been destroyed.

The third is confusion with infection of the spine or with other processes that can deform vertebrae, including conditions affected by altered sensation or repeated minor injury. The shared theme is that a butterfly vertebra can imitate the outline of bone that has been damaged, even though the bone is in fact intact.

The features that distinguish the benign variant are consistent and reassuring. A front-on view typically reveals the tell-tale symmetrical butterfly pattern that the side view conceals. The margins of the cleft tend to be smooth and well-corticated rather than ragged. On MRI there is no marrow oedema to suggest a recent fracture and no aggressive soft-tissue mass or marrow replacement to suggest a tumour or infection. Taking these together, and reviewing the appropriate views and scans, allows the variant to be recognised confidently for what it is. This recognition is the whole point: getting the diagnosis right avoids unnecessary alarm, unnecessary further tests and unnecessary treatment.

Associations with syndromes and other anomalies

For most people a butterfly vertebra is an isolated, solitary finding with no wider significance. In a minority of cases, however, it occurs as one feature among several, either alongside other vertebral anomalies or as part of a recognised congenital syndrome.

Among the syndromes reported in association with butterfly vertebrae, Alagille syndrome is one of the better recognised; butterfly vertebrae are among the more common skeletal features described in that condition. Other associations reported in the literature include Pfeiffer syndrome, Jarcho-Levin syndrome (a condition affecting the formation of the vertebrae and ribs, also discussed under the heading of spondylocostal dysostosis), Crouzon syndrome, and the broader pattern of features grouped under the VACTERL association, which links several anomalies of the spine, heart, kidneys, limbs and other systems. Spondylocostal dysostosis in particular has been highlighted as one of the more frequent syndromic associations in reviews of the topic.

A butterfly vertebra may also keep company with other developmental variations of the spine, such as hemivertebra (where only half of a vertebral body forms), block vertebrae (where adjacent vertebrae fail to separate), and clefts of the vertebral arch behind. When multiple vertebral anomalies are present together, or when a butterfly vertebra is accompanied by a curvature of the spine such as scoliosis, the chance of an underlying syndrome rises. Reviews note that having more than one butterfly vertebra, rather than a single isolated one, is more strongly linked with an associated syndrome or with additional anomalies. This is one reason the broader context of a butterfly vertebra — whether it stands alone or is one of several findings — is taken into account when its significance is being judged.

It is important to keep this in proportion. The existence of these associations does not mean that a butterfly vertebra implies a syndrome; in most individuals it does not. The associations describe patterns observed across groups of reported cases, and the presence of a syndrome is generally signalled by the wider clinical picture rather than by the butterfly vertebra in isolation.

How it is assessed

Assessment of a butterfly vertebra rests on imaging, and the central aim is to confirm that the appearance is a benign developmental variant and to exclude the more serious mimics.

Plain X-rays, especially a front-on view, are often where the butterfly shape is first appreciated, because that view displays the symmetrical wing pattern most clearly. A side-on view alone can be misleading, as already described, which is why looking at more than one projection matters.

CT is particularly useful for showing the bony architecture of the cleft in detail — its course, its margins and the shape of the two halves — and for demonstrating that the edges are smooth and well-formed rather than the irregular edges of a recent break. Where there is any doubt about whether an appearance represents an old developmental variant or a new injury, this level of bony detail is valuable.

MRI adds information about the soft tissues and the bone marrow. Its great contribution in this setting is to demonstrate the absence of the features that would accompany something sinister: no marrow swelling of a fresh fracture, no destructive mass of a tumour, no inflammatory change of an infection. The cleft instead tends to be bridged by disc-type material with otherwise normal marrow on either side. Together these tests allow a confident, benign diagnosis to be reached and the mimics to be set aside.

What the evidence shows about management — impersonal

It should be stated plainly that the evidence base concerning butterfly vertebra is built almost entirely on individual case reports, small case series and narrative reviews, together with at least one systematic review gathering these together. There are no large trials, and there is no formal guideline that prescribes a course of action, because for an incidental, benign variant none is generally required. The descriptions that follow report what this literature observes, not advice for any individual, and any decision in a particular case is a matter for assessment by the treating team.

The overwhelming theme of that literature is recognition rather than intervention. Because a butterfly vertebra is, in the typical case, an asymptomatic congenital variant, the single most important step described is simply identifying it correctly and distinguishing it from a fracture, a tumour or an infection, so that no unnecessary investigation or treatment follows. For the isolated, asymptomatic variant, the reported approach amounts to reassurance and recognition; the variant itself is not something that is treated.

Where symptoms such as back pain coexist, the literature is careful to note that those symptoms usually have their own, separate explanations, and any care is directed at the actual cause of the symptoms rather than at the butterfly vertebra as such. The small minority of reported cases that have involved surgery have generally done so because of an accompanying problem — a significant spinal deformity such as scoliosis, or another structural issue — rather than because of the butterfly vertebra in isolation. Where a butterfly vertebra forms part of a wider syndrome or sits alongside multiple other anomalies, attention is naturally directed to that broader picture and to the team managing it.

In summary, the evidence points overwhelmingly towards correct recognition and reassurance for the common, isolated, asymptomatic butterfly vertebra; towards addressing the genuine cause when symptoms are present; and towards considering the wider context only where additional anomalies, a deformity or a syndrome are present — all within a framework of individualised assessment rather than any fixed rule.

Outlook

For most people the outlook associated with a butterfly vertebra is entirely reassuring, and it follows directly from the variant's benign, congenital nature. A solitary butterfly vertebra found incidentally is a shape the person has carried since before birth, has lived with unknowingly, and will generally continue to live with without consequence. It does not, in itself, weaken the spine in the way a fracture does, it is not a sign of disease, and it does not require monitoring or treatment in its own right.

The matters that influence the wider picture are not the butterfly vertebra alone but its company: whether it is isolated or one of several anomalies, whether it is accompanied by a spinal curvature such as scoliosis, and whether it forms part of a recognised syndrome. In those less common situations, the outlook is shaped by the associated condition rather than by the cleft itself, and is a matter for the team looking after that broader picture.

The consistent messages across the whole field are that a butterfly vertebra is usually an incidental and harmless variant of normal anatomy, that its chief importance is being recognised so it is not mistaken for a fracture or a tumour, that it seldom needs anything beyond that recognition, and that any individual situation is best understood through assessment by the treating team rather than read from the appearance alone.