

Lumbosacral Transitional Vertebra (LSTV)

A patient guide

In brief: A lumbosacral transitional vertebra, often shortened to LSTV, is one of the most common anatomical variations of the lower spine. It describes a vertebra at the junction between the lumbar spine and the sacrum that has taken on a mixture of lumbar and sacral characteristics, sitting somewhere between the two. In the usual arrangement the five lumbar vertebrae sit above a fused block of bone called the sacrum. In an LSTV the lowest lumbar vertebra may become partly or wholly incorporated into the sacrum, a pattern known as sacralisation, or the uppermost sacral segment may separate and behave more like a lumbar vertebra, a pattern known as lumbarisation. The hallmark is an enlarged sideways-projecting bony wing, the transverse process, of the last lumbar segment, which may simply be broadened, may form a false joint with the sacrum or pelvis, or may fuse to it completely. This is a variant of normal anatomy rather than a disease. It is present from birth, is found in something like a quarter of people across the published range, and in the great majority causes no symptoms whatsoever and is discovered incidentally on a scan performed for another reason. Its importance is twofold: in a minority it is associated with back pain through a mechanism named Bertolotti syndrome, and in everyone it matters for the accurate counting and labelling of spinal levels before any procedure on the spine.

What a lumbosacral transitional vertebra is

The human spine is built as a column of separate, mobile vertebrae stacked above a solid foundation. In the lower back there are conventionally five lumbar vertebrae, labelled L1 to L5 from the top down, and beneath them the sacrum, a single wedge of bone formed from five sacral segments that have fused together during early life. The lowest mobile disc, between L5 and the first sacral segment, is written as the L5/S1 disc, and it marks the boundary between the moving spine above and the fixed pelvis below.

A lumbosacral transitional vertebra is a variation in exactly where that boundary falls and how cleanly it is drawn. Instead of a sharp division between a fully lumbar L5 and a fully fused sacrum, there is a vertebra of intermediate character. Its defining feature is the transverse process, the wing of bone that projects to each side. In a transitional vertebra this process is enlarged, and instead of standing free it may reach across to touch, articulate with, or fuse to the wing of the sacrum, the sacral ala, or to the rim of the pelvis.

Two broad patterns are described. In **sacralisation**, the lowest lumbar vertebra is drawn into partnership with the sacrum, so that the spine appears to have one fewer free lumbar vertebra and a correspondingly larger sacral block. In **lumbarisation**, the uppermost sacral segment is released from the sacrum and takes on the appearance and some of the mobility of a lumbar vertebra, so that the spine appears to have an extra, sixth lumbar vertebra. Both are simply different expressions of the same underlying theme: a vertebra at the lumbosacral junction that does not commit fully to being either lumbar or sacral.

It is worth stating plainly at the outset that this is a normal anatomical variant, present from birth and reflecting the way the segments of the lower spine took shape in early development. It is not an injury, not a degeneration, and not in itself a disorder.

How common it is

A lumbosacral transitional vertebra is a frequent finding. Across the literature, prevalence figures span a wide range, from roughly 4 per cent to over 35 per cent of the people studied, and a commonly cited shorthand is that something approaching a quarter of the population carries one form or another. The breadth of this range is not a sign of disagreement so much as a reflection of how the figure is measured: studies differ in the populations they

examine, in whether they use plain radiographs, computed tomography or magnetic resonance imaging, and in how strictly they define the more subtle grades.

Some patterns recur. Prevalence appears to differ between populations, with figures reported around 16 per cent in some Asian groups, around 8 to 9 per cent in some North American series, and approaching a quarter in some southern European series. Sacralisation of the last lumbar vertebra is generally described as more common than lumbarisation of the first sacral segment. Studies of people attending with low back pain sometimes report higher figures than studies of the general population, a point discussed further below.

The central message is one of commonness. A variant found in such a large share of people, the overwhelming majority of whom have no related symptoms, is best understood as part of the ordinary spectrum of human anatomy rather than as a rare abnormality.

Sacralisation and lumbarisation

The distinction between sacralisation and lumbarisation describes which way the transitional vertebra has leaned, and it has practical consequences chiefly for how the levels are counted.

In **sacralisation**, the last true lumbar vertebra has partly or completely joined the sacrum. On imaging the lowest lumbar segment may appear wedge-shaped or squared off, and its transverse processes are enlarged and connected to the sacrum on one or both sides. Because one segment that would ordinarily be counted as lumbar now behaves as part of the sacrum, a spine with sacralisation may seem to have only four free lumbar vertebrae.

In **lumbarisation**, the uppermost sacral segment has separated from the rest of the sacrum and acquired the form of a lumbar vertebra, often with a recognisable disc beneath it. The upper sacral segment appears squared rather than wedge-shaped, and the spine may seem to have six lumbar vertebrae rather than five.

The reason this distinction matters is that it disturbs the simple act of counting vertebrae. When the number of apparently lumbar vertebrae is not the expected five, the labels assigned to each level can shift, and a level that one observer calls L5 another might call L4 or a lumbarised S1. This is the root of the level-numbering issue that runs through the whole subject and is addressed in its own section below.

The Castellvi classification

To bring order to the variety of transitional vertebrae, a radiographic classification was described by Castellvi and colleagues in 1984, and it remains the standard framework. It sorts transitional vertebrae into four types according to the size of the transverse process and whether it merely enlarges, forms a false joint, or fuses to the sacrum, with each type subdivided by whether the change is on one side or both.

Type I describes a transverse process that is simply enlarged and dysplastic, broadened to a width conventionally taken as at least 19 millimetres, without forming a joint or fusion with the sacrum. Type Ia is one-sided and type Ib is two-sided.

Type II describes an enlarged transverse process that forms a false joint, a pseudoarticulation, with the sacrum. Here the wing of the transitional vertebra and the wing of the sacrum meet at a diarthrodial-like junction with cartilage-bearing surfaces, an incomplete transition rather than a solid bony union. Type IIa is one-sided and type IIb is two-sided. It is this false joint that is most often implicated when a transitional vertebra is associated with pain.

Type III describes complete bony fusion of the enlarged transverse process to the sacrum, so that the two are joined into a continuous block of bone with no joint between them. Type IIIa is one-sided and type IIIb is two-sided.

Type IV describes a mixed pattern, with a type II false joint on one side and a type III bony fusion on the other.

In large imaging series the milder grades dominate. Type I accounts for the majority of cases, with the joint-forming and fused types together making up a smaller share. The classification is descriptive: it records the anatomy seen on a scan and does not by itself state whether a given transitional vertebra is or is not causing any symptoms.

Bertolotti syndrome: when the variant is linked to pain

For the great majority of people an LSTV is silent. In a minority, however, a transitional vertebra is associated with low back pain, and this association has a name: Bertolotti syndrome, after the Italian physician Mario Bertolotti, who in 1917 first linked an enlarged transverse process seen on imaging with back pain reported by patients.

The term Bertolotti syndrome is reserved for the situation in which a transitional vertebra is considered to be the actual source of a person's pain, rather than simply being present on the scan. This is a meaningful distinction, because transitional vertebrae are so common that one will frequently be found in a person whose pain in fact arises from an entirely separate cause. The presence of an LSTV does not establish that it is responsible for any given symptom.

Where pain is genuinely attributable to the transitional vertebra, several mechanisms are described. The most discussed centres on the false joint of a Castellvi type II variant. This pseudoarticulation is an unusual joint that was never designed to bear load in the way it does, and like other joints it can develop wear, inflammation and bony spurs over time, becoming a potential pain generator in its own right. Pain has also been described as arising from the disc and facet joints at the mobile level immediately above the transition, which can carry altered loads; from the facet joint on the opposite side in one-sided variants, where the mechanics are asymmetric; and, less commonly, from irritation of the nearby L5 nerve as it passes through the narrow channel between the enlarged transverse process and the sacrum, an extraforaminal entrapment sometimes called far-out syndrome.

Bertolotti syndrome is described as an under-recognised and often overlooked contributor to low back pain, and as one that may present at a relatively young age, in some series typically in the thirties and forties, younger than much ordinary degenerative back pain. The literature is clear, though, that it accounts for only a minority of transitional vertebrae and a minority of back pain, and that distinguishing a symptomatic transitional vertebra from an incidental one is one of the central challenges of the topic.

Altered biomechanics and effects on neighbouring levels

Because a transitional vertebra changes the architecture of the lumbosacral junction, it also changes the way forces pass through the lower spine, and this altered mechanics is the thread connecting the variant to the patterns of wear sometimes seen around it.

A transitional vertebra is, in mechanical terms, partly anchored. Where its transverse process joins or fuses to the sacrum, the lowest segment loses some of the movement a normal mobile level would have. The transitional level itself is therefore relatively stiff and tends to be comparatively protected from wear at its own disc. The consequence is that movement and load are redistributed to the neighbouring levels, and in particular to the mobile disc immediately above the transition, which must accommodate the motion the stiffened junction no longer provides.

This redistribution is reflected in the imaging literature. Several large studies report that the disc immediately above a transitional vertebra shows degenerative change, including disc bulging and herniation, considerably more often than discs at other levels, with one analysis finding herniation at that interspace many times more frequent than elsewhere. By contrast, the disc at the transitional level itself, being relatively immobilised, is often comparatively well preserved. Computer-based finite-element modelling supports the same picture, showing altered ranges of motion and concentrations of stress in the segment above the transition, particularly on backward bending.

These observations describe tendencies across groups of scans, not the certain fate of any individual spine. Many people with a transitional vertebra never develop accelerated wear at the level above, and degeneration of the lower lumbar discs is extremely common in the general population regardless of whether a transitional vertebra is present. The biomechanical account explains why an association exists; it does not convert that association into a prediction for any one person.

The critical issue of level numbering

Perhaps the single most important practical point about a transitional vertebra has nothing to do with pain at all. It is that the variant disrupts the ordinary counting of spinal levels, and that correct counting is fundamental to the safe and accurate planning of any procedure on the spine.

Spinal levels are normally labelled by counting vertebrae, and clinicians rely on the expectation of five lumbar vertebrae above the sacrum. A transitional vertebra breaks that expectation. With sacralisation there may appear to be four lumbar vertebrae, and with lumbarisation six, so that the same bony segment may be called L5 by one observer, L4 by another, or a lumbarised S1 by a third. When imaging of only the lower spine is reviewed in isolation, the scope for miscounting is real, and studies put the rate of disagreement at well over one in ten in the presence of a transitional vertebra.

The consequence of mislabelling is the prospect of an intervention being directed at the wrong level: an injection placed at a level adjacent to the intended one, or surgery planned around a numbering that does not match the anatomy. The literature on transitional vertebrae returns repeatedly to this point, identifying the variant as a recognised contributor to wrong-level procedures and emphasising that its identification before any intervention is, in the words of one review, beyond dispute.

Several methods are described to count levels reliably in the presence of a transitional vertebra. Counting down from the top of the spine on whole-spine imaging is regarded as a dependable reference, since it does not rely on assuming a normal number of lumbar vertebrae. Anatomical landmarks are also used, among them the iliolumbar ligament, a band that characteristically arises from the L5 vertebra, and the morphology of the lowest nerves, alongside specific radiographic views of the lumbosacral junction. The common purpose of all these techniques is to ensure that the level seen on a scan is matched correctly to the level acted upon, so that the numbering is unambiguous before anything is done.

How a transitional vertebra is identified

A transitional vertebra is an anatomical finding, and it is identified on imaging. Each form of imaging contributes something different, and the assessment is as much about counting and labelling the levels correctly as about characterising the variant itself.

****Plain radiographs****, ordinary X-rays of the lower back, were the basis of the original Castellvi classification and remain useful. A view that includes the whole lumbar spine down to the sacrum allows the levels to be counted, and a specific angled view of the lumbosacral junction, sometimes called a Ferguson view, displays the enlarged transverse process and any false joint or fusion to good effect.

****Computed tomography, the CT scan****, gives the most detailed picture of the bony anatomy. It shows the size and shape of the transverse process, demonstrates clearly whether a false joint or a solid fusion is present, and is well suited to assigning a Castellvi type. It also depicts any arthritic change or bony spur formation at a false joint.

****Magnetic resonance imaging, the MRI scan****, is the workhorse for examining the discs and nerves of the lower back, and it is on MRI that many transitional vertebrae are first noticed incidentally. MRI can show changes at a false joint, including fluid and inflammation, and can demonstrate the condition of the disc above the transition and any effect on the nearby nerves. Because routine lumbar MRI may not include the whole spine, particular care is taken with level counting, using landmarks such as the iliolumbar ligament or, where available, imaging that extends up the spine to allow counting from the top.

Where a false joint is suspected of being a source of pain, a diagnostic injection of local anaesthetic into the pseudoarticulation is sometimes described in the literature as a way of testing whether that specific structure is contributing to symptoms, the reasoning being that temporary relief points towards the false joint as a pain generator. Such assessments are matters for the treating team and are noted here only to describe how the question is approached.

What the evidence shows about significance and management

It is important to be clear that the literature on transitional vertebrae is built largely on imaging surveys, retrospective series, biomechanical and computer-modelling studies, case reports and narrative reviews, rather than on large randomised trials. The descriptions that follow report what that literature observes about the variant and its associations; they are not guidance for any individual, and any decisions in practice are individualised and made within a clinical relationship.

The first and broadest observation is that the transitional vertebra is, for most people, an incidental finding of no consequence. It is present in a large share of the population, the overwhelming majority of whom have no related symptoms, and its discovery on a scan performed for another reason does not in itself signify a problem. The literature is at pains to separate the common, asymptomatic variant from the uncommon situation in which it is genuinely contributing to pain.

Where a transitional vertebra is associated with pain through Bertolotti syndrome, the management described in the literature follows the same broad pattern as for low back pain generally, beginning with non-operative measures and reserving anything more only for the minority in whom careful assessment points clearly to the transitional vertebra as the source and in whom simpler measures have not settled the symptoms. Non-operative measures described include physical activity and exercise-based approaches, simple pain-relieving and anti-inflammatory medication, and, as a more targeted step, injections placed into or around the false joint, which several series report can provide both diagnostic information and a period of relief.

For the small number in whom symptoms are persistent, clearly localised to the transitional vertebra, and unresponsive to such measures, the literature describes procedural options, principally surgical removal of the enlarged transverse process and its false joint, sometimes called resection, or fusion of the segment. Reported outcomes from these procedures are mixed and drawn from relatively small series, and the literature emphasises careful patient selection, including confirmation that the transitional vertebra is indeed the source of pain, as central to a satisfactory result. These descriptions are offered to explain how the question is approached in the published experience, not as a recommendation for any person.

Running through the whole of this evidence are a few stable themes: that the variant is common and usually incidental; that it is associated with pain only in a minority and through identifiable mechanisms; that its effect on neighbouring levels is a matter of altered mechanics rather than of certainty; and that its single most universal practical importance is the correct counting of spinal levels before any procedure.

Outlook

The outlook for a person found to have a lumbosacral transitional vertebra is, for the great majority, entirely unremarkable, because for most people the variant never causes any difficulty at all. It is a feature of their anatomy, present since early life, often discovered by chance, and compatible with a completely normal and active spine.

Where a transitional vertebra is genuinely associated with pain, the picture is more individual and depends on the mechanism involved, the grade of the variant, the response to non-operative measures, and the wider context of the person's spine. Even here the framing in the literature is measured: Bertolotti syndrome accounts for only a minority of transitional vertebrae and a minority of back pain, and much of the apparent association between transitional vertebrae and degenerative change reflects mechanics common to the lower lumbar spine in general.

The most durable practical message is the one about level numbering. Whatever else is or is not true of a particular transitional vertebra, its accurate identification and the correct labelling of the spinal levels around it are the foundation on which any safe assessment or procedure rests. Across the whole subject the consistent themes are that the transitional vertebra is common, that it is usually incidental and harmless, that it is linked to pain only in a minority and through recognisable routes, and that its identification chiefly matters so that the right level is always matched to the right label. Any individual interpretation is a matter for assessment by the treating team rather than something that can be read from a category or a scan alone.