

Lumbarisation of S1

A patient guide

In brief: Lumbarisation of S1 is a common, usually harmless anatomical variant in which the first segment of the sacrum is partly or fully separated from the rest of the sacrum and takes on the appearance and behaviour of an extra, sixth lumbar vertebra. It belongs to a family of variants known collectively as lumbosacral transitional vertebrae, in which the boundary between the mobile lumbar spine and the fused sacrum is shifted in one direction or the other. Lumbarisation is the less common of the two main forms, the other being sacralisation, in which the lowest lumbar vertebra fuses partly with the sacrum. In the great majority of people, lumbarisation of S1 is discovered by chance on a scan performed for some other reason and is of no consequence to health. Its principal importance is practical rather than medical: because it changes the number of mobile segments and the way the spine is counted, it can confuse the labelling of vertebral levels on imaging, and that matters when planning any procedure that must be carried out at a precise level. This page is strictly educational and does not offer medical advice.

What lumbarisation of S1 means

The human spine is conventionally described as having a fixed pattern of segments: seven cervical vertebrae in the neck, twelve thoracic vertebrae carrying the ribs, five lumbar vertebrae in the lower back, and then five sacral segments that are normally fused together into a single solid block of bone, the sacrum, which forms the back of the pelvis. The first of those sacral segments is called S1, and in the usual arrangement it is firmly joined to the segment below it, S2, with no mobile disc and no independent movement.

Lumbarisation of S1 describes the situation in which this first sacral segment fails to fuse fully with the rest of the sacrum and instead remains partly or completely separate. When this happens, S1 no longer behaves as part of the solid sacral block. It develops, to a greater or lesser degree, the features of a lumbar vertebra: a recognisable disc space beneath it, more lumbar-shaped transverse processes to the sides, and a measure of independent movement. To the eye, and on a scan, the lower spine then appears to have six lumbar-type vertebrae stacked above the sacrum rather than the usual five. For this reason lumbarisation of S1 is often described, informally, as a sixth lumbar vertebra.

It is important to hold on to the idea that this is a variant of normal anatomy present from birth, not a disease, an injury, or something that has gone wrong over time. The segment has simply formed and separated in a slightly different way during development. The spine of a person with lumbarisation of S1 is a normal spine built to a slightly different blueprint, and in most people it works perfectly well throughout life without ever causing a problem.

Lumbosacral transitional vertebrae: the wider family

Lumbarisation of S1 does not stand alone. It is one expression of a broader phenomenon known as the lumbosacral transitional vertebra, often abbreviated to LSTV. The lumbosacral junction is the point at which the mobile lumbar spine meets the fixed sacrum, and a transitional vertebra is one that sits at this border and shares characteristics of both regions, so that it is neither fully lumbar nor fully sacral but somewhere in between.

There are two principal directions in which the transition can shift. In ****sacralisation****, the lowest lumbar vertebra, usually L5, takes on the characteristics of the sacrum, with its transverse processes enlarging and joining or fusing to the sacrum or the pelvis, so that the lumbar spine appears to have only four free segments and the sacrum appears to have gained one. In ****lumbarisation****, the opposite occurs: the uppermost sacral segment, S1, separates from the sacrum and takes on lumbar characteristics, so that the lumbar spine appears to have six free

segments and the sacrum appears to have lost one. The two are mirror images of the same underlying tendency for the lumbosacral boundary to be set slightly higher or slightly lower than usual.

Of the two, sacralisation is reported more often, and lumbarisation is generally described as the less common form. The wider group of transitional vertebrae as a whole is common, which is one of the reasons this variant attracts so much attention in radiology and surgery despite being, in most individuals, of no clinical importance.

How common it is

Transitional vertebrae at the lumbosacral junction are among the more frequently encountered anatomical variants of the spine, although the reported figures vary widely between studies. This variation reflects genuine differences between populations, differences in the imaging used, and, above all, differences in how strictly the variant is defined and counted. Across the literature, the prevalence of lumbosacral transitional vertebrae of all kinds is commonly described as falling somewhere between about four per cent and a third of people, with many studies clustering around the region of twelve to twenty per cent, and figures tending to be higher in series of patients investigated for back pain than in the general population.

Within this overall group, lumbarisation is the smaller share. Sacralisation of L5 is reported to be somewhat more frequent than lumbarisation of S1, with some series placing sacralisation at around seven to eight per cent and lumbarisation at around five to six per cent of people, although these numbers should be read as broad indications rather than precise values. Lumbarisation is also reported more often in women, whereas sacralisation is reported more often in men, a difference noted across several studies.

One further point explains why the figures are so variable. When vertebrae are counted accurately, by tracing the whole spine from the top downwards rather than looking at the lower back in isolation, the true prevalence of an isolated extra lumbar-type segment is lower than casual counting suggests, because an apparent sixth lumbar vertebra in the lower back can sometimes reflect a variation higher up the spine rather than a true lumbarisation of S1. The headline message remains that this is a common family of variants of which lumbarisation is a real but less frequent member.

How it arises during development

To understand why the lumbosacral boundary can be set in a slightly different place, it helps to consider how the spine is built before birth. The vertebral column forms from a series of paired blocks of tissue called somites, which appear in a regular sequence down the length of the embryo, from head to tail. Each region of the future spine, cervical, thoracic, lumbar and sacral, is given its identity by a coordinated set of control genes, among them the family known as the Hox genes, which act rather like a positional address system, telling each developing segment what kind of vertebra it should become.

The boundaries between these regions are not absolutely rigid. The point at which the lumbar pattern gives way to the sacral pattern is determined by where this genetic addressing draws the line, and small shifts in that boundary produce the transitional vertebrae seen in adult life. If the boundary is set one segment lower than usual, the topmost sacral segment is instructed to behave more like a lumbar vertebra, and lumbarisation of S1 results. If it is set one segment higher, the lowest lumbar vertebra is instructed to behave more like the sacrum, and sacralisation of L5 results.

Because the same developmental process governs the whole length of the spine, variations at the lumbosacral junction are sometimes accompanied by variations elsewhere, such as a different number of rib-bearing thoracic vertebrae. This is why the count of vertebrae in one region cannot always be assumed from the count in another, and why understanding the developmental origin of these variants is more than a matter of curiosity: it underlies the practical business of counting levels correctly, considered below.

The appearance of a sixth lumbar vertebra

The most visible feature of lumbarisation of S1 is the impression, on imaging or on examination of the skeleton, that the lower back contains an extra mobile vertebra. Instead of the familiar five lumbar vertebrae sitting above a five-segment sacrum, there appear to be six lumbar-type vertebrae sitting above a sacrum that seems to have only four segments. This is the origin of the everyday description of the variant as a sixth lumbar vertebra, sometimes informally written as L6, although that is a description of appearance rather than a formal anatomical name.

The degree to which the separated S1 segment resembles a true lumbar vertebra varies. In some people the separation is partial, with a rudimentary disc space and only some lumbar features, while in others it is more complete, with a well-formed disc beneath the segment and transverse processes shaped much like those of the vertebrae above. The clearer and more complete the lumbarisation, the more convincingly the lower spine resembles a six-segment lumbar region.

This apparent extra segment is the source of both the interest and the difficulty surrounding the variant. On the one hand it is a striking and easily recognised feature. On the other hand, precisely because it changes the count, it is the reason the variant can mislead the labelling of spinal levels, which is the single most clinically relevant aspect of the whole subject.

Why level numbering can go wrong

In a spine with the usual number of vertebrae, the levels are labelled by a convention that almost everyone shares: the lowest mobile disc is called L5 to S1, the one above it L4 to L5, and so on. This convention works smoothly because the number of segments is fixed and predictable. Lumbarisation of S1 disturbs this predictability by adding what looks like an extra lumbar level, and that is where errors in numbering can creep in.

The core of the problem is that vertebral levels are most reliably identified by counting from a fixed reference point at the top of the spine downwards, ideally from the second cervical vertebra, which is easy to recognise. In day-to-day practice, however, a scan of the lower back is often looked at in isolation, without the rest of the spine in view. When this is done in a person with lumbarisation of S1, the counting can go astray, because the segment that an isolated lumbar scan calls the lowest lumbar vertebra may in fact be the lumbarised S1, and what looks like S1 may be S2. The same anatomical level can therefore be given different labels depending on whether the counter starts from the top of the spine or from the bottom.

Landmarks that are usually reliable in normal spines become less dependable when a transitional vertebra is present. The iliolumbar ligament, a band that in ordinary anatomy arises from the transverse process of L5 and is widely used as a marker of that level, has been shown to be a far less reliable indicator of L5 when a transitional vertebra is present, identifying the correct level in only a minority of such cases. This is why landmarks taken from a limited view of the lower back cannot be trusted in isolation when a transitional segment is suspected.

The risk of wrong-level procedures

The practical consequence of confused numbering is the risk of a procedure being carried out at the wrong level. Because lumbarisation of S1 can cause the level labelled on a lower-back scan to differ from the true level counted from the top of the spine, a procedure planned from the scan alone could be directed one segment higher or lower than intended.

Wrong-level surgery is a recognised, if uncommon, event, and it is reported more often in the lower back than in the neck. Anatomical variants, transitional vertebrae prominent among them, are repeatedly identified in the literature as contributing factors. Surveys of spine surgeons have attributed a substantial share of wrong-level events, in part, to anomalous anatomy, and transitional vertebrae have featured in published series of such cases. The point is not that lumbarisation of S1 makes wrong-level surgery likely, for it does not; it is that the variant is one of the well-recognised situations in which extra care over level identification is warranted.

This is also why the recognition of the variant is regarded as important quite apart from any symptoms it may or may not cause. A person may have lumbarisation of S1 that is entirely silent and irrelevant to their health, and yet

its accurate identification still matters, because if that person were ever to need a precisely targeted procedure on the spine, the levels would need to be counted correctly from the whole spine to ensure the right one was treated. The clinical relevance of the variant lies as much in this labelling question as in anything it does to the back itself.

How the levels are counted correctly

The remedy for the numbering problem is, in principle, straightforward: count the vertebrae along the whole length of the spine rather than from the lower back alone. An image that takes in the spine from the upper neck down to the sacrum allows the count to proceed from the second cervical vertebra downwards, segment by segment, so that the true position of every level is established and the transitional segment is correctly placed in the sequence.

For this reason, whole-spine imaging, or at least imaging that captures enough of the spine to count reliably from a fixed upper landmark, is the approach described in the literature for establishing accurate vertebral numbering when a transitional vertebra is present or suspected. Plain radiographs of the entire spine, or modern cross-sectional imaging reconstructed to show the whole column, allow not only the lumbosacral junction but also the rib-bearing thoracic vertebrae to be counted, which helps to distinguish a true sixth lumbar segment from a variation elsewhere in the spine.

Several refinements have been studied as aids to numbering on limited images, including the shape and origin of particular nerves, the level of the iliac crests, and the iliolumbar ligament. These can be helpful, but the recurring conclusion of the literature is that none of them is wholly reliable in the presence of a transitional vertebra, and that counting from the whole spine remains the reference standard. The practical principle that emerges is simple to state: where the count matters, the whole spine should be counted.

Biomechanics and the question of back pain

Because lumbarisation of S1 alters the structure of the lower spine, a natural question is whether it changes the way the back bears load and whether it predisposes to pain. The honest answer drawn from the literature is nuanced. As a group, transitional vertebrae do change the local mechanics of the lumbosacral junction. The transitional level itself, where the segment is partly tethered to the sacrum or pelvis, tends to move less than a normal mobile segment, while the level immediately above it may take up the slack and move more, bearing altered loads and twisting forces.

This redistribution of movement and load is the basis for the association, reported in some studies, between transitional vertebrae and degeneration of the disc and facet joints at the segment just above the transition, which carries more of the mechanical demand. It is also the basis of the named condition, sometimes called Bertolotti's syndrome, in which a transitional vertebra is held responsible for low back pain, classically through an irritated false joint between the enlarged transverse process and the sacrum or pelvis. Much of this literature concerns sacralisation and the enlarged-transverse-process variants rather than lumbarisation specifically, but the underlying mechanical principles apply across the transitional family.

Two important qualifications must be kept firmly in view. First, transitional vertebrae are common and low back pain is extremely common, so the two will frequently coexist by chance alone; finding a transitional vertebra in a person with back pain does not establish that the one is causing the other. Second, the great majority of transitional vertebrae, including most cases of lumbarisation of S1, are entirely without symptoms and are discovered incidentally. The symptomatic syndrome attributed to a transitional vertebra is considered uncommon and, by general agreement, both under-recognised and over-diagnosed in different settings, which is precisely why careful, individual assessment rather than assumption is the approach described in the literature. None of this constitutes advice for any particular person.

How it is identified on imaging

Lumbarisation of S1 is, in the first instance, an imaging diagnosis, since it concerns the form and arrangement of the bones. Plain radiographs, particularly views that show the whole spine and the lumbosacral junction clearly, have traditionally been the means of recognising the variant and of counting the segments. They show the apparent sixth lumbar-type vertebra, the disc space beneath it, and the shape of the transverse processes, and they allow the count to be made from the top of the spine if enough of the column is included.

Cross-sectional imaging adds detail. Computed tomography, which renders bone in fine detail and can be reconstructed in any plane and in three dimensions, is well suited to demonstrating the precise bony anatomy of a transitional vertebra, to showing whether the transition is partial or complete and whether a false joint is present, and to counting the segments accurately along the whole spine. Magnetic resonance imaging shows the discs, nerves and soft tissues and is the usual means of investigating symptoms, but a transitional vertebra can be a particular source of numbering confusion on magnetic resonance imaging when only the lower back is included, which is one reason the count is best confirmed against a wider view.

The recurring theme across all imaging is not the recognition of the variant itself, which is generally straightforward, but the correct numbering of the levels around it. This is why the literature repeatedly returns to the importance of counting from a fixed upper landmark, and why imaging that captures enough of the spine to do so is so valued whenever a transitional vertebra is present.

Keeping it in proportion

It is worth ending where the subject began, with proportion. Lumbarisation of S1 is, for the overwhelming majority of people who have it, a harmless quirk of anatomy that they were born with, that causes no symptoms, and that they may live their whole lives without ever knowing about. When it is discovered, it is usually by chance, on a scan arranged for some unrelated reason. Its discovery does not imply that anything is wrong, and in most people it changes nothing about how the spine functions or how it should be cared for.

The reasons the variant attracts attention are specific and limited. It can confuse the counting of spinal levels, which matters when any precisely targeted procedure is being planned, and it can, in a minority of people and chiefly through its effects on the mechanics of the segment above, be associated with degeneration or, occasionally, with a symptomatic syndrome. These are genuine considerations, but they are the exception rather than the rule, and they are matters for individual assessment by an appropriately qualified clinician rather than for assumption from the presence of the variant alone.

The settled message of the literature is therefore a calm one. Lumbarisation of S1 is a common, usually incidental variant within the wider family of lumbosacral transitional vertebrae; its main practical importance is the need to count vertebral levels carefully, from the whole spine, before any level-specific procedure; and the relationship between the variant and symptoms is loose, individual and often coincidental. This page is provided for general education only and is not a substitute for individual medical assessment or advice.