

Facet Tropism

A patient guide

In brief: Facet tropism is asymmetry in the orientation, or angle, of the two paired facet joints at a given level of the spine, so that one joint sits in a more sideways-facing (coronal) plane while its partner sits in a more front-to-back (sagittal) plane. The facet joints are the small paired joints at the back of each spinal segment that guide and limit movement. Their angle normally changes smoothly from the upper to the lower spine, and a degree of left-right difference is extremely common. When that difference exceeds an agreed threshold on a cross-sectional scan, it is labelled facet tropism. It is best understood as a common anatomical variant, an ordinary difference in build, rather than a disease in its own right. Much of the medical literature has examined whether tropism is associated with conditions such as disc degeneration, disc herniation and degenerative spondylolisthesis, and the picture that emerges is of a possible contributory factor whose links remain debated and inconsistent, not a proven cause. This page explains the normal anatomy, what tropism means, how it is measured, and what the evidence does and does not show. It is strictly educational and does not offer medical advice.

What the facet joints are and how they are normally oriented

Every level of the mobile spine is connected at three points. At the front, two vertebral bodies are separated by an intervertebral disc. At the back, the two vertebrae meet through a pair of small synovial joints, one on the left and one on the right, known as the facet joints or, more formally, the zygapophyseal joints. Each facet joint is formed where the downward-pointing process of the vertebra above (the inferior articular process) meets the upward-pointing process of the vertebra below (the superior articular process). Like other synovial joints they have cartilage-covered surfaces, a lubricating lining and a surrounding capsule.

The facet joints do not bear most of the body's weight; that task falls largely to the discs and vertebral bodies. Instead they act as guide rails. The angle at which their surfaces are set determines which movements a segment permits and which it resists. Because the joints are paired and roughly mirror-imaged across the midline, they jointly steer the segment through bending, straightening, side-bending and twisting.

The orientation of these surfaces is usually described relative to two reference planes. A joint lying in the sagittal plane faces front-to-back, like a pair of bookends, and chiefly limits rotation, or twisting. A joint lying in the coronal plane faces side-to-side, like a wall, and chiefly limits forward sliding and forward bending. Crucially, the normal orientation is not the same throughout the spine, and it is not purely one plane or the other; the lumbar joints in particular are gently curved, biplanar surfaces that carry both a sagittal and a coronal component.

In the lower back the orientation changes in an orderly way from level to level. The upper lumbar joints are predominantly sagittal, which favours their role in restraining rotation, while the joints become progressively more coronal lower down, towards the junction with the pelvis, where resisting forward slide becomes more important. Reported mean orientations illustrate this gradient, rising from roughly thirty degrees at the upper lumbar levels to around forty-seven degrees at the lowest. This smooth regional change is entirely normal and is part of how the lumbar spine is engineered to be the most rotationally rigid part of the mobile spine while still permitting bending.

What facet tropism means

Against this background of normal, gradually changing orientation, the two facet joints at a single level are expected to be broadly symmetrical with one another, mirror images across the midline. Facet tropism is the term for the situation in which they are not: one joint of the pair is set in a more sagittal plane and the other in a more coronal plane, so that the left and right angles differ from each other by more than would be regarded as ordinary

symmetry.

The word tropism here simply denotes a turning or orientation, and the finding is a structural one, visible on a cross-sectional image of the segment. It is important to separate two related but distinct ideas. Facet orientation refers to how sagittal or coronal the joints are overall, taken as the average of the two sides. Facet tropism refers specifically to the asymmetry between the two sides. A segment can have joints that are both quite sagittal yet symmetrical, in which case there is sagittal orientation but no tropism; or it can have one sagittal and one coronal joint, in which case there is marked tropism. Several of the debates in the literature turn on this distinction, because orientation and tropism do not always behave the same way in relation to spinal conditions.

Tropism is, above all, a common variant of human anatomy. A degree of left–right difference can be found in a large proportion of healthy spines, and its presence does not by itself indicate that anything is wrong or that anything will go wrong. It is a description of how a particular segment is built.

How tropism is measured and defined

Tropism is assessed on cross-sectional imaging, most often an axial slice from a CT or MRI scan taken at the level of the mid-disc, where the facet joint surfaces are well displayed. On that slice a line is drawn along the joint surface on each side, joining the front and back margins of the superior articular facet. The angle between this facet line and the midline of the body, the midsagittal line, is then measured for the left and the right joint separately, in degrees. A smaller angle indicates a more sagittal joint; a larger angle indicates a more coronal one.

Facet orientation is reported as the average of the two angles. Facet tropism is reported as the difference between them. The larger the difference between the left and right angles, the more pronounced the tropism.

There is, however, no single agreed threshold at which a difference becomes tropism, and this lack of a universal definition is a recurring theme in the literature. Different studies have drawn the line in different places. Commonly cited cut-offs for the angular difference between the two sides include differences of around five, seven, eight and ten degrees, with seven and ten degrees frequently used. Some authors further grade the asymmetry into mild, moderate and severe bands. Because these thresholds are not interchangeable, the same spine may be counted as having tropism under one definition and not under another. This is one of the main reasons reported rates and reported associations vary so much from study to study, and it is a strong argument for caution in interpreting any single figure.

How common it is

Facet tropism is common. Across the lumbar literature its reported prevalence varies widely, with many studies placing it somewhere between forty and seventy per cent of the segments examined, depending heavily on the level studied, the population and, above all, the threshold chosen to define it. The lowest two lumbar levels, and the L4–L5 level in particular, are the segments most often reported to show tropism, which is also where some of the degenerative conditions of interest are most frequent.

Large, modern datasets have reinforced this picture. A population-based study using automated measurement of lumbar MRI in a Finnish birth cohort of well over a thousand people confirmed that tropism is frequent, found it more often in men, and identified the L4–L5 level as the most affected. The breadth of these figures, rather than pointing to a single true rate, mainly underscores how much the apparent frequency of tropism depends on how it is measured and defined.

The biomechanical theory: asymmetric loading and rotational tendency

The reason tropism has attracted so much research attention lies in a plausible mechanical theory. If the two facet joints at a level face in different planes, they do not share and restrain loads symmetrically. Under an axial load or a twisting force, a segment with tropism has a tendency to rotate towards the side of the more obliquely oriented joint, because that joint offers less resistance to the turning movement. This small, asymmetric rotation is thought

to place uneven, torsional stresses on the structures of the segment, particularly the intervertebral disc.

Laboratory and computer-model studies have explored this idea and have suggested that asymmetric facet orientation can produce uneven stress distribution within the disc and the joint tissues, raise intradiscal pressure and concentrate load on one side. The proposed chain of reasoning is that, over many years, such repeated asymmetric and torsional loading could contribute to wear of the disc, to the conditions that allow a disc to herniate, and to the gradual forward slip of one vertebra on another seen in degenerative spondylolisthesis. The theory is coherent and mechanically reasonable.

It is essential, however, to read this as a hypothesis about mechanism rather than as established fact about outcomes in people. A plausible mechanical pathway does not, on its own, prove that tropism causes these conditions, and as the following sections describe, the clinical evidence linking tropism to actual disease is mixed.

Tropism and disc degeneration

Disc degeneration is the age-related and partly inherited process by which the intervertebral disc loses water, height and structural integrity. The mechanical theory predicts that the asymmetric loading associated with tropism might accelerate this process, and some studies have indeed reported associations between tropism, or sagittal facet orientation, and disc degeneration, including early biochemical changes within the disc detectable on specialised imaging.

The overall evidence, however, is far from uniform. Other studies have found no clear or consistent relationship between tropism and the presence or severity of disc degeneration. A central difficulty is the direction of cause and effect. Disc degeneration alters the loads passing through a segment and can be accompanied by remodelling of the facet joints themselves, which raises the possibility that asymmetry seen alongside degeneration is partly a consequence of the degenerative process rather than purely a pre-existing cause of it. The question of whether tropism is developmental, present from early life, or is in part acquired through degeneration has been examined directly in large multicentre work, which concluded that facet orientation and tropism may have a partly developmental basis combined with secondary degenerative changes. In short, tropism and disc degeneration are sometimes found together, but a clean, one-directional causal link has not been established.

Tropism and disc herniation

A herniated disc occurs when the soft inner material of the disc pushes through a tear in its outer wall. Because tropism is thought to load the disc asymmetrically, it has long been proposed as a possible predisposing factor for herniation, and a number of studies have reported tropism to be more frequent in segments with disc herniation, with some early work even linking the side of greater asymmetry to the side of the herniation.

Yet here too the findings conflict. Some studies report a significant association, particularly at the lowest lumbar level, L5–S1, while finding none at the level above. Others find no association between tropism and herniation at all, and report instead that it is the overall sagittal orientation of the joints, rather than their asymmetry, that relates to herniation in some groups. Systematic reviews that have pooled the available studies confirm that the associations are inconsistent and level-dependent, and that conclusions differ markedly between datasets. The most honest summary is that tropism may be one of several contributory factors at certain levels in certain populations, but it is neither a necessary nor a sufficient condition for a disc to herniate, and it cannot be regarded as a proven cause.

Tropism and degenerative spondylolisthesis

Degenerative spondylolisthesis is the slow forward slip of one vertebra over the one below, occurring without any fracture of the bony arch, most commonly at the L4–L5 level and more often in older adults. It is the condition for which the facet-orientation literature is arguably most consistent, but with an important nuance that bears directly on what tropism means.

The more reproducible finding is that sagittal facet orientation, the joints facing front-to-back rather than side-to-side, is associated with degenerative spondylolisthesis. Sagittally oriented joints resist forward sliding less effectively, which fits the mechanical logic of a slip. A classic observation is that individuals whose facet joints at L4–L5 are markedly sagittal are many times more likely to have a degenerative slip than those whose joints are more coronal. Some studies report that people with degenerative spondylolisthesis also tend to show more facet tropism than controls, and pooled analyses have detected a modest excess of tropism in this group.

However, several careful studies have found that it is the sagittal orientation, the average angle of the joints, rather than the tropism, the asymmetry between them, that carries the stronger and more consistent association with the slip; in some of these, the prevalence of tropism itself did not differ between those with and without spondylolisthesis. As with disc degeneration, the question of whether sagittal orientation and tropism precede the slip or are partly reshaped by it remains debated, because an established slip changes the mechanics and can remodel the joints. The reasonable conclusion is that facet orientation is relevant to degenerative spondylolisthesis, that tropism may contribute, and that the relationship is better characterised by orientation than by asymmetry alone.

A variant, not a disease

Drawing these threads together, the most important message is one of proportion. Facet tropism is a common anatomical variant, a description of how a particular spinal segment is built, found in a large share of ordinary, healthy spines. It is reported on scans as an incidental observation far more often than it is the explanation for any symptom.

The research interest in tropism arises from a reasonable mechanical theory and from a body of studies that have looked for links with disc degeneration, disc herniation and degenerative spondylolisthesis. What that body of work shows, taken as a whole, is a set of associations that are inconsistent, level-dependent, threshold-dependent and entangled with the chicken-and-egg problem of whether asymmetry causes degeneration or is shaped by it. Where a relationship is most reproducible, with degenerative spondylolisthesis, it is the overall sagittal orientation of the joints rather than their asymmetry that stands out. Across the field, tropism emerges at most as a possible contributory variant, one factor among many in complex multifactorial conditions, and not as a definite or independent cause of disease.

For these reasons tropism is best regarded in the same light as many other normal anatomical variations: a feature of an individual spine that is interesting, sometimes relevant to understanding mechanics, frequently noted in passing on imaging, and rarely the whole story. The appearance on a scan and what a person actually experiences are only loosely connected, and the significance of any individual finding is a matter for assessment by a qualified clinician rather than something that can be read from the label alone.