

Congenital (Dysplastic) Spondylolisthesis

A patient guide

In brief: Congenital, or dysplastic, spondylolisthesis describes a forward slip of one vertebra upon another that arises from a developmental deficiency present from birth at the lumbosacral junction, most commonly where the fifth lumbar vertebra (L5) meets the top of the sacrum (S1). It differs in a fundamental way from the more familiar isthmic and degenerative forms. In dysplastic disease the building blocks of the L5-S1 junction are malformed: the small joints (facets) at the back of the spine may be poorly developed or abnormally oriented, the top of the sacrum may be rounded into a dome rather than flat, the L5 vertebral body may be wedge-shaped (trapezoidal), and there is frequently an incomplete closure of the bony arch behind the spinal canal (spina bifida occulta). Crucially, the bony bridge known as the pars interarticularis is often intact in the dysplastic form. Because the neural arch remains attached, when L5 slips forward it carries the back of the canal with it, and the bundle of nerves passing through (the cauda equina) can be dragged forward over the prominent sacral dome. This anatomy is the reason dysplastic slips tend to carry a higher neurological risk and a greater tendency to progress than comparable low-grade isthmic slips. This page describes the condition and the published evidence in general terms and is intended for information only.

What makes the dysplastic form different

It helps to set the three main types of spondylolisthesis side by side, because their mechanisms, and therefore their behaviour, are quite distinct.

In the **dysplastic (congenital)** form the problem is developmental. The bony and joint architecture of the lumbosacral junction is malformed from the outset. The facets at L5-S1 may be sagittally oriented or otherwise dysplastic, providing little of the bony hook that normally resists forward translation. The sacral dome and the trapezoidal L5 reflect remodelling under load through a junction that was never well shaped to bear it. Because the pars and the rest of the neural arch are commonly intact, a forward slip pulls the posterior elements and the contained neural tissue forward as a unit, so the cauda equina is placed under tension across the dome of the sacrum. This is the anatomical basis for the higher reported frequency of neurological symptoms in this group.

In the **isthmic** form the defect is an acquired fatigue fracture (a stress-type lysis) through the pars interarticularis, typically thought to develop in childhood or adolescence in response to repetitive loading. Here the front of the vertebra can slip forward while the posterior arch, tethered by the pars defect, is left behind. The central canal is therefore relatively spared, and symptoms more often arise from the foramen where the exiting L5 nerve root can be compressed by the fibrocartilaginous tissue at the defect.

In the **degenerative** form the pars is intact, but the slip is acquired later in life through wear of the discs and facet joints, most often at L4-L5 and predominantly in older adults. Because an intact, non-mobile arch moves forward with the body, this form characteristically produces central canal narrowing (stenosis).

Reading these contrasts together explains the recurring theme of this page: the developmental dysplastic junction combines features that both encourage progression and place neural tissue at risk.

Pathoanatomy and the dysmorphic features

Several recognisable features tend to cluster in dysplastic disease, although not every feature is present in every person.

The **dysplastic or sagittally oriented facets** at L5-S1 reduce the normal bony resistance to forward shear. The **domed (dome-shaped) sacrum** describes rounding of the upper sacral endplate, which both reflects and worsens the tendency of L5 to slide forward and tip into kyphosis. The **trapezoidal (wedged) L5** is a vertebral body that has become narrower at the back than the front, a shape associated with chronic loading across a slipping segment. **Spina bifida occulta**, an incomplete fusion of the posterior bony arch, is frequently seen and is part of the developmental picture rather than a separate disease. The **pars interarticularis is often intact**, which, as described above, is the single most important distinction from isthmic disease in terms of neurological consequence.

The combination of these features tends to produce not just a translation of one vertebra on another but a local angular deformity, a forward tipping of L5 on the sacrum known as lumbosacral kyphosis. The degree of this kyphosis, often expressed as the slip angle, has long been recognised as at least as important as the percentage of slip in describing severity.

Classification

Several classification systems are used in the literature, and they describe different aspects of the same condition.

The **Wiltse, Newman and Macnab** scheme places the developmental dysplastic form as Type I (congenital or dysplastic), separating it from Type II (isthmic), Type III (degenerative) and the traumatic and pathological types.

The **Marchetti and Bartolozzi** framework draws the major divide between developmental and acquired slips, and within the developmental group it distinguishes **high-dysplastic** from **low-dysplastic** subtypes according to the severity of the bony dysplasia. A low-dysplastic junction retains a more competent, less domed sacrum and behaves more like a low-grade slip, whereas a high-dysplastic junction, with marked sacral doming, a wedged L5 and pronounced lumbosacral kyphosis, carries the greater tendency to progress and to involve the nerves. The original Marchetti and Bartolozzi description is published as a textbook chapter rather than a journal article, and access to the full text may require an institutional library.

The **Spinal Deformity Study Group (SDSG)** classification builds on spinopelvic shape, sorting cases by slip grade and by the relationship between pelvic incidence and pelvic balance, which helps describe whether a given high-grade slip sits in a balanced or unbalanced pelvis.

The **Meyerding grade** remains the simplest descriptor of magnitude, dividing the slip into grades I to IV by the proportion of the sacral endplate over which L5 has translated, with grade V (spondyloptosis) describing complete loss of contact.

Spinopelvic parameters

Modern understanding places the lumbosacral junction within the wider geometry of the pelvis. **Pelvic incidence** is a fixed anatomical measure of pelvic shape, and dysplastic high-grade slips are characteristically associated with a very high pelvic incidence. A high incidence increases the shear across a poorly supported L5-S1 junction and is part of why these slips tend to advance.

As the slip progresses, the sacrum may dome and the pelvis may rotate backwards (retrovert) to keep the trunk balanced over the hips. The work associated with Hresko and colleagues described a useful division of high-grade slips into **balanced** and **unbalanced (retroverted)** pelvic patterns based on sacral slope and pelvic tilt. A balanced pelvis maintains a more favourable posture, whereas an unbalanced, retroverted pelvis reflects a body working harder to compensate. These measurements are made from standing radiographs and have become central to how surgeons describe and discuss high-grade disease.

How common it is and who it affects

Dysplastic spondylolisthesis is the minority of all spondylolisthesis. Most slips encountered in general practice are isthmic or degenerative. However, dysplastic morphology is over-represented in surgical series and among high-grade slips, because the developmental features that define it are the same features that drive progression and bring people to specialist attention. There is a recognised female predominance in the dysplastic and high-grade groups, and presentation is often in childhood or adolescence, during the growth years when the lumbosacral junction is loaded and remodelling. The large prospective natural-history work in unselected populations, such as the studies associated with Fredrickson and with Beutler, principally tracked pars-defect (isthmic) disease, and so subtype-specific figures for the dysplastic form are drawn from smaller and more selected cohorts.

Natural history

The natural history of spondylolisthesis is best understood for the common isthmic form, where long-term follow-up has shown that many low-grade slips remain stable and well tolerated. For the dysplastic form the published data are more limited and come from mixed and selected cohorts, so any statement carries uncertainty.

What the literature does support is that the dysplastic morphology, taken as a package, is associated with a greater tendency to progress and with greater segmental instability than a low-grade isthmic slip. The recurring markers are a domed sacrum, a trapezoidal L5, a high slip angle (marked lumbosacral kyphosis) and a high pelvic incidence. The contribution of Boxall, Bradford and colleagues was to establish that the slip angle and the degree of lumbosacral kyphosis are as important as the percentage of slip in describing severity and the risk of further progression, a shift in thinking away from translation alone and towards the angular deformity. Subtype-specific natural-history data that isolate the high-dysplastic group remain limited, and this should be borne in mind when interpreting any single figure.

How it presents

The clinical picture reflects the underlying deformity. People may present with a postural change at the lumbosacral region, sometimes described as a flattening of the buttocks, with a palpable step felt over the lower spine where one vertebra has moved forward on the next. Lumbosacral kyphosis at the slip is often accompanied by a compensatory increase in the curve above (hyperlordosis), as the body works to keep the trunk upright. Gait may take on a crouched or waddling quality, and tightness of the hamstrings is a characteristic finding, reflecting the altered posture and, in some cases, neural tension.

Symptoms referable to the nerves are more frequent than in a comparable-grade isthmic slip, again because of the intact arch dragging the cauda equina forward over the sacral dome. These can range from an L5 pattern of radiculopathy, with symptoms travelling into the leg, through to features attributable to the cauda equina. The greater neurological liability of the dysplastic form is one of its defining clinical characteristics.

Imaging

Imaging is descriptive in this account and is used to characterise the deformity rather than to direct any individual.

Standing lateral radiographs, and increasingly **full-spine or low-dose (EOS) imaging**, allow the slip grade, the slip angle, the degree of sacral doming and the spinopelvic parameters (pelvic incidence, pelvic tilt and sacral slope) to be measured in the upright, loaded position in which the deformity is best appreciated.

Computed tomography (CT) gives the most detailed view of the bony anatomy, including whether the pars interarticularis is intact, which is central to distinguishing the dysplastic from the isthmic form, and the extent of the sacral doming and facet dysplasia. **Magnetic resonance imaging (MRI)** shows the neural structures, the discs and the relationship of the cauda equina and exiting nerve roots to the slipped segment. Together these modalities build a picture of the bony deformity, the spinopelvic balance and the state of the nerves.

Management: a description of the evidence

The following is a description of the published evidence and the debates within it, not guidance for any individual. Decisions in practice are made between a person and their own clinical team in the light of their particular circumstances.

For **low-grade dysplastic** slips, the evidence base is broadly handled in the same way as low-grade isthmic disease, where many people are managed without surgery and surgical fusion is reserved for selected situations.

For **high-grade dysplastic** slips, the literature centres on a long-running debate between **fusion in situ** (joining the vertebrae in their slipped position without attempting to pull the slip back) and **reduction** (realigning the vertebrae before fusion). Each approach carries a different balance of benefits and risks.

The evidence favouring **in-situ fusion** includes the long-term Finnish series associated with Helenius, Remes, Poussa and colleagues, which compared posterolateral, anterior and circumferential (combined front-and-back) in-situ techniques. In that work, **circumferential in-situ fusion** was associated with the best long-term outcome scores and was the most effective at preventing further progression of lumbosacral kyphosis. The long-term comparison reported by Poussa and colleagues in adolescents favoured fusion in situ over reduction. Earlier long-term follow-up of grade III and IV slips, such as that reported by Harris and Weinstein, also informs the understanding that a solid fusion in the slipped position can yield durable function.

The argument for **reduction** is that it restores alignment, lumbosacral profile and spinopelvic balance, which can be mechanically attractive in a markedly kyphotic high-grade slip. The principal concern is the risk to the L5 nerve root. The biomechanical work of Petraco and colleagues showed that the strain on the L5 nerve root is not evenly distributed through a reduction: roughly 71 per cent of the total L5 nerve strain occurs during the second half of the reduction, so the final part of realignment is disproportionately demanding on the nerve. Clinical series bear this out. The instrumented reduction series reported by Sailhan and colleagues described a neurological complication rate of around 9 per cent, with persistent deficit in around 2 per cent. No high-level randomised controlled trial has resolved the question of in-situ fusion versus reduction, and so the literature continues to describe a balance of considerations rather than a single answer.

Prognosis

Where a solid bony fusion (arthrodesis) is achieved, and particularly where this is circumferential, the long-term published functional outcomes are generally good and durable. The principal adverse outcomes described in the literature are **pseudarthrosis** (failure of the bones to fuse), **progressive lumbosacral kyphosis** despite treatment, and **iatrogenic injury to the L5 nerve root or cauda equina** occurring during attempted reduction. The relative weight given to these risks is exactly what underlies the in-situ versus reduction debate described above.

Common questions

What does congenital or dysplastic spondylolisthesis actually mean?

It describes a forward slip of one vertebra on another that arises from a developmental deficiency present from birth at the lumbosacral junction. The bones and joints there are malformed in ways that reduce the spine's natural resistance to forward movement at that level.

How is it different from isthmic spondylolisthesis?

Isthmic spondylolisthesis is caused by an acquired fatigue fracture through a bony bridge called the pars interarticularis, which allows the front of the vertebra to slip while the back arch stays behind. The dysplastic form is a developmental malformation in which the pars is often intact, so the whole arch tends to move forward together.

How is it different from degenerative spondylolisthesis?

The degenerative form is acquired later in life through wear of the discs and facet joints, usually in older adults and most often at the L4-L5 level. The dysplastic form is present from birth, usually involves L5-S1, and typically presents in childhood or adolescence.

Why is the neurological risk described as higher in the dysplastic form?

Because the pars and posterior arch are often intact, a forward slip drags the bony arch and the contained nerves (the cauda equina) forward as a unit. The nerves can then be stretched over the prominent dome of the sacrum, which is why nerve symptoms are reported more frequently than in a comparable-grade isthmic slip.

What is a domed sacrum?

The sacrum normally has a relatively flat upper surface on which L5 sits. In dysplastic disease this surface can become rounded into a dome. This shape both reflects the slip and tends to encourage L5 to slide and tip further forward.

What is a trapezoidal or wedged L5?

It describes an L5 vertebral body that has become narrower at the back than at the front, taking on a wedge shape. This is associated with chronic loading across a segment that is slipping and tipping into a forward angle.

What is spina bifida occulta and why is it mentioned here?

It is an incomplete closure of the bony arch at the back of the spine. It is frequently seen as part of the developmental picture in dysplastic spondylolisthesis rather than as a separate problem, and on its own it is often an incidental finding.

What is the difference between high-dysplastic and low-dysplastic types?

This division comes from the Marchetti and Bartolozzi classification. A low-dysplastic junction retains a more competent, less domed sacrum and tends to behave like a low-grade slip. A high-dysplastic junction has marked sacral doming, a wedged L5 and pronounced lumbosacral kyphosis, and is associated with a greater tendency to progress and to involve the nerves.

The full set of questions and answers, with references, is available on the condition page.