

Prader-Willi Syndrome and the Spine

A patient guide

In brief: Prader-Willi syndrome is a rare genetic condition caused by the loss of function of certain genes on the paternally inherited copy of chromosome 15. It affects many systems of the body, but from the point of view of the spine its single most important feature is a very high frequency of scoliosis, the sideways curvature and rotation of the spine. Up to four out of five people with Prader-Willi syndrome develop scoliosis at some point, a rate far above that of the general population. Several features of the syndrome combine to produce this: low muscle tone, or hypotonia, which deprives the growing spine of its muscular support; a tendency to early-onset obesity driven by an insatiable appetite, which both loads the spine and makes it harder to examine; reduced bone density; and the hormonal changes of growth and puberty. Curvature can appear in two distinct waves, one in infancy and one around adolescence, and kyphosis, an excessive forward rounding of the spine, is also common. This guide describes Prader-Willi syndrome as it relates to the spine, the reasoning behind close spinal monitoring, and what the published evidence shows about bracing, surgery, growth hormone therapy and the particular anaesthetic considerations that surround spinal operations in this group.

What Prader-Willi syndrome is

Prader-Willi syndrome is a complex genetic disorder arising from the absence of normally active genes in a small region of chromosome 15, known as 15q11-q13, on the copy inherited from the father. In most affected people this happens because the paternal segment is deleted; in a smaller proportion both copies of chromosome 15 are inherited from the mother, a situation called maternal uniparental disomy; and in a small minority the genes are present but switched off by a fault in the imprinting mechanism that decides which parental copy is active. The diagnosis is confirmed by a genetic test, most often DNA methylation analysis, which identifies the great majority of cases.

The condition affects the brain's hypothalamus, the small region that governs appetite, growth, temperature and several hormonal systems. From this single origin flows a wide-ranging picture: profound floppiness and feeding difficulty in infancy, followed in early childhood by a relentless appetite and a strong tendency to gain weight, short stature, incomplete sexual development, varying degrees of learning difficulty, and a characteristic pattern of behaviour. Although Prader-Willi syndrome touches almost every system, the spine is one of the areas most consistently affected, and it is the spinal dimension that is the focus of this guide.

Why the spine is so often involved

The spine in Prader-Willi syndrome sits at the meeting point of several of the syndrome's core features, and this is why scoliosis is so much more common here than in the general population.

The first and most important factor is hypotonia, the low muscle tone that is present from birth and persists, in milder form, into later life. The spinal column does not hold itself upright by its bones alone; it depends on a continuous, balanced pull from the muscles that surround it. When that muscular support is weak, the growing spine is far more prone to drift into a curve, both sideways into scoliosis and forwards into kyphosis. Reduced volume and strength of the muscles running alongside the spine, the paravertebral muscles, has been linked directly to the development and progression of curvature in this group.

The second factor is body weight. The same appetite regulation problems that define the syndrome lead, without careful management, to early and substantial weight gain. Excess weight places additional mechanical load on a spine that is already poorly supported by muscle. It also makes the spine considerably harder to examine and to

image clearly, so that a developing curve can be less obvious on simple inspection.

The third factor is bone. Bone density tends to be lower than normal in Prader-Willi syndrome, with osteopenia and osteoporosis appearing at unusually young ages. Contributing influences include incomplete pubertal hormone production, reduced physical activity and dietary factors. Weaker bone has implications both for the spine itself and for any surgery that might be contemplated.

Finally, growth and the hormonal changes of puberty add their own influence. Periods of rapid skeletal growth are recognised, across many conditions, as times when an existing curve is most likely to advance, and the spine in Prader-Willi syndrome is monitored particularly closely through these windows.

How common scoliosis is in Prader-Willi syndrome

Scoliosis is among the most frequently reported skeletal features of Prader-Willi syndrome. Across the published literature the reported prevalence ranges widely, from around fifteen per cent to over eighty per cent, the spread reflecting differences in the ages studied and the methods used. In one of the largest cohorts examined, scoliosis was present in more than eighty per cent of people overall, affecting roughly four in five children and adolescents and an even greater proportion of adults. The cumulative risk through childhood, up to the point of skeletal maturity, is often cited at seventy per cent or higher.

A striking feature is the distribution of curves by age. Rather than appearing at a single point, scoliosis in Prader-Willi syndrome tends to follow a bimodal pattern, with one peak in early childhood, often before the age of four, and a second peak around the adolescent growth spurt. Studies describe a prevalence of around a quarter in the first years of life, rising through childhood and reaching roughly eighty per cent in adolescence. The early-onset curves are generally attributed to the profound hypotonia of infancy, while the later wave coincides with the rapid growth of puberty. Severe curves tend to be diagnosed earlier than mild ones, with one cohort placing the median age of diagnosis of severe scoliosis below four years.

Kyphosis, the excessive forward rounding of the spine, is also more common than in the general population, with reported frequencies of roughly eight to forty per cent, and the combination of the two as kyphoscoliosis is described as an under-recognised problem in younger patients.

How scoliosis in Prader-Willi syndrome differs from idiopathic scoliosis

Adolescent idiopathic scoliosis, the common form seen in otherwise healthy teenagers, provides a useful point of comparison, and the differences are instructive.

The first difference is the age of onset. Idiopathic scoliosis classically declares itself around adolescence, whereas in Prader-Willi syndrome a substantial share of curves appear in the first few years of life, driven by infantile hypotonia, long before the adolescent growth spurt.

The second difference lies in the underlying mechanism. Idiopathic scoliosis arises in a spine with normal muscle tone and bone for reasons that remain incompletely understood. In Prader-Willi syndrome the curve develops against a background of identifiable contributing factors: weak muscular support, frequently excess body weight, and reduced bone density. Some reports note that curves in this group may show less of the vertebral rotation that characterises idiopathic curves, a difference that influences how they are monitored.

The third difference concerns response to treatment and the surrounding medical picture. The syndrome brings additional considerations, from bone fragility and soft-tissue quality to the respiratory and anaesthetic factors discussed below, all of which colour how curvature is assessed and managed. For these reasons the literature treats Prader-Willi scoliosis as a distinct entity rather than simply an early or more frequent version of the idiopathic form.

Growth hormone therapy and the spine

Growth hormone treatment has become a standard part of the care of many people with Prader-Willi syndrome. It is given to improve growth in height and body composition, to increase lean muscle mass and muscle strength, to support bone density and to counter the tendency to obesity. Because growth hormone accelerates skeletal growth, and because rapid growth is a recognised driver of curve progression, a longstanding question has been whether the treatment might worsen scoliosis.

The accumulated evidence is reassuring on this point. Both short-term and longer-term studies, including one following children over eight years of treatment, have found no adverse effect of growth hormone therapy on either the frequency or the severity of scoliosis. The prevailing view in the literature is that growth hormone does not cause or accelerate scoliosis, and that the development of a curve is not in itself a reason to stop the treatment. Indeed, by improving muscle bulk, muscle strength and bone density, growth hormone may help to stabilise the spine rather than destabilise it.

This does not remove the need for vigilance. Because growth hormone is often started in early childhood and continued through periods of rapid growth, spinal monitoring is generally intensified around its introduction and during the phases of fastest growth, so that any curve is followed carefully alongside the treatment. The relationship between growth hormone, growth velocity and the spine is described in the literature as one to be observed rather than feared.

Obesity and its effect on spinal assessment and surgery

Weight occupies a particular place in any discussion of the spine in Prader-Willi syndrome, because it influences both how curvature is detected and how any operation is approached.

On assessment, excess soft tissue can obscure the contours of the spine, making a curve harder to see and to feel on examination and reducing the clarity of plain images. This is one of the reasons that scheduled radiographic surveillance, rather than reliance on inspection alone, is emphasised in the published guidance for this group.

On surgery, obesity adds layers of complexity. It increases the mechanical demand on any reconstruction, complicates surgical access, and raises the background risk of wound and respiratory problems. Combined with the reduced bone density and the fragile soft tissues that are characteristic of the syndrome, it forms part of the reason that spinal surgery in Prader-Willi syndrome is regarded as technically demanding and carries a higher complication profile than scoliosis surgery in otherwise healthy children. These are considerations weighed by the treating team rather than fixed rules, and they help explain the cautious, individualised approach that the literature describes.

Bracing and conservative management

For curves that are not yet large enough to warrant surgery, non-operative management is the mainstay, centred on observation, physical therapy and, in selected cases, bracing.

A thoraco-lumbo-sacral orthosis, a moulded brace covering the trunk, is the usual device, and to be effective it generally needs to be worn for a large part of each day. Bracing is typically considered for curves above a threshold in the region of twenty to twenty-five degrees in a growing child, with the aim of slowing progression while growth continues.

The literature is candid that bracing in Prader-Willi syndrome faces particular obstacles. The underlying hypotonia means the brace is working against a spine with little intrinsic support; early curves can progress rapidly; tolerance of the brace can be limited; and skin and behavioural issues can complicate consistent wear. For these reasons some series have reported limited success and frequent progression to surgery. Against this, individual long-term reports describe curves kept within acceptable limits, and sometimes improved, by diligent conservative care sustained over many years, and several authors argue that for non-progressive curves below around fifty degrees, conservative management is preferable given the considerable risks of surgery. The balance between bracing and other paths is one that depends heavily on the individual curve, the age of the child and the response over time.

Surgical treatment and its particular challenges

Surgery is generally reserved for curves that are large or relentlessly progressive despite conservative measures, often quoted in the region of fifty degrees or beyond, where the deformity threatens trunk balance, sitting, breathing or further progression.

The choice of operation depends heavily on the age and remaining growth of the child. In a younger child with substantial growth ahead, fusing the spine outright would arrest its growth, so growth-friendly constructs are often favoured. These include growing-rod systems, among them magnetically controlled growing rods that can be lengthened through the skin without repeated open surgery, designed to control the curve while allowing the spine and chest to continue developing. Where the child is closer to skeletal maturity, a definitive posterior spinal fusion, in which the curved segment is straightened and held with metalwork until the bones knit solid, becomes the more usual option. Because skeletal maturation can be delayed in Prader-Willi syndrome, some authors suggest deferring definitive fusion where possible, often to around twelve years in girls and fourteen in boys.

The challenges of surgery in this group are well documented and substantial. Reduced bone density makes secure fixation of the metalwork more difficult and raises the risk of the hardware loosening or failing. The fragile soft tissues, compounded in some by a tendency to skin-picking, contribute to high reported rates of wound breakdown and deep infection. Series have described major complication rates as high as half of cases, including deep infection, failure of the bones to fuse, the development of a new kyphosis above the fused segment requiring further surgery, and, in rare instances, serious neurological injury. These figures explain why the threshold for surgery is set carefully, why the literature stresses meticulous planning, and why decisions are made by a multidisciplinary team weighing the risks of the deformity against the risks of intervening.

Anaesthetic and respiratory considerations in spinal surgery

The anaesthetic surrounding any major spinal operation deserves particular attention in Prader-Willi syndrome, because the syndrome brings together several features that complicate anaesthesia and recovery.

Respiratory function is a central concern. Hypotonia weakens the muscles of breathing; obesity and any kyphoscoliosis restrict the expansion of the chest, producing a restrictive pattern of lung function; and disordered control of breathing from the hypothalamus contributes to both obstructive and central sleep apnoea. Together these raise the risk of breathing difficulty during and after surgery. The literature also notes that the airway can be difficult to manage, that there is an increased risk of aspiration, that responses to certain anaesthetic and sedative drugs may be altered, and that disturbances of temperature regulation and blood glucose, along with the cardiovascular effects of obesity, all require attention. Published anaesthetic recommendations for the syndrome describe careful preoperative assessment of breathing and airway, vigilant monitoring, and strategies to protect respiratory function in the recovery period. These respiratory and anaesthetic factors form an integral part of the overall risk picture when major spinal surgery is being considered, and are among the reasons such decisions are taken with great care.

Monitoring of the spine

Because curvature is so frequent, can begin so early, and can be hidden by body habitus, scheduled monitoring of the spine is a recurring theme in the published guidance for Prader-Willi syndrome.

Screening is generally described as beginning once a child can sit independently and continuing at regular intervals until skeletal maturity. The published approaches favour radiographs taken in sitting or standing at regular intervals, often yearly in the early years and adjusted in frequency according to whether a curve is present and how it is behaving. Monitoring is intensified around the introduction of growth hormone and through the phases of rapid growth in which curves are most likely to advance. Where a brace is in use, out-of-brace films at intervals are described as a means of tracking the true behaviour of the curve. Some frameworks stratify children into lower- and higher-risk groups to guide how intensively they are followed. The consistent message of this literature is that regular, structured observation of the spine, rather than waiting for a curve to become obvious, is central to the care of this group.

Outlook

The outlook for the spine in Prader-Willi syndrome is varied and depends greatly on the size and behaviour of the curve, the age at which it appears, the response to conservative measures and the surrounding medical picture.

Many curves are mild or moderate and can be followed, supported by physical therapy and, where appropriate, bracing, sometimes remaining stable or improving over long periods of careful management. A minority become severe or progress relentlessly and come to surgery, where the gains in deformity correction and trunk balance have to be weighed against a genuinely higher rate of complications than is seen in otherwise healthy children. Growth hormone therapy, far from being a threat to the spine, appears not to worsen scoliosis and may help to stabilise it through its effects on muscle and bone.

Across the whole picture the consistent themes are that the spine is very commonly involved; that hypotonia, weight and bone quality are the forces driving curvature; that monitoring needs to be early, regular and structured because curves can be both early and concealed; and that any decision about bracing or surgery is an individualised judgement made by the treating team, balancing the curve against the considerable particular risks the syndrome carries.