

# Pierre Robin Sequence and the Spine

*A patient guide*

**In brief:** Pierre Robin sequence is a pattern of congenital features present at birth, made up of an unusually small lower jaw (micrognathia), a tongue that sits further back and lower than usual (glossoptosis), and obstruction of the upper airway, frequently accompanied by a cleft of the palate. It is called a sequence rather than a syndrome because one early event, underdevelopment of the lower jaw, is thought to set off the others in a chain: the small jaw crowds the tongue backwards, the displaced tongue can block the airway, and its position can interfere with closure of the palate. The features themselves lie in the face and airway rather than the spine, yet the subject earns a place on a spinal page for a specific reason. Pierre Robin sequence is often the visible tip of an underlying syndrome, and several of those syndromes carry their own consequences for the spine, ranging from scoliosis and Scheuermann-like changes to vertebral malformations and, in a minority, instability at the top of the neck. The airway difficulty that defines the sequence also bears directly on any anaesthetic, including anaesthesia for spinal surgery. This page concentrates on those spinal and syndromic threads rather than on the facial and feeding aspects that dominate infancy.

## What Pierre Robin sequence is, and why it appears on a spinal page

Pierre Robin sequence is defined by a triad: micrognathia, the small and set-back lower jaw; glossoptosis, the backward and downward displacement of the tongue base; and upper airway obstruction. A cleft of the soft palate, often U-shaped, accompanies the picture in a large proportion of cases. The term sequence captures the prevailing developmental theory, in which the small mandible is the primary event and the other features follow from it, the tongue falling back into the space the jaw fails to create, and the palate failing to close around the displaced tongue.

The features described above belong to the face, the mouth and the airway. The spine is not part of the defining triad, and a child with Pierre Robin sequence does not, by virtue of the sequence alone, have a spinal problem. The connection to the spine is indirect but important, and runs along two routes. The first is syndromic association: the sequence is frequently one element of a wider genetic condition, and a number of those conditions involve the spine. The second is the airway: the difficulty in securing the airway that defines the sequence is the single most important practical consideration in any operation requiring a general anaesthetic, spinal operations included.

This page therefore treats Pierre Robin sequence chiefly as a signpost. The interest, from a spinal standpoint, lies less in the jaw and more in what the jaw may be pointing towards, and in the anaesthetic considerations that travel with it.

## Isolated versus syndromic: the central distinction for the spine

The most useful division in Pierre Robin sequence, and the one that matters most for the spine, is between the isolated (non-syndromic) form and the syndromic form. In the isolated form, the sequence occurs on its own, without an identifiable wider condition. In the syndromic form, sometimes called Robin-plus, the sequence is one feature among several within a recognised genetic or developmental syndrome.

Estimates of how the cases divide vary across studies, but a commonly cited figure places roughly a fifth to two-fifths of cases in the isolated category, with the remainder syndromic or associated with additional anomalies. Across the literature, Stickler syndrome is reported as the most common single syndrome underlying Pierre Robin sequence, followed by conditions such as 22q11.2 deletion syndrome, Treacher Collins syndrome, and others.

This distinction carries weight for the spine because spinal disease in Pierre Robin sequence is reported very largely within the syndromic group. A systematic review of patients with both Pierre Robin sequence and spinal disease found that the spinal pathologies clustered with underlying syndromes and chromosomal abnormalities, and the authors concluded that spinal problems are an understudied and probably under-recognised contributor to the overall burden in these patients. The isolated form, by contrast, is not characteristically associated with a defined spinal disorder. In broad terms, then, the question of whether the spine is involved in any individual is bound up with the question of which, if any, syndrome underlies the sequence.

## Stickler syndrome: the most common syndromic link, and its spine

Because Stickler syndrome is the syndrome most often found beneath Pierre Robin sequence, its spinal features deserve particular attention. Stickler syndrome is an inherited disorder of connective tissue, usually autosomal dominant, arising most commonly from changes in the gene COL2A1, which encodes type II collagen, the principal collagen of cartilage and the intervertebral disc. Changes in related collagen genes, including COL11A1 and COL11A2, account for further cases. Cleft palate, often within a Pierre Robin sequence, is one of its recognised features, alongside short-sightedness with a risk of retinal detachment, hearing loss and early-onset joint disease.

The spine in Stickler syndrome reflects the underlying collagen abnormality. The condition involves a mild spondyloepiphyseal dysplasia, meaning that the vertebrae and the growth regions of bones develop abnormally. A study of the thoracolumbar spine in a series of patients with Stickler syndrome documented a strikingly high frequency of spinal findings: scoliosis in roughly a third, endplate irregularities in the majority, Schmorl's nodes in around two-thirds, flattened vertebrae (platyspondyly) in just under half, and Scheuermann-like kyphosis in a similar proportion. Chronic back pain was reported by most of the patients and by the great majority of the adults. These figures describe a group of patients studied at a specialist centre and are not a forecast for any individual, but they establish that the spine is a genuine site of involvement in this syndrome.

A separate and narrower question is instability at the very top of the neck. In the more severe type II collagen disorders, such as spondyloepiphyseal dysplasia congenita, underdevelopment of the odontoid peg of the second cervical vertebra can produce instability between the first and second vertebrae. The reference literature notes that, by contrast, clinically significant atlantoaxial instability of this kind is not well documented in Stickler syndrome itself, which sits at the milder end of the type II collagen spectrum. The distinction matters: scoliosis and kyphosis are the characteristic spinal issues in Stickler syndrome, whereas frank upper cervical instability is a feature reported more in its severe collagen relatives than in Stickler syndrome proper.

## Other syndromes carrying spinal anomalies

Beyond Stickler syndrome, several other conditions that can present with Pierre Robin sequence carry their own spinal implications, and they illustrate the range of ways the spine may be involved.

**\*\*22q11.2 deletion syndrome\*\*** is among the more frequent syndromic backgrounds. Its skeletal literature describes a high frequency of cervical and occipital anomalies, with reports of an open or clefted arch of the first cervical vertebra, a dysmorphic odontoid, and increased segmental movement on bending films. Scoliosis is reported across a wide range of frequencies, with some series placing it near half of patients, and a small proportion requiring surgical correction. Butterfly vertebrae and variations in rib number are also described. This condition is sometimes discussed as a naturally occurring human model for the study of scoliosis.

**\*\*Campomelic dysplasia\*\***, caused by changes affecting the SOX9 gene, classically presents with Pierre Robin sequence and cleft palate together with bowing of the long bones. Among long-term survivors, the spinal features reported include cervical spine instability with the potential for cord compression, cervical kyphosis, and progressive scoliosis. It thus represents one of the syndromic backgrounds in which both deformity and instability of the spine can occur.

**Cerebro-costo-mandibular syndrome**, linked to the gene SNRPN, pairs severe micrognathia, often with a Pierre Robin sequence, with characteristic gaps in the posterior ribs. Vertebral anomalies are part of the picture, with reports of absent transverse processes, abnormal fusion of ribs to the vertebral bodies, and failure of normal separation at the costovertebral junctions, reflecting disordered development of the somites that give rise to the vertebrae and ribs.

**Marshall syndrome**, related to COL11A1 and overlapping with Stickler syndrome, may include a Pierre Robin sequence and shares a tendency to spondyloepiphyseal dysplasia, scoliosis and Scheuermann-like kyphotic change. Across these conditions, the recurring vertebral findings reported in the wider Pierre Robin literature include hemivertebrae, butterfly and block vertebrae, irregular ossification at the cervicothoracic junction, and abnormalities of the sacrum, alongside the better-recognised scoliosis and kyphosis.

## Vertebral malformations and the patterns reported

It is worth drawing together the kinds of vertebral malformation that have been reported in association with Pierre Robin sequence, since these differ in character from the developmental deformities such as scoliosis and kyphosis described above. Whereas a scoliosis is a three-dimensional curvature of an otherwise normally formed column, a vertebral malformation is a fault in the formation of an individual vertebra during early development.

The literature describes a range of such malformations in syndromic cases: hemivertebrae, where a vertebra forms only on one side and acts as a wedge that can drive a curve; butterfly vertebrae, where the body of a vertebra is split; block vertebrae, where adjacent vertebrae fail to separate and fuse into a single mass; and irregular or aberrant ossification, particularly around the cervicothoracic junction. Widened or narrowed spacing between the pedicles, incomplete closure of the posterior arches, and non-ossification of the lower sacral segments have also been reported. At the top of the neck, descriptions include features overlapping with Klippel-Feil anomaly and, in occasional reports, atlanto-occipital subluxation.

These malformations matter because, where present, congenital vertebral anomalies are themselves a recognised cause of scoliosis, distinct from the developmental and dystrophic curves seen in collagen disorders. They are, however, features of the underlying syndrome rather than of the Pierre Robin sequence as such, and they are reported in a minority of cases rather than being a general expectation.

## The airway: why it dominates any anaesthetic, including spinal surgery

No account of Pierre Robin sequence written from a surgical standpoint can omit the airway, because it is the consideration that overrides almost all others when a general anaesthetic is required, and spinal surgery is performed under general anaesthetic. The same small jaw and displaced tongue that define the sequence make the airway difficult to manage. The view of the larynx at laryngoscopy is often obscured, a seal for face-mask ventilation can be hard to achieve, and intubation that is straightforward in others can be demanding.

Recent airway guidelines identify Pierre Robin sequence as a condition carrying an anticipated difficult airway. The approaches described in the anaesthetic literature include videolaryngoscopy as a first-line technique, fiberoptic-assisted intubation, the early use of supraglottic airway devices, careful oxygenation, and limiting the number of intubation attempts to reduce trauma and the risk of low oxygen. The difficulty is generally greatest in infancy and tends to ease as the lower jaw grows through childhood, though it does not always disappear.

This airway difficulty intersects with the spine in a particular and important way. Securing the airway typically involves positioning the head and neck, and in a difficult airway the neck may be placed in marked extension. In the subset of patients whose underlying syndrome involves instability at the craniocervical junction, this manipulation is not without hazard. The literature contains cautionary reports of cervical cord injury arising from unrecognised craniocervical instability in severe Pierre Robin sequence associated with a skeletal dysplasia, where repeated airway procedures involving neck movement preceded the recognition of the instability. This is the reason that imaging of the cervical spine and cautious handling of the neck are emphasised in infants with Pierre

Robin sequence and a suspected skeletal dysplasia. It is also the reason that, for any spinal operation in such a patient, the airway and the cervical spine are considered together rather than separately.

## Anaesthetic and positioning considerations for spinal surgery

Spinal deformity surgery, such as correction of a scoliosis, brings its own anaesthetic demands, and in a patient with a syndromic Pierre Robin background these are layered on top of the airway considerations already described. The general anaesthetic literature for spinal deformity surgery emphasises the use of videolaryngoscopy or fibreoptic intubation where a difficult airway is anticipated, a reinforced tracheal tube to resist kinking when the patient is turned face down, and minimisation of neck movement where cervical instability is a concern.

The prone, or face-down, position required for posterior spinal surgery is itself relevant. Once a patient is anaesthetised and turned prone, the airway is far harder to reach, and any displacement of the tube is a serious event because regaining access may require turning the patient back. In a patient whose airway was difficult to secure in the first place, these stakes are higher. Where the underlying syndrome carries cardiac, respiratory or other organ involvement, as several of the conditions associated with Pierre Robin sequence can, the preoperative assessment widens accordingly. The literature on syndromic and neuromuscular spinal surgery consistently stresses thorough preoperative evaluation of the airway, the cervical spine and the heart and lungs. These are descriptions of how such surgery is approached in the published literature, not instructions for any individual, whose care is planned by the treating team.

## How the spine is assessed in this context

Where the spine is examined in a patient with a syndromic Pierre Robin sequence, the assessment follows the general principles used for any suspected spinal deformity or malformation, adapted to the syndrome in question. Plain radiographs, including standing films of the whole spine where deformity is in question, allow scoliosis and kyphosis to be measured and vertebral malformations to be identified. Dedicated views and cross-sectional imaging of the cervical spine, including flexion and extension films where instability is a concern, are described in the literature for syndromes carrying craniocervical risk, with computed tomography giving fine bony detail and magnetic resonance imaging showing the spinal cord and any compression.

Because spinal involvement in Pierre Robin sequence is overwhelmingly a feature of the underlying syndrome, the literature frames spinal assessment as part of the broader characterisation of that syndrome rather than as a routine consequence of the sequence itself. Genetic evaluation, which identifies the syndrome, therefore sits alongside imaging in building the overall picture. The detail and timing of any such assessment are matters for the treating teams involved.

## What the evidence shows about management

The evidence base in this area is built from case reports, case series, systematic reviews of those reports, and the management literature of the individual syndromes, rather than from trials specific to the spine in Pierre Robin sequence. The descriptions that follow report what the literature observes and are not guidance for any person.

In infancy, the management described centres on the airway and feeding rather than the spine. Conservative measures such as positioning, and surgical measures such as mandibular distraction osteogenesis or tongue-lip adhesion, are the interventions discussed in the literature for relieving airway obstruction, with comparative series reporting that distraction osteogenesis and tongue-lip adhesion are both effective alternatives to tracheostomy in those who do not settle with conservative measures. These airway interventions are mentioned here only because the airway frames every subsequent anaesthetic, including any for the spine.

For the spine itself, management in the literature follows the principles of the relevant condition. A developmental scoliosis or kyphosis arising in a collagen disorder such as Stickler or Marshall syndrome is described as being approached as scoliosis and kyphosis are generally, with observation of mild curves, and bracing or surgery considered for larger or progressive ones, all individualised. A scoliosis driven by a congenital vertebral

malformation, such as a hemivertebra, is approached according to the principles of congenital scoliosis. Where an underlying syndrome carries craniocervical instability, the literature emphasises recognition of that instability and protection of the neck, particularly around anaesthesia, with surgical stabilisation reserved for established, significant instability or cord compression. Across all of these, the recurring theme is that the spine is managed in the context of the whole syndrome and the whole patient, by the teams responsible.

## Outlook

The outlook in Pierre Robin sequence is shaped first by the airway and feeding challenges of infancy and then, where a syndrome is present, by the features of that syndrome, of which the spine may be one. For the airway, the difficulty that defines the sequence tends to ease as the lower jaw grows, and the published outcomes of airway management are broadly encouraging.

For the spine, the outlook is best understood through the isolated-versus-syndromic distinction that runs through this whole subject. The isolated form is not characteristically associated with a defined spinal disorder. Where a syndrome is present, any spinal outlook follows that syndrome: a collagen disorder such as Stickler syndrome carries a real but variable tendency to scoliosis, Scheuermann-like kyphosis and back pain across a lifetime; a condition with congenital vertebral malformations carries the outlook of those specific malformations; and the small number of conditions with craniocervical instability carry the particular importance of recognising and protecting against that instability. Throughout, the consistent themes are that spinal involvement is a feature of the underlying syndrome rather than of the sequence itself, that it is reported in a minority overall, that the airway remains the dominant practical consideration for any anaesthetic, and that any individual outlook is a matter for assessment by the treating teams rather than something that can be read from the diagnosis alone.