

What classifications are used to evaluate scolioses?

Classifications are used to facilitate the objective assessment of a disease for different examiners, thus making the results as uniform and comparable as possible. A classification system makes it possible to “speak the same language” in the evaluation.

Therefore, classifications must fulfill two important criteria:

- Reproducibility

The structure of the classification system should ensure that the same examiner would arrive at the same assessment by repeating the examination at any other time. This criterion is also known as intraobserver reliability.

- Reliability

This criterion measures the level of dependability with which a classification system ensures that all examiners using it would arrive at the same result when examining the same case. This is also known as interobserver reliability.

Depending on the classification used, the evaluation of scoliosis includes an x-ray assessment. The quality of the image is important. A poorly centered picture does not allow for a reliable evaluation because the correct determination of the measuring points (upper and lower neutral vertebra, apex vertebra, terminal vertebra) is absolutely essential to the accurate evaluation of the scoliosis angle. The more complex a classification system is, the greater the number of parameters required for the exact assignment to a class, the greater the error rate will be for inexperienced examiners.

As early as 1905, Wilhelm Schulthess defined classes of scoliosis according to location and curve form. He defined 5 types of manifest scoliosis:

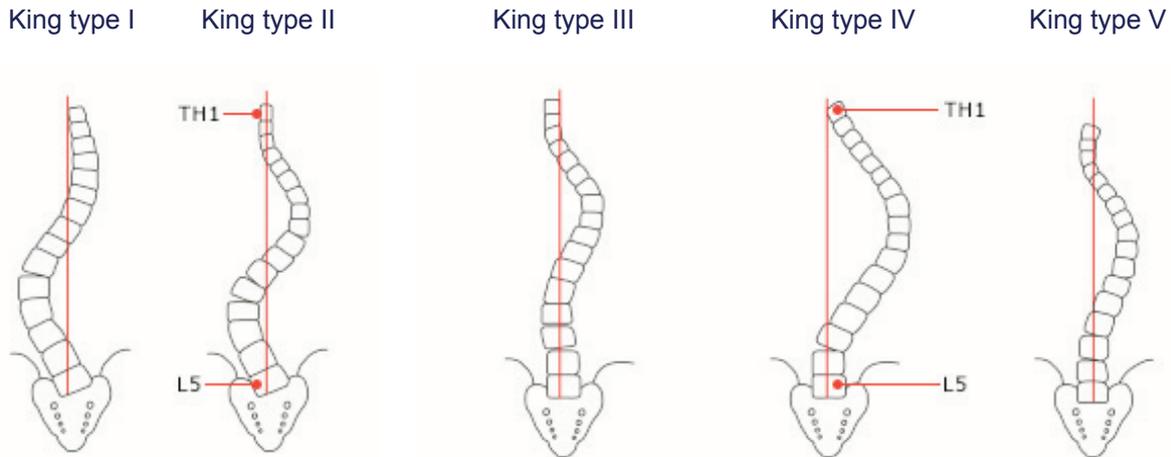
- Cervicothoracic type (at the cervical-to-thoracic spine transition)
- Thoracic type (in the thoracic spine)
- Thoracolumbar type (at the thoracic-to-lumbar spine transition)
- Lumbar type (in the lumbar spine)
- Type with primary double curves in the thoracic and lumbar spine

This classification system was then further modified in the following decades, until in 1983 the King classification of idiopathic scoliosis was introduced.

King classification of idiopathic scoliosis

King scoliosis classification defines 5 types of idiopathic scoliosis, whereby the severity of a case is determined based on the following parameters:

- Cobb determination of scoliosis angle based on x-ray image
- Determination of flexibility index based on bending radiographs



King type I

Shows an S-shaped curve crossing the midline of the thoracic and lumbar curves. The lumbar curve is larger and more rigid than the thoracic curve. The flexibility index in the bending radiographs is negative.

King type II

Shows an S-shaped curve where both the thoracic major curve and the lumbar minor curve cross over the midline. The thoracic curve is larger.

King type III

Shows a thoracic curve where the lumbar curve does not cross the midline.

King type IV

Shows a long thoracic curve where the 5th lumbar vertebra is centered over the sacrum, but the 4th lumbar vertebra is already angled in the direction of the curve.

King type V

Shows a thoracic double curve where the 1st thoracic vertebra (Th 1) angles into the convexity of the upper curve.

The disadvantages of the King classification system:

- The sagittal profile is not included in the evaluation
- So-called “double and triple major curves” (scoliosis forms with two or three major curves) are not considered.

King scoliosis classification is still widely used for evaluating scolioses. A number of modifications with further subtypes have been introduced.

Lenke classification of idiopathic scoliosis

In 2001, Lenke introduced a new classification system for idiopathic scolioses which is much more complex than the King system. Determination of the scoliosis type is based on survey spine radiographs in 2 planes, as well as right and left side bending radiographs with the following parameters:

· Definition of 6 curve types

The curve type is determined by the localization, degree, and flexibility of the manifested curves. The curve apex is defined as follows for localization purposes:

- Upper thoracic localization: Curve apex between Th2 and Th6
- Thoracic localization: Curve apex between Th6 and intervertebral disc Th11/12
- Thoracolumbar localization: Curve apex between Th12 and L1
- Lumbar localization: Curve apex between intervertebral disc L1/2 and L4

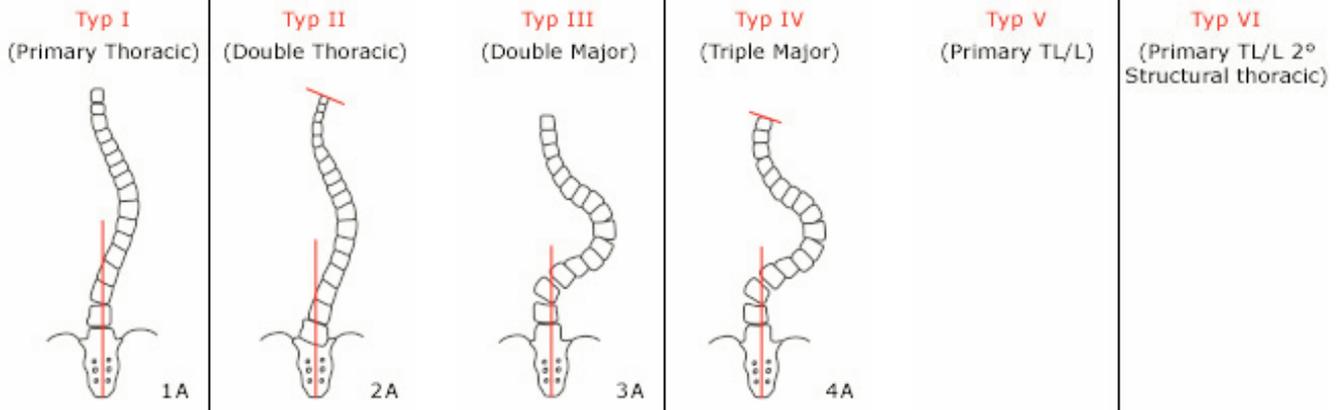
· Determination of the flexibility of the curve

The flexibility is assessed either based on the residual curve in the bending radiograph or the extent of kyphosis. A curve is defined as structural if the bending Cobb angle exceeds 25° or the kyphosis angle exceeds 20°.

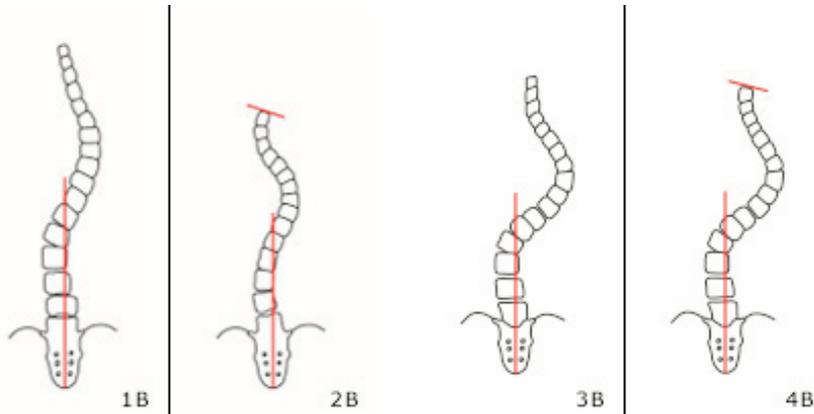
The following 6 curve types can be defined based on these parameters:

- Type I (main thoracic, major curve thoracic only)
The major curve is structural, the others are not
- Type II (double thoracic, 2 thoracic curves)
The thoracic major curve and the upper thoracic minor curve are structural; all others are non- structural.
- Type III (double major, 2 major curves)
The thoracic, thoracolumbar or lumbar curve is structural; the thoracic curve is larger than the thoracolumbar or lumbar curve. If there is an upper thoracic curve, it is not structural.
- Type IV (triple major, 3 major curves)
All three curves are structural; the thoracic curve is the major curve
- Type V (primary thoracolumbar/lumbar, major curve thoracolumbar or lumbar only)
The major curve is located in the thoracic-to-lumbar transition or in the lumbar spine and is structural; the upper thoracic or thoracic minor curve is not structural.
- Type VI (primary thoracolumbar/lumbar, main thoracic)
The thoracolumbar or lumbar major curve is structural; the thoracic minor curve is also structural, but its Cobb angle is at least 5° smaller.

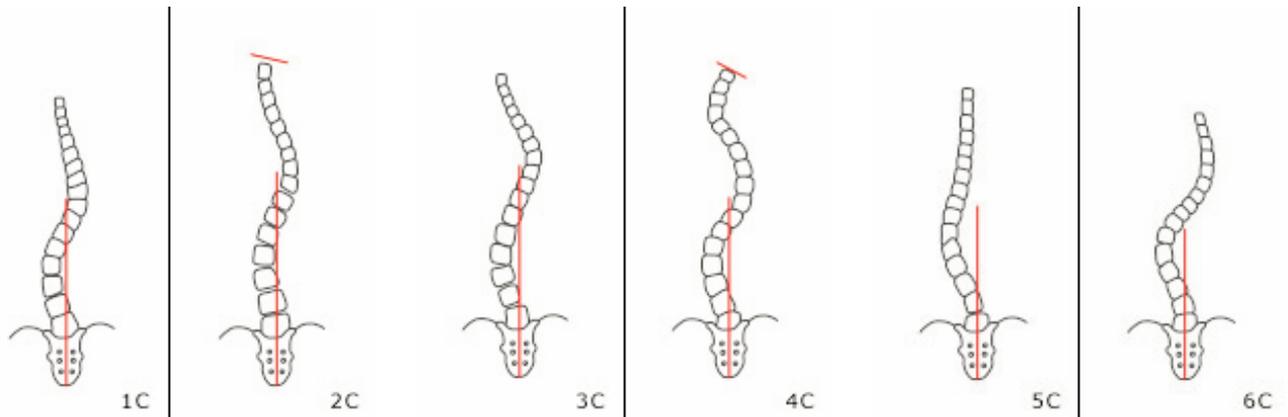
• **A (no to Minimal Curve)**



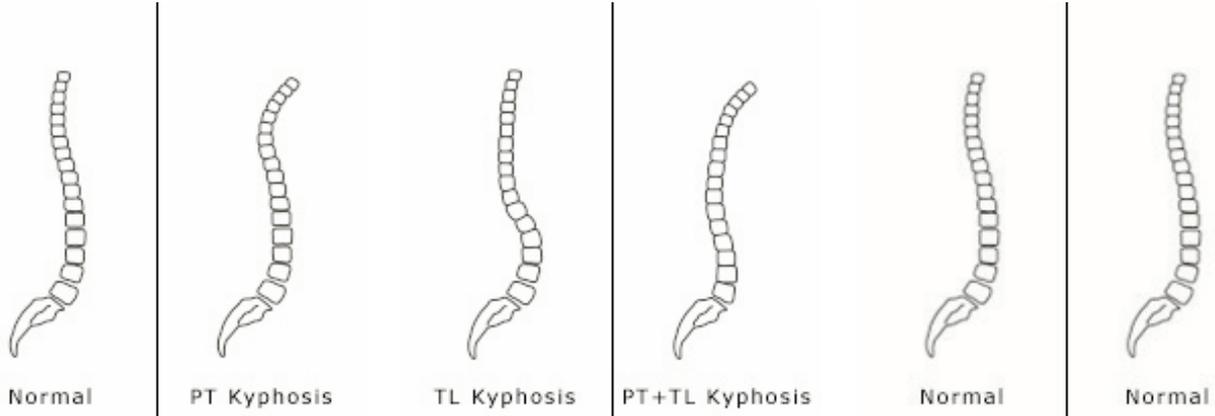
• **B (Moderate Curve)**



• **C (Large Curve)**



• Possible Sagittal Contours (to determine specific curve type)



• Definition of the “lumbar spine modifier”

This parameter covers the changes in the lumbar part of the scoliosis. Three modifier types, A, B and C, are differentiated.

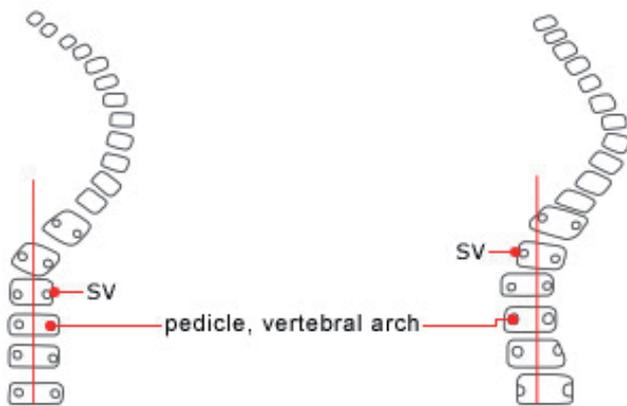
To determine the type, a line at right angles to the horizontal is drawn over the center of the sacrum to the top of the image on the AP x-ray plane.

The vertebra cut into nearly equal halves by this upright line is called the “stable vertebra” (SV). If this central division applies to an intervertebral disc, the vertebra below it is the stable vertebra.

Lumbar spine modifier type A

The upright line runs between the pedicles to the stable vertebra (SV). This is a minimal lumbar curve.

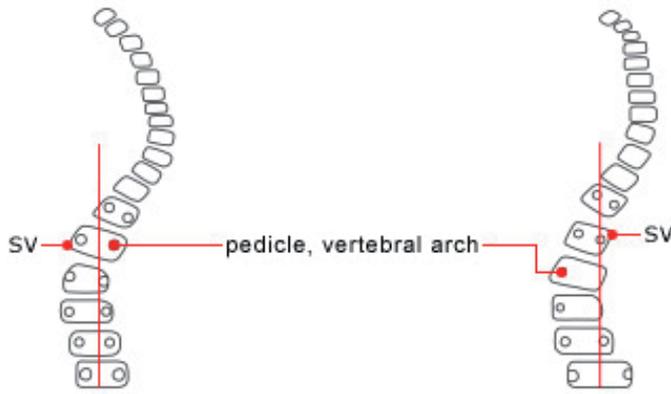
• Lumbar spine modifier, type A



Lumbar spine modifier type B

The upright line runs between the concave-side margin of the apical vertebra and the medial margin of the concave-side pedicle. This is a moderate lumbar curve.

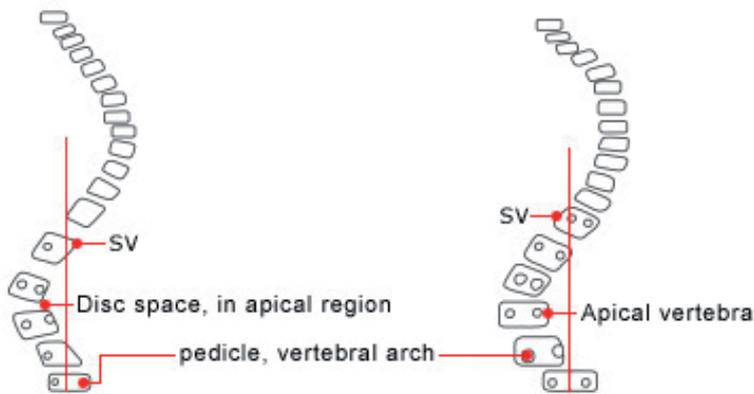
- Lumbar spine modifier, type B



Lumbar spine modifier type C

The upright line is entirely medial to the apical vertebra. This is a large lumbar curve.

- Lumbar spine modifier, type C



- Definition of the “sagittal thoracic modifier”

The last parameter determined is the extent of manifest kyphosis (humpback) in the sagittal profile (x-ray from the side).

The measured values are entered with the indices - , N or +.

The following Cobb kyphosis angles have been defined:

- Cobb angle of kyphosis between Th 5 and Th 12 less than 10°: -
- Cobb angle of kyphosis between Th 5 and Th 12 between 10° and 40°: N
- Cobb angle of kyphosis Th 5 and Th 12 greater than 40°: +

With the help of the parameters mentioned, classification covers a total of 42 different subtypes of idiopathic scoliosis where each subtype takes curve type (types 1-6), the sagittal kyphosis profile (-, N, +) and the lumbar modifier (A, B, C) into account.

Since the Lenke classification system covers many different scoliosis forms, it provides a differentiated tool for classifying the severity of an idiopathic scoliosis, facilitating the planning of both a therapeutic and a surgical strategy. Lenke classification calls for an experienced examiner to determine the scoliosis type, and because this method clearly differentiates between the forms of idiopathic scoliosis, is considerably more accurate and informative than King classification.

This method is increasingly being established as a standard in clinical departments worldwide.