What is the diagnostic procedure for scoliosis?

The most important part of the diagnostic procedure is the specific review of the patient's medical history, followed by an exhaustive physical examination. These enable the physician to posit a tentative diagnosis based on a complete picture of the patient's current health status, and this diagnosis can then be further differentiated and supported by additional instrumental examinations.

The medical history can include the following aspects:

Family medical history:
Have any family members had severe diseases?
Are there any hereditary diseases?
Do any diseases occur with a high level of frequency in the family?

Social history:
Schooling, professional training?
Current work?
Financial situation?
Family situation?

Are you experiencing pain?
Pain quality: lacerating, burning, nagging, blunt, etc.?
Pain duration: When did pain start, how frequent, how long does pain persist?
Pain intensity: How strong is the pain?
Pain localization: Where does pain occur?

Anything abnormal in muscles or locomotor system:
How strong and since when?
Abnormality worsening or improving?
Restricted movements? Blocked movements or stiffness?
Where do they occur?
Weakness in arms or legs?
Reduced strength?
Uncertain gait?

Whether menstruation has begun (menarche, pubarche) is important for the evaluation of the further development, since height growth continues for about 2 years after menstruation begins.

Existing ailments:
Currently existing organ system diseases:
· Cardiovascular
· Pulmonary
· Gastrointestinal
· Renal and efferent urinary tract
· Metabolic diseases

Any known allergies?

Has the patient had any surgery?

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

Klinische Untersuchung

The clinical examination, for which the patient must disrobe, consists of the structured “looking at” the patient, palpation, a neurological examination, and functional and movement tests.

Inspection

View from the front
· Pelvic obliquity?
· Leg axis correct?
· Form of ribcage?
· Head and neck posture?
· Shoulders same height?

View from behind
· Plumbline deviation of the spinal column?
· Lineup of spinous processes?
· Muscle relief?
· Form of ribcage?
· Shoulder height equal on both sides?
· Horizontal pelvic position?
· Waist triangles symmetrical?
· Michaelis rhomboid symmetrical?
· Torso overhang?
· Lumbar bulge when bent forward?
· Costal hump when bent forward?
· Costal concavity visible?

View from the side
· Head and neck posture?
· Normal pelvic inclination?

Form of the spinal column from the side (sagittal profile):
· Humpback?
· Hollow back?
· Sway back?
· Kyphosis?
· Flat back?

Palpation
· Does this cause pain?
· Percussion or compression pain caused in spinal column?
· Muscle tenderness or pain upon application of pressure?
· Painful spinous or transverse processes?
· Sacroiliac joints painful?
· Sciatic triggers points (Valleix points) painful?
· Muscle atrophies present?
· Joint contractures indicated?

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

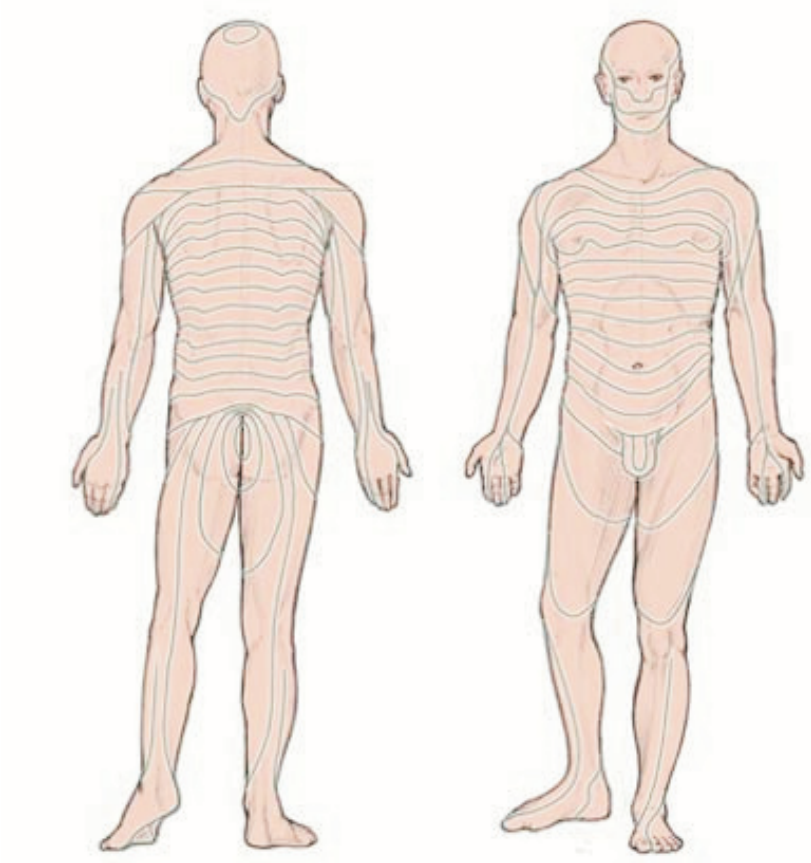
Neurological examination

The examination of the nerves is a procedure of particular importance in spinal column orthopedics, because a neurological examination for orientation can clarify whether neurological abnormalities, such as locomotor or sensory disorders, paralyses, or bladder and rectum dysfunctions, are present.
Any acute neurological dysfunctions detected must then be clarified as quickly as possible.

The following aspects are examined:

· Proprioceptive muscle reflexes, i.e. to check the functionality of the 2nd or lower motoneuron in each section of the spinal column. The reflex is elicited by means of passive stretching of the muscles, e.g. with a tap of a reflex hammer on the patellar tendon
· Polysynaptic reflexes are reflexes that elicit an effect at a location different from the stimulus location. In the abdominal wall reflex, stroking of the abdominal skin causes the contraction of the abdominal muscles.
· Pathological reflexes are signs of damage to the pyramidal tract and cannot be caused in neurologically healthy persons.
· Sensibility test
The regions of the skin supplied by specific spinal nerves are called dermatomes. The detection of sensory dysfunctions in these areas of the skin can lead to conclusions about the place of origin of a spinal ailment.

• Dermatomes



· Testing of coarse muscle group strength
· Lasègue and Bragard Test: With the patient lying down, the passive raising of the leg causes pain in leg and back in the presence of sciatic nerve root irritation.

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

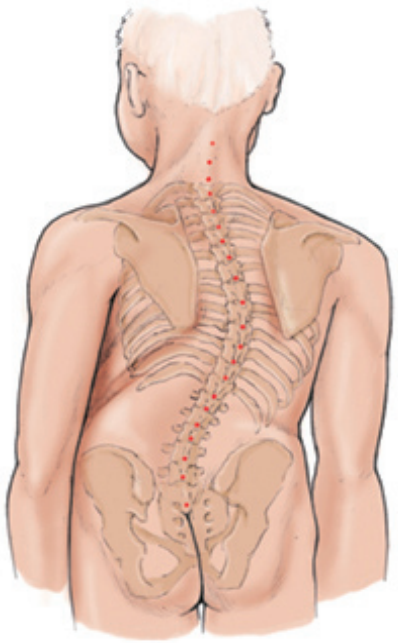
Functional and movement tests

· The forward bend test is a simple method of arriving at a tentative diagnosis of “scoliosis.”
In this test, the patient bends the naked upper body forward and down. The examiner then looks at the back from the front and back. Normally, both sides of the back are the same height. In the presence of a thoracic scoliosis (pathological curvature of the thoracic spinal column), the back may show a notable costal hump (“humpback”) on one side and be notably flattened (“costal concavity”) on the other side. In a scoliosis exhibiting its curve in the lumbar spine (lumbar scoliosis), there is a notable lumbar bulge.

Explanation using the example of a “right convex thoracic scoliosis”:

The picture shows a patient’s back where the course of the spinal column has been drawn in as a dotted line. It is readily apparent that the spinal column, seen from behind, is deformed in a curve towards the right in the thoracic spine (“right convex”).

• Right convex scoliosis

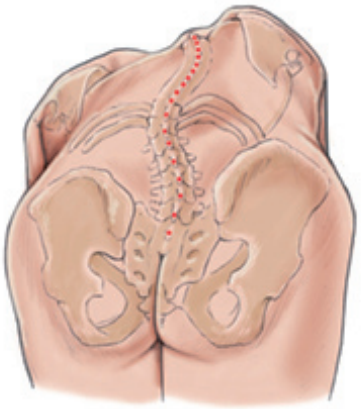


• Right convex scoliosis

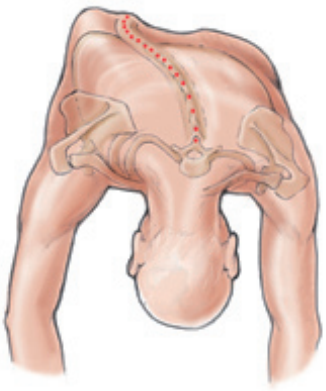
Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

• Costal hump and costal concavity in right in convex scoliosis; forward bend test, viewed from the rear



• Costal hump and costal concavity in right convex scoliosis; forward bend test, viewed from the front



• Ribcage with thoracic spine, from the rear

In the thoracic spine, the ribs of the ribcage are connected to the vertebrae. Thoracic scoliosis results in a costal hump because the lateral curvature and torsion of the vertebrae deform the bony ribcage in such a manner that the costal hump develops on the side where the scoliosis bends outward (convex side), and the costal concavity develops on the other side (concave side).
In scoliosis of the lumbar spine (lumbar scoliosis), the lumbar bulge may be apparent in the forward bend test. This bulge on the convex side of the lumbar scoliosis is also caused by the torsion of the vertebrae, causing the paraspinal muscles to bulge outwards, resulting in the visible lumbar bulge in the bent-over position.

· Götze measurement of the costal hump

The costal hump is measured when the patient is bent over far to the front. The maximum difference in height between the costal hump and the costal concavity is determined using the highest point of the hump and the deepest point in the concavity as the measuring points. Thin pieces of wood are used to compensate for any existing leg length difference before the measurement is carried out.

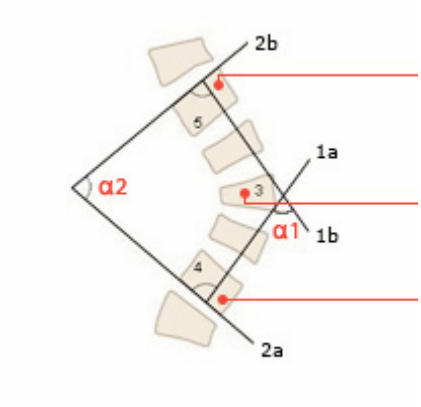
· Scoliometer (inclinometer)
Using this device, the curve of the spinal column can be measured without radiation exposure. The method is suitable for following the course of the disease. The degree of curvature measured with the scoliometer allows for conclusions concerning the Cobb angle, as measured on an x-ray image.

· Cobb angle measurement in scoliosis
The degree of lateral deviation in scoliosis is measured on a survey spinal x-ray of the patient while standing. At the apical vertebra (3) a straight line is drawn (1a) at right angles to the plane of the base plate (2a) of the lower neutral angle (4) and another straight line (1b) is drawn at right angles to the plane of the upper plate (2b) of the upper neutral angle (5). The intersection of these two straight lines results in the angle (a1) of lateral deviation (scoliosis angle). The angle a2 at the intersection of the planes of the lower and upper neutral angle also corresponds to the scoliosis angle (identical alternate angles). However, this intersection is often outside of the x-ray, which is why the equivalent angle a1 is used.

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

• Cobb method of scoliosis angle measurement



· Upper neutral vertebra

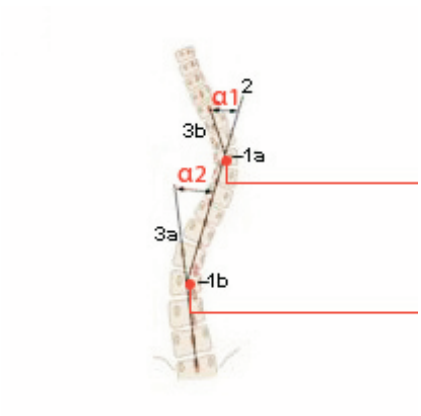
·Apical vertebra

·Lower neutral vertebra

· Ferguson method of determining the angle of curvature

The Ferguson method of determining the angle of curvature is more complex and less frequently used than the Cobb method. The measuring points used are the midpoints of the upper (1a) and lower (1b) apical vertebra, which are connected by a straight line (2).
The midpoints of the vertebrae below and above the apical vertebra are then connected by straight lines (3a, 3b). The intersections of these straight lines with the straight line 2 result in the angles of curvature a1 and a2.

• Ferguson method of determining angle of curvature



· Upper apical vertebra

·Lower apical vertebra

The measuring methods named above may not be as accurate as the new computer-supported methods, but they are easy to do and economical.

· Nash-Moe rotation assessment

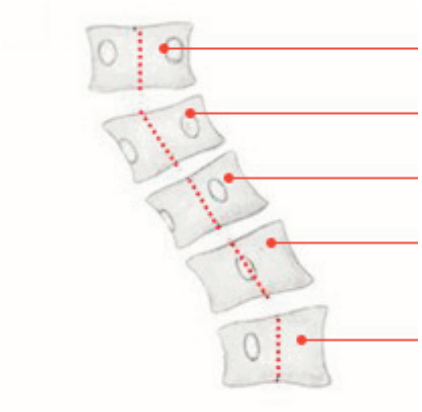
This method is used to determine the degree of rotation of the scoliotic spine. In the x-ray image, the positions of the pedicles in relation to the vertebral body are assessed and 4 different degrees of rotation determined:

a: Normal findings, no rotation
b: Degree of rotation I
c: Degree of rotation II
d: Degree of rotation III
e: Degree of rotation IV

© www.harms-spinesurgery.com 2007. All rights reserved.

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

• Nash-Moe rotation assessment



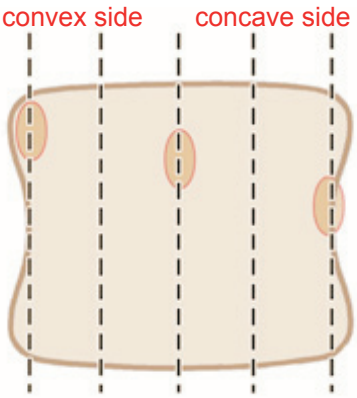
· a: Normal findings, no rotation

· b: Degree of rotation I

· c: Degree of rotation II

· d: Degree of rotation III

· e: Degree of rotation IV



· **Raimondi rotation assessment**

This method of rotation measurement also uses an x-ray image. In a frontal image, the measuring points used are the right and left side edges of the vertebra and the midpoint of the convex-side pedicle. Using these points, the width of the vertebra (x) is calculated along with the distance from the midline of the convex-side pedicle to the edge of the convex-side vertebral body (y). The measured values are indicated in millimeters. Based on the measured values for x and y, the corresponding degree of vertebral rotation can be read off a table.

· Determination of rotation using templates
B. Drerup and Perdriolle developed various templates with which the degree of rotation of individual vertebrae can be measured.

· Measurement of spinal column mobility using the neutral zero method, in which the mobility parameters are measured based on a standardized method for bending over (flexion), bending backward (extension), lateral inclination, and rotation.

· Finger-floor distance
Distance between fingertips and floor when bent over forward with legs and arms extended. This distance is an indicator for the flexion capacity of the spinal column.

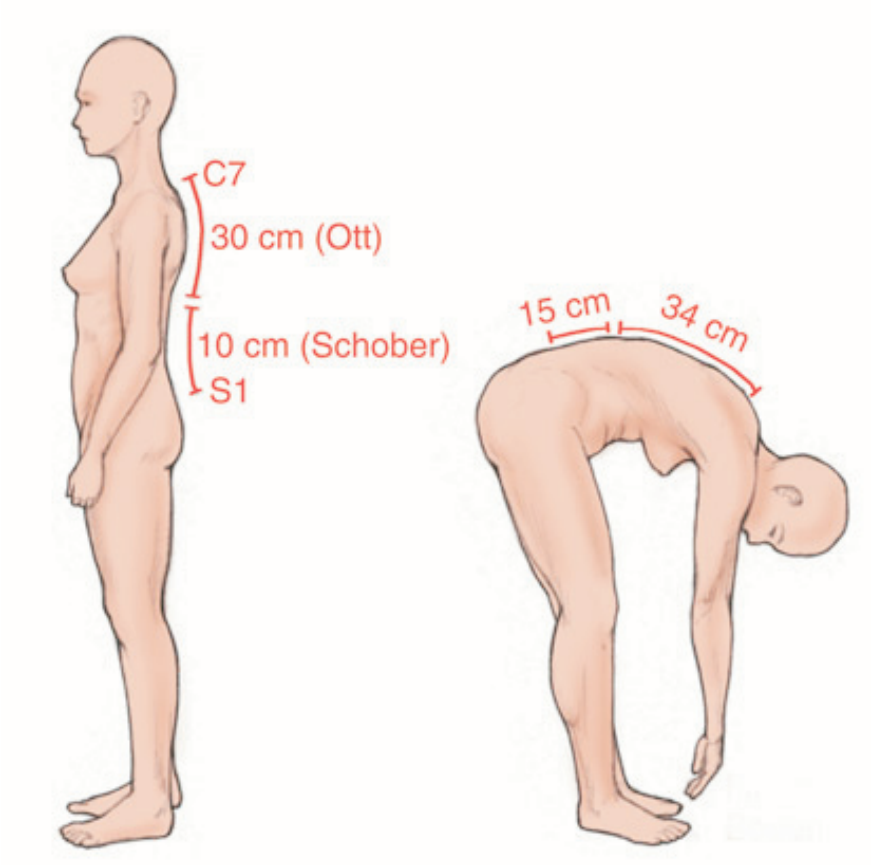
· Schober's sign
Measurement of extent to which the lumbar spine can unfold and extend. In a standing position, a point 10 cm above S1 is marked. With the torso at maximum flexion the distance increases by approx. 5 cm.

· Ott's sign
Measurement of unfolding and extension of the thoracic spine. A point 30 cm below C7 is marked on the spinal column. With the torso at maximum flexion the distance increases by approx. 3 cm.

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

• Schober's and Ott's signs, Finger-floor distance



Determination of skeletal age

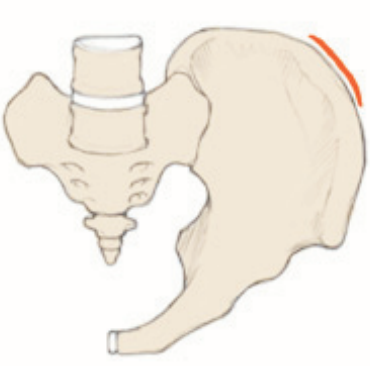
Determination of skeletal age is an important factor when predicting the further progression of an existing spinal deformity.

· Risser's sign
The iliac crests are shown in an x-ray image. Conclusions can be drawn concerning the remaining skeleton from the degree of ossification of the iliac crest apophyses. Stages 0-5 are used, where "Risser stage 5" means the apophyses of the iliac crest are completely ossified, and skeletal growth is complete.

Risser assessment of skeletal age, stages 0-5

• Stage 0

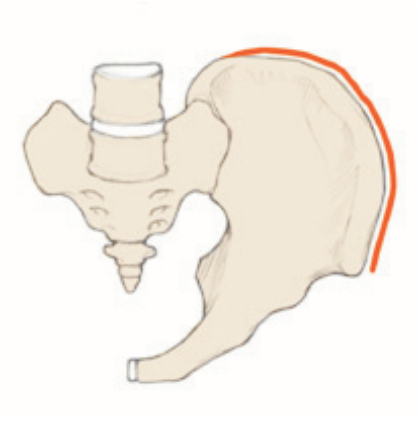
• Stage 1



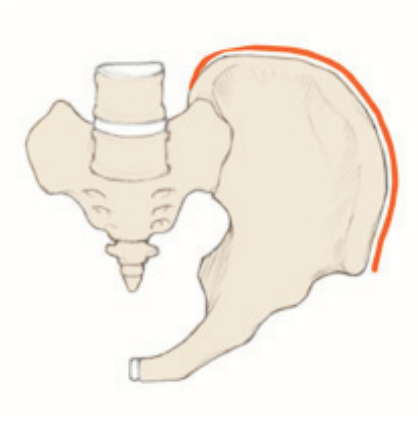
Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

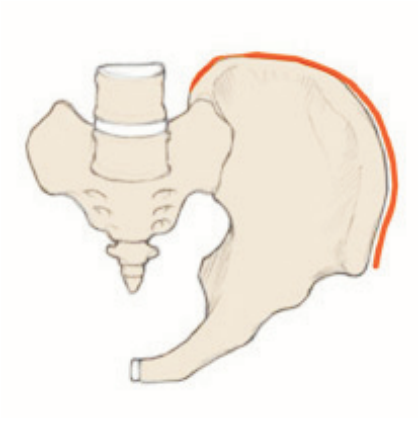
• Stage 2



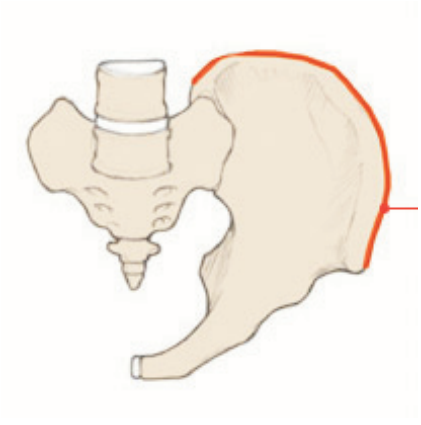
• Stage 3



• Stage 4



• Stage 5

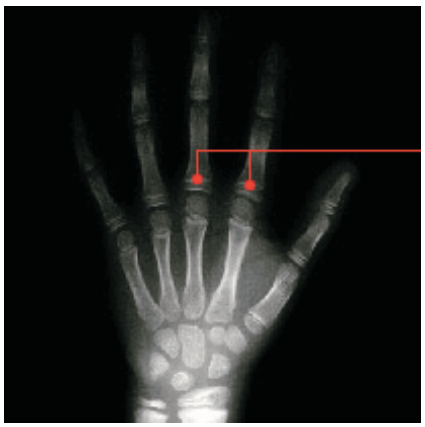


· Increasing ossification of the apophyses of the iliac crest

· Greulich and Pyle evaluation of skeletal growth

The ossification status of the epiphyses of the hand skeleton can be determined using AP x-rays of the hand. Greulich and Pyle published an atlas that can be used to determine skeletal age. The stages of epiphyseal closure in the hand skeleton are the indicators of further growth.

• Greulich and Pyle assessment of skeletal growth



· Epiphyses

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.

· Photographic documentation of progression

· 3D scanning stereography (e.g. Formetric, Moiré topography, or ISIS)
Using these methods, a three-dimensional static and dynamic measurement of the spinal column can be taken without exposing the patient to x-rays.
Since these methods work without the use of x-rays, they are particularly well suited for monitoring the course of disease in children and young adults.

Radiographic diagnostics

· Conventional x-ray images
X-ray images are always two-dimensional, so that the additional rotation of the vertebrae creates a summation effect on the image.

Despite the x-ray exposure of the patient, these images are necessary to obtain the following information:
- · Current spinal status
- · Course monitoring
- · Basis for formulation of therapeutic strategy
- · Documentation of curvature correction in conservative treatment or post-surgery

· Survey spinal radiographs while standing, in frontal and sagittal planes
These images are used to present and measure spinal deformities in the frontal plane (scoliosis curve) and for assessment of the sagittal profile of the spinal column (lordosis and kyphosis). The images should always be made on a long plate and not with two images that are then combined, since in the combined images, the x-ray planes are often not identical, which may throw the evaluation off. Any leg length difference should be compensated with thin pieces of wood before the images are made to avoid a tilted pelvic position and improve the horizontal positioning of the pelvis.
· Survey spinal radiographs AP in extension (Cotrel or halo extension device)
This imaging technique (traction images) is used to determine the extent to which straightening of the existing lateral deviation is feasible in scoliosis. An extension device exerts longitudinal traction on the spinal column.
· Bending test
For these x-ray images, the curved spinal column is “recurved” with manual pressure while the patient is lying on the table. The image of maximum possible recurve provides information about the rigidity of the lateral deviation, i.e. as to whether lateral deviations of the spinal column can be spontaneously corrected or are already fixated.

The straightening of the spinal column achievable by passive bending can be expressed in terms of a percentile using the following formula:

Curve straightening in % = angle of curve in standing radiograph - angle of curve in bending radiograph x100/angle of curve in standing radiograph

Example: angle of curve in standing radiograph = 60°
angle of curve in bending radiograph = 40°

© www.harms-spinesurgery.com 2007. All rights reserved.

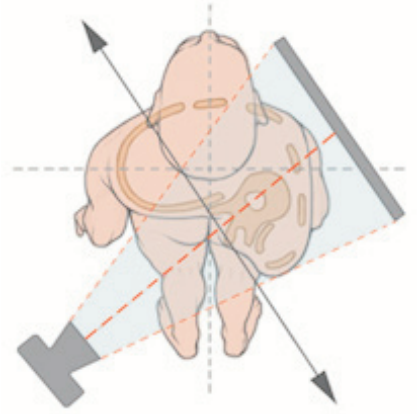
Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

Calculation: $(60° - 40°) \times \frac{100}{60} = \frac{2{,}000}{60} = 33{,}33\%$

In this example, the lateral axial deviation can be straightened by 33.33% by means of passive bending.

· Stagnara method: x-ray image in elective plane, plan d'élection
Stagnara improved the radiological assessment of kyphosing scolioses by introducing a special angled image where the x-ray plate is held parallel to the median surface of the costal hump ("plan d'élection").

• Stagnara, plan d'élection



· Computer tomography/magnetic resonance tomography
These computer-supported layered imaging techniques provide for the good assessment of the bone and soft tissue situation and facilitate the spatial presentation of the spinal deformity by way of a three-dimensional reconstruction. These examination methods are used if congenital scoliosis is suspected and in patients who cannot stand.

· Pulmonary diagnostics
Spirometry is used to measure the vital capacity of the lungs. The measured value tells the examiner whether a manifest deformity of the ribcage due to scoliosis has already affected pulmonary function.

Spine Surgery Information Portal · Prof. Dr. Jürgen Harms · www.harms-spinesurgery.com

© www.harms-spinesurgery.com 2007. All rights reserved.