CONTINUING MEDICAL EDUCATION

Idiopathic Scoliosis

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SUMMARY

Background: Scoliosis is a three-dimensional deviation of the spinal axis. The main diagnostic criterion is spinal curvature exceeding 10° on a plain anteroposterior X-ray image. Scoliosis is called idiopathic when no other underlying disease can be identified.

Methods: Selective literature review and recommendations of the relevant medical societies in Germany and abroad.

Results: Scoliosis in children of school age and above primarily occurs in girls. Its prevalence is 1% to 2% among adolescents, but more than 50% among persons over age 60. The therapeutic goal in children is to prevent progression. In children, scoliosis of 20° or more should be treated with a brace, and scoliosis of 45° or more with surgery. The treatment of adults with scoliosis is determined on an individual basis, with physiotherapy and braces playing a relatively minor role. Adults (even elderly adults) who have scoliosis and sagittal imbalance may be best served by surgical treatment.

Conclusion: Scoliosis is common. Early diagnosis makes a major difference in the choice of treatment.

► Cite this as:
Trobisch P, Suess O, Schwab F: Idiopathic scoliosis. Dtsch Arztebl Int 2010; 107(49): 875–84.
DOI: 10.3238/arztebl.2010.0875

Scoliosis is a three-dimensional deviation of the spinal axis. The main diagnostic criterion is a coronal curvature exceeding 10° on an anteroposterior X-ray image *(Figure 1)*.

Idiopathic scoliosis is a diagnosis of exclusion: This condition is diagnosed only when the history and the clinical and radiological findings do not provide clear evidence for any specific etiology. The major types of non-idiopathic scoliosis are congenital scoliosis due to malformation or faulty segmentation of the vertebrae and neuromuscular scoliosis due to muscular imbalance.

Idiopathic scoliosis is classified as infantile, juvenile, or adolescent depending on the age at which it is first noted. A fourth category is that of adult scoliosis, which may be either a continuation of adolescent idiopathic scoliosis or a *de novo* development owing to degenerative changes or other causes. In elderly patients, *de novo* scoliosis is often hard to tell apart from pre-existing idiopathic scoliosis with superimposed degenerative changes.

Learning objectives

This article is intended to give the reader an understanding of

- the clinical manifestations, diagnostic evaluation, and prognosis of idiopathic scoliosis and
- the options for treating idiopathic scoliosis.

The article is based on the authors' assessment of the recommendations in existing guidelines from Germany and abroad, and on their selective review of the literature.

Epidemiology, etiology, and pathogenesis

Idiopathic scoliosis is extremely rare in infancy and early childhood but has a prevalence of 1% to 2% among schoolchildren up to age 15 (1). Degenerative changes are presumed to account for the further rise in prevalence to over 8% in adults aged 25 and above, and to as high as 68% in persons aged 60 to 90 (2, 3).

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Definition

Scoliosis is a three-dimensional deviation of the spinal axis.

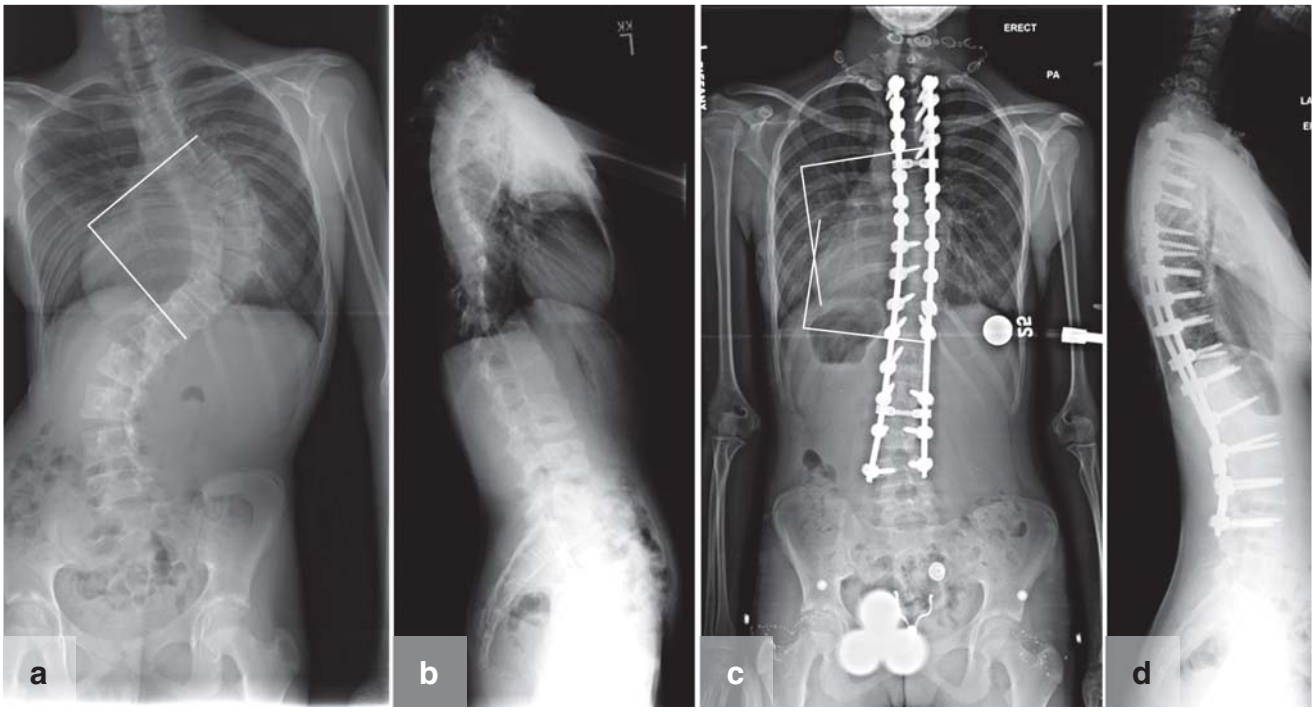

Figure 1: X-rays of a 14-year-old girl with a 90° scoliosis that was nearly fully corrected through dorsal surgery with stabilization; a) preoperative posteroanterior view with the Cobb angle indicated; b) preoperative lateral view; c) postoperative posteroanterior view with the Cobb angle indicated with the aid of radio-opaque markers; d) postoperative lateral view

The etiology of idiopathic scoliosis is unknown and presumably multifactorial. The near relatives of persons with idiopathic scoliosis are more likely to have the condition, and its concordance rate among monozygotic twins is reportedly as high as 70%; clearly, at least part of the cause is genetic.

The sex distribution of idiopathic scoliosis has not been clearly determined. Idiopathic scoliosis comes in different degrees of severity, and the prevalence of each degree varies with age. Male and female infants are equally affected by infantile scoliosis, but girls tend to be more commonly affected with increasing age, so that the sex ratio from age 10 onward is already 6:1. There is a similar development with respect to the severity of curvature: Boys are somewhat more likely than girls to have mild scoliosis, yet the ratio of girls to boys among children with spinal curvatures greater than 20° is 5:1, and it rises to 10:1 in children whose spinal curvature exceeds 30°.

Prognosis

The prognosis of scoliosis depends on its severity as well as on the patient's age and stage of bone growth.

Infantile scoliosis resolves spontaneously in more than 80% of cases, requiring no treatment. In the remaining 20%, however, scoliosis progresses, and long-term, complex treatment may be necessary. If progressive infantile scoliosis remains untreated, severe restrictive pulmonary disease may ensue; this is one of the few potentially life-threatening complications of an orthopedic condition. Mehta described the rib vertebral angle (RVA), which is the angle between the vertebral body and the rib measured bilaterally at the apex of the curve. In her study of 138 patients, Mehta observed spontaneous improvement in 80% of patients whose RVA difference (RVAD) was less than 20°, and progression in 80% of patients whose RVAD was greater than 20° (4).

Prevalence

The prevalence of scoliosis is 1% to 2% in schoolchildren and rises above 8% in adults aged 25 and older.

Prognosis

Infantile scoliosis frequently corrects itself spontaneously and thus needs no treatment in over 80% of cases. The remaining cases of progressive scoliosis often require lengthy and complex treatment.

Adolescent scoliosis takes a considerably more benign course. The likelihood of progression among adolescents with a Cobb angle less than or equal to 20° is in the range of 10% to 20%. In adolescents just as in children, the more marked the scoliosis, the more likely it is to progress: Among adolescents with a scoliotic curvature exceeding 20° combined with immature bone status, the likelihood of progression may be 70% or higher (5).

Various clinical findings are used to assess the developmental stage of spinal growth. In girls, the age of menarche is most often used as a rough guide: According to a rule of thumb, the growth spurt of puberty generally ends by the time of the menarche, and the spinal column generally stops growing about two years afterward.

The stage of bone maturation can also be assessed on plain X-rays of various regions of the skeleton, including the iliac crests, the triradiate cartilage of the acetabulum, and the ossification zones of the hands *(eFigure 1)*. The degree of ossification of the iliac crest apophysis is categorized in Risser stages. Ossification in this area progresses in a lateral-to-medial direction, and the Risser stage is defined as the quarter of the iliac crest, proceeding from lateral to medial, in which the medial end of the apophysis is currently located. Thus, if ossification has proceeded along 60% of the iliac crest, then the medial end of the apophysis is in the third quarter from lateral to medial, and the Risser stage is 3. If no apophysis is yet visible, the Risser stage is 0; an apophysis that is completely fused to bone corresponds to Risser stage 5. Stages 0 through 2 are associated with as yet incomplete bone growth. The growth spurt of puberty usually takes place during Risser stage 0, just before closure of the triradiate cartilage. Judging epiphyseal ossification in the hand, which proceeds from distal to proximal, is somewhat more difficult but yields a more precise estimate of the rate of growth (e1).

In patients who have stopped growing, scoliosis of less than 30° can generally be considered stable, while scoliosis of more than 30° can be expected to progress at a rate of approximately 1° per year (6). The course of scoliosis in any particular individual cannot be reliably predicted, as still unidentified factors seem to play a large role in this process.

Middle-aged patients with idiopathic scoliosis, whether or not they have undergone surgery for it, have an elevated frequency of disc degeneration and mild back pain. The latter problems, however, do not have any major deleterious effect on these patients' perception of their quality of life; the quality of life is defined as a composite of well-being in multiple areas including pain, functional status, and mental health (e2, e3, 7).

Scoliosis does not interfere with sexuality or pregnancy in any way that would impair the patient's quality of life (8).

The effect of scoliosis on morbidity and mortality in old age has not yet been adequately studied. It was once assumed, on the basis of studies in heterogeneous patient populations, that patients with untreated adolescent scoliosis would necessarily become wheelchair-dependent in old age and were likely to die of cardiopulmonary arrest for reasons related to scoliosis. This is no longer held to be the case (9).

Classification

Idiopathic scoliosis is classified according to the age of the patient at the time of diagnosis. On the basis of the notion that three growth spurts correspond to the phases of highest risk for worsening of scoliosis, the condition is subdivided into three types:

- infantile scoliosis (under age 3),
- juvenile scoliosis (ages 3 to 9), and
- adolescent scoliosis (ages 10 to 18).

Recent research findings, however, suggest that longitudinal growth in the juvenile phase proceeds at an even pace, rather than in a spurt (10).

Accordingly, scoliosis can also be classified into two types, early- and late-onset scoliosis, with the dividing line at age 5 (10). Adult scoliosis, by definition, affects patients aged 18 or older.

Further useful features for the clinical description of scoliosis include the spinal level of maximal curvature (thoracic, thoracolumbar, or lumbar) and the side on which it is convex (right-convex or left-convex).

The most popular academic classification schemes are those of King and Lenke, which divide adolescent idiopathic scoliosis into five or six main types, respectively, depending on the pattern of curvature (11, 12).

Symptoms and physical findings

Idiopathic scoliosis only rarely causes pain in children and adolescents and often comes to attention only because of the hunched rib cage and lumbar bulge that it causes, or because of asymmetry of the shoulders, chest, or pelvis *(Figure 2)*. Particularly in adolescents,

Adolescent scoliosis

Adolescent scoliosis takes a markedly more benign course. If the Cobb angle does not exceed 20°, the probability of progression is only about 10% to 20%.

Classification

Scoliosis is classified according to the patient's age at the time of diagnosis, as follows:
- infantile (under age 3),
- juvenile (age 3 to 9), and
- adolescent scoliosis (age 10 to 18).

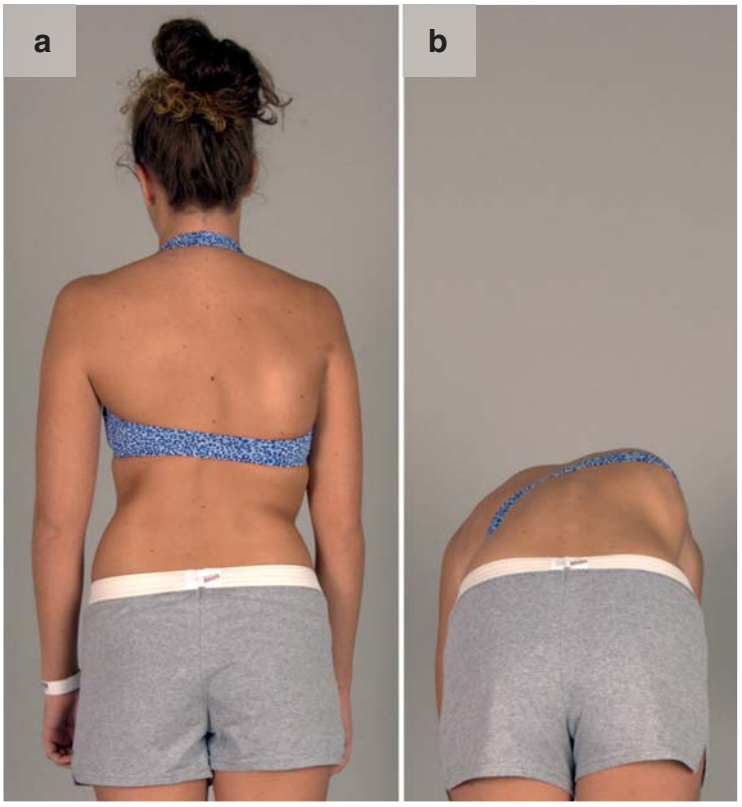

Figure 2: The Adams forward-bending test in a 15-year-old girl with right-convex adolescent idiopathic thoracic scoliosis; a) when the patient stands upright, mild asymmetry at the waist and a mild shoulder tilt are noted; b) when she bends forward, spinal rotation becomes evident through the appearance of a hunched rib cage on the right

this asymmetry can lead to psychosocial problems such as a lack of self-confidence, a tendency towards depression, suicidal thoughts, and elevated alcohol consumption (e4, 13).

The symptoms in adults depend on the level at which the maximal curvature is located. Lumbar scoliosis of degenerative origin often causes back pain, while thoracic scoliosis more commonly comes to attention by restricting pulmonary function when the angle is 80° or more. Additional abnormal deviation of the sagittal profile, if present, often causes neck pain and compensatory shortening of the ischiocrural muscles.

Diagnostic evaluation

The general historical interview should include specific questioning about potentially associated conditions, such as a congenital heart defect or urological problems, and may serve to identify causes of non-idiopathic scoliosis. Urogenital abnormalities such as horseshoe kidney are present in about 25% of patients with congenital scoliosis, and cardiological abnormalities in about 10%. The family history may suggest a hereditary predisposition to scoliosis. Pain and mental distress should be evaluated by specific questioning. Further things to be specifically asked about include the timing of the menarche, the rapidity of growth, and any growth spurt that might be taking place at present.

Elderly patients often present with symptomatic scoliosis. Pain, when the patient complains of it, must be precisely categorized. Nonspecific back pain has a lifetime prevalence of 70% in the normal population and should not be attributed to scoliosis. Pain radiating into a lower limb may be a sign of spinal nerve root compression.

The examiner inspects the patient to assess shoulder stance and the symmetry of the chest and waist. A pelvic obliquity when the patient stands with the lower limbs fully extended and both feet planted flatly on the ground indicates an asymmetry of leg length. The lateral profile should reveal the three normal curves: cervical lordosis, thoracic kyphosis, and lumbar lordosis. When the patient stands up straight with the legs fully extended, the head should be centered over the pelvis when viewed both from the front and from the side. Unusually pronounced focal growth of hair over the lumbar spine frequently accompanies incomplete fusion of the laminae and can indicate a neurological cause of scoliosis, as can abnormal pigmentation, e.g., café-au-lait spots, a sign of neurofibromatosis.

The Adams forward-bending test increases the prominence of a rib hump or a lumbar bulge on the convex side of the curvature *(Figure 2)*. Stiffness of the lumbar spine on extension may indicate spondylolysis or, less commonly, discitis. The neurological survey includes testing of the reflexes (including the abdominal skin reflexes) and of the segment-indicating muscles and dermatomes of the lumbar spine.

Scoliosis is diagnosed from X-ray images. Precise assessment requires a plain X-ray of the entire vertebral column with the patient standing. Ideally, the iliac crests should also be included to enable evaluation of the patient's bone growth status, and the clavicles as well, to display the shoulder stance. The severity of scoliosis is expressed by the Cobb angle. This is calculated by taking the two vertebral bodies that are

Clinical manifestations

Idiopathic scoliosis rarely causes pain. It often comes to attention through a hunched back, lumbar bulging, and/or asymmetry of the shoulders, chest, and pelvis.

History

The family history may indicate a predisposition. About 25% of patients with congenital scoliosis have urogenital abnormalities, and about 10% have cardiological abnormalities.

most markedly tilted from the horizontal—the so-called end vertebrae *(Figure 1)*. A Cobb angle of more than 10° is considered pathological, but the diagnosis of scoliosis is made only when there is also a rotational deviation, as indicated by projection of the pedicles or spinous processes toward the concavity of the curvature in the postero-anterior X-ray view. A Cobb angle exceeding 10° without any rotational deviation can be seen, for example, in transient abnormal postures due to pain. The lateral X-ray view provides information about the sagittal profile. The spine-to-pelvis ratio can be determined from the images of the pelvis and hip joints on the lateral view. In sagittal deformities of the spine, there may be a compensatory rotation of the pelvis pivoting on the femoral heads that returns the spine to an upright position. When this happens, however, global imbalance persists, and the non-physiological compensatory force is simply passed on to the lower limbs.

An MRI is recommended for certain patient subgroups with a higher frequency of spinal abnormalities: boys, girls with unusual types of curvature (left convex thoracic), patients with symptomatic scoliosis, and those with an abnormality on neurological examination. MRI can provide evidence of bone tumors or intraspinal lesions, if present.

The treatment of infantile and juvenile scoliosis

There is no well-defined treatment algorithm for infantile scoliosis because data on this rare condition are available only from retrospective case-control studies. At the first author's institution, infantile scoliosis is treated if the Cobb angle exceeds 35° and the RVAD exceeds 20°. Casting seems to be a better treatment than a brace, though the advantage of the former over the latter is small (e5). Scoliosis that does not respond to conservative treatment may require surgery. Alveolar development is not complete until age 8 and might be impaired by reduced volume of the chest; therefore, growth-directing spinal instrumentation is recommended *(Figure 3)*. Late-onset juvenile scoliosis can be treated as recommended for adolescent scoliosis.

The treatment of adolescent scoliosis

Scoliosis of less than 20° should be followed up in periodic outpatient visits at 4- to 6-month intervals, and new X-rays should be taken if progression is suspected. Two technical aids may be useful: a scoliometer, which is a variant of a carpenter's level used to measure the severity of the rib hump and lumbar bulge; and raster stereography, in which the shape of the back is documented with the aid of reflected light beams.

Physiotherapy can be initiated even when the scoliosis is only mild. The most popular type of physiotherapy for scoliosis is Schroth therapy. This was introduced almost a century ago by Katharina Schroth, further developed by her daughter Christa, and popularized in the academic world as well by her grandson, an orthopedist in private practice (14). He reported that patients who underwent inpatient Schroth therapy for several weeks had curvature progression less frequently than untreated patients, by a factor of up to 2.9 (14). There have not, however, been any independent, controlled, long-term studies that might confirm these observations.

Treatment with a brace is recommended for scoliosis between 30° and 45° before the termination of bone growth and for scoliosis between 20° and 30° that progresses by more than 5° in 6 months. The aim is straightening by at least 50% in the brace. Follow-up assessment of the correction is performed with a spine X-ray in the brace, taken a few weeks after the brace is first used to allow a period of adaptation. Many different types of orthosis are now available; thoracolumbar orthoses are usually used. Prefabricated orthoses such as the Boston orthosis, which need to be fitted to the patient with special pads, are common in the USA, while custom-made orthoses such as the Chenau corset are common in Europe. Both types of brace correct the spinal curvature through passive adaptation to pressure. The Milwaukee brace, which effectuated an active correction by means of a neck support, is used only rarely because of its highly immobilizing shape. Controversy over the efficacy of treatment with orthoses persists. No clinical trials providing level I evidence are available, and the inclusion criteria in the trials that have been carried out to date vary widely from one trial to another; these might be two reasons why a systematic review in 2007 revealed no advantage of orthotic treatment over observation alone, even though such an advantage might actually exist (15). A few years ago, the Scoliosis Research Society officially recommended a list of inclusion criteria to be used in clinical trials of corset treatment for scoliosis. In adapted form, these criteria can also serve as clinical guidelines, because they describe the group of patients that is considered most likely to benefit from a corset. Included, for example, are patients with adolescent idiopathic scoliosis

Diagnosis

Scoliosis is diagnosed on plain X-ray films. Its severity is expressed by the Cobb angle.

The treatment of infantile scoliosis

There is no well-defined treatment algorithm for infantile scoliosis because data on this rare condition are available only from retrospective case-control studies.

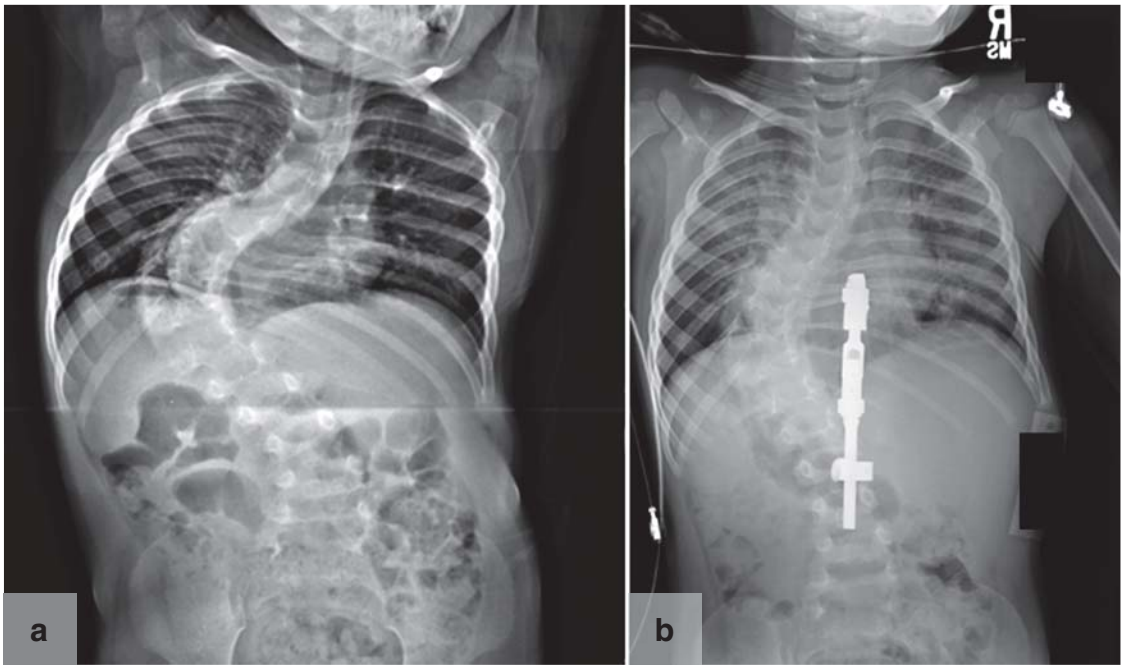

Figure 3: X-ray of a 3-year-old boy with infantile 90° scoliosis. The scoliosis was reduced to 55° with the implantation and distraction of a Vertical Expandable Prostethic Titanium Rib (VEPTR). Further distractions are now being performed manually in approximately 6-month intervals

in Risser stage 0–2 who have a 25° to 40° curvature (16). A short while ago, Katz et al. published the first prospective, blinded, and randomized study of orthoses (17). All patients were treated with orthoses but wore them for varying times, as determined by randomization. The authors found that the time spent in the brace was linearly related to decreases in curvature progression and in the need for surgery. More than two-thirds of the children who wore no brace suffered a worsening of their scoliosis, but less than one-fifth of those who regularly wore a brace did. Compliance was less severely hindered by embarrassment than by discomfort and by the low chance of success in the treatment of rigid scoliosis (e6).

As an alternative to orthoses for patients who choose not to wear them, Betz et al. advocate vertebral body stapling on the convex side to restrict growth unilaterally *(Figure 4)*. This can be performed as a minimally invasive procedure, and the patient does not need to wear an orthosis afterward. Vertebral body stapling is suitable for patients in Risser stage 0 or 1 with a thoracic scoliosis of less than 35° or a lumbar scoliosis of less than 45°. Results after 3 years of follow-up were recently published; a comparison of these with the results of classic orthosis studies suggests that vertebral body stapling is slightly better at preventing progression of the curvature and also affords the possibility of correcting scoliosis, which cannot be achieved with a brace (18). Long-term findings are not yet available, and no randomized trial has been performed to date.

Surgical correction and stabilization of the affected segment of the spine is considered for the treatment of adolescent scoliosis exceeding 45°, as the affected patients can otherwise expect their scoliosis to worsen. There is a fluid transition between cosmetic and protective indications for surgery in this patient group, because many patients whose scoliosis measures only a little more than 45° will probably not experience any restriction of breathing when they are older (this generally happens only when the scoliosis exceeds 80°). The operation can be performed through a ventral, dorsal, or combined approach, depending on the type of scoliotic curve and the surgeon's preference. The dorsal systems currently in use are designated as the third

The treatment of adolescent scoliosis

Scoliosis of less than 20° should be followed up every 4 to 6 months and rechecked with X-rays if progression is suspected.

A brace can help patients who

- have adolescent idiopathic scoliosis,
- are in Risser stage 0, 1, or 2, or
- have a 25° to 40° curvature.

generation of spinal instrumentation. Long-term results are available only for first-generation instrumentation with the Harrington rod, a type of distracting rod that is applied to the concave side of the curve. The spinal curvature is corrected by distraction, with the disadvantage of simultaneous undesired flattening of the sagittal profile. The second generation consists of segmental hook-and-rod systems, which enable two-dimensional correction of scoliosis by means of segmental anchoring (in each vertebral body) and a malleable rod. Systems with screws and rods became popular in the mid-1990's. Pedicle screws that are placed all the way into the anterior portion of the vertebral body have the additional advantage of providing rotational correction, thus enabling correction in three dimensions *(Figure 1)*. The dorsal systems are in competition with the less commonly used anterior systems. Most of the latter are further elaborations of the ventral derotation spondylodesis originally developed by Prof. Zielke.

Modern instrumentation systems enable 60% to 80% correction as well as immediate ambulation without the need for a brace after surgery (e7–e9). The rate of neurological complications varies from 0.2% to 1.8% depending on the extent of the procedure; most such complications are transient (19). The complication rate can be held to a minimum through the use of

- intraoperative neuromonitoring,
- intraoperative blood pressure control by the anesthesiologist,
- intra- and postoperative control of the hematocrit and hemoglobin concentration, with allo- or autogenic blood transfusion if necessary, and/or with the use of a cell saver.

Adequate postoperative analgesia and physiotherapy help prevent pain, ileus, and thrombotic events. In institutions where this type of surgery is commonly performed, the patient generally stays in the hospital two to three weeks after surgery (e10). A retrospective analysis of the long-term results shows that surgery significantly lowers the probability of progressive scoliosis compared to treatment with an orthosis. Patients with scoliosis suffer disc degeneration at a significantly higher rate than the general population whether or not they have undergone surgery for scoliosis, and no difference has been found between the surgically and conservatively treated groups in this respect (20). Long-term results with respect to complications are not available for the recently introduced types of instrumentation, but the reported intermediate-term results include a revision rate of just over 4% after a mean of 5.7 years of postoperative follow-up. 43% of the revisions were necessitated by pseudoarthrosis or by kyphosis adjacent to the operated segment, 34% by infection, and 15% because of pain related to the instrumentation (21).

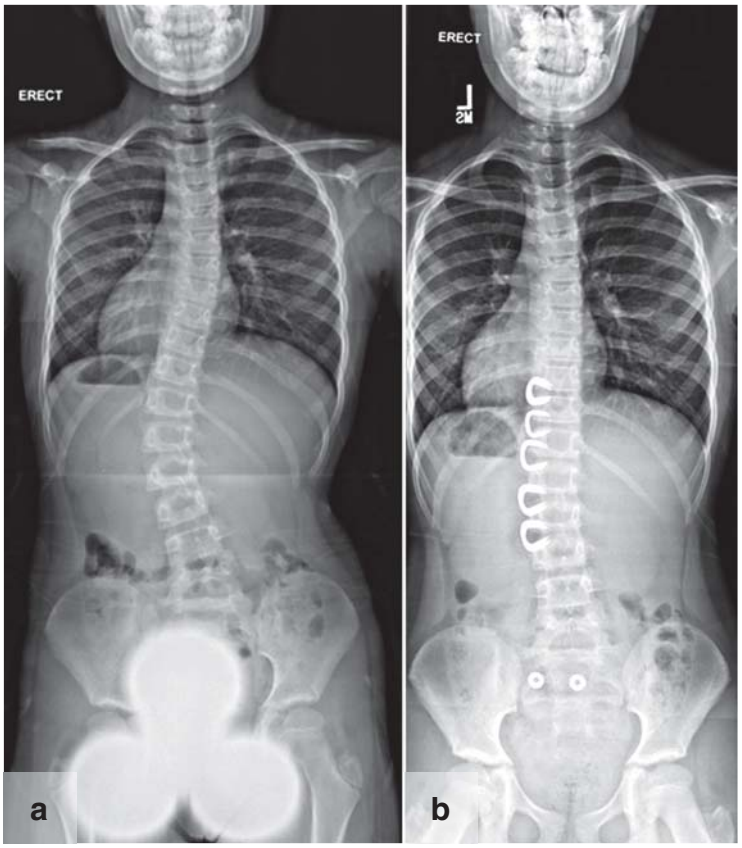

Figure 4: X-ray of an 8-year-old girl a) with lumbar 45° scoliosis: b) stapling not only stabilized the scoliosis, but almost completely corrected it as well. Because the patient was so young, progressive scoliosis would have been a near certainty without surgery

The treatment of adult scoliosis

Unlike adolescent scoliosis, in which the goal of treatment is to prevent progression, adult scoliosis is treated in order to improve the existing manifestations of the condition. The cause of adult scoliosis, whether idiopathic or *de novo,* is irrelevant with respect to the

Alternatives to orthoses

Vertebral body stapling on the convex side of the scoliosis to prevent growth unilaterally is an alternative to treatment with an orthosis.

Vertebral body stapling on the convex side of the scoliosis can help patients who:

- are in Risser stage 0 or 1,
- have thoracic scoliosis of less than 35°, or
- have lumbar scoliosis of less than 45°.

indications for surgery and has no bearing on the likelihood of therapeutic success (e11).

Asymptomatic scoliosis in an elderly patient needs no treatment. If, however, the patient suffers from back pain, radicular pain, or functional impairment due to the scoliosis, targeted treatment should be provided.

The level of evidence in support of conservative treatment measures for adult scoliosis is not high. Analgesic drugs, injections, physiotherapy, and orthoses can bring most patients transient relief, but they improve quality of life over the long term in only about one-quarter, even when the indications are precisely defined (22, 23, e12).

Surgery for scoliosis was long discounted as an option for elderly patients because of the complexity and high morbidity of such procedures. This attitude has changed markedly, however, as a result of increased operative experience and innovations in spinal instrumentation. Today, even elderly patients can expect scoliosis surgery to bring about a significant improvement in their quality of life compared to what it would have been without surgery, although the risk of perioperative complications is high (22, 24). Major and minor complications are each experienced by 18% of elderly patients who undergo surgery for scoliosis (22).

The goal of surgery for adolescent scoliosis, as mentioned above, is the surgical correction or stabilization of the scoliosis. In adult patients, the goals of surgery are a much more complex matter and depend on

- the type and severity of the deformity,
- the patient's symptoms,
- and the patient's comorbidities.

In some cases, where the main clinical problem is local nerve impingement, a microsurgical procedure suffices to bring relief. More often, however, complex reconstructions are needed, particularly when there is a sagittal deformity in addition to scoliosis *(eFigure 2)*. The spine must always be considered as a complete unit, and the spine-to-pelvis ratio must always be taken into account.

Prevention

The development of scoliosis cannot be prevented. Thus, attention is currently being focused on early detection, so that timely treatment can be provided. The use of a forward-bending test for screening is a controversial matter, however, as its predictive value is apparently low (25).

Conflict of interest statement
The authors state that they have no conflict of interest as defined by the guidelines of the International Committee of Medical Journal Editors.

Manuscript submitted on 1 July 2010, revised version accepted on 27 September 2010.

Translated from the original German by Ethan Taub, M.D.

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The treatment of adult scoliosis

The treatment of adult scoliosis depends on the severity of its clinical manifestations.

Prevention

Scoliosis cannot be prevented. "Preventive" measures are thus restricted to early diagnosis and timely treatment.

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Further Information on CME

This article has been certified by the North Rhine Academy for Postgraduate and Continuing Medical Education.

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The solutions to the following questions will be published in issue 5/2011. The CME unit "Gliomas in Adults" (issue 45/2010) can be accessed until 24 December 2010. For issue 1–2/2011, we plan to offer the topic "Neonatal Screening for Metabolic and Endocrine Disorders"

Solutions to the CME questionnaire in issue 41/2010:
Schulte-Körne G: The Diagnosis and Treatment of Dyslexia.
Solutions: 1c, 2e, 3c, 4c, 5a, 6b, 7e, 8a, 9d, 10b

Please answer the following questions to participate in our certified Continuing Medical Education program. Only one answer is possible per question. Please select the answer that is most appropriate.

Question 1

By definition, scoliosis is . . .

a) ... an anomaly of the vertebral bodies.
b) ... a type of osteoporosis inherited in an autosomal dominant pattern.
c) ... a three-dimensional deviation of the spinal axis.
d) ... a consequence of a pelvic tilt.
e) ... a comorbid condition accompanying spina bifida.

Question 2

What is the prevalence of idiopathic scoliosis among 15-year-old boys?

a) <0.1%
b) 0.1% to 1%
c) 1.1% to 5%
d) 5.1% to 10%
e) >10%

Question 3

Which of the following is valid as a rule of thumb about the probability that scoliosis will progress?

a) Scoliosis measuring 20° in an adolescent who is still growing has an approximately 50% chance of progressing.
b) Scoliosis measuring less than 30° in a patient who has stopped growing can be considered stable.
c) Adult scoliosis measuring 30° will probably progress at the rate of ca. 1° per year.
d) Adult scoliosis measuring 50° will probably progress at the rate of ca. 3° per year.
e) Among adolescents with scoliosis, boys outnumber girls by 6 to 1.

Question 4

What is the definition of adolescent scoliosis?

a) Scoliosis arising from age 3 onward
b) Scoliosis arising from age 5 onward
c) Scoliosis arising from age 7 onward
d) Scoliosis arising from age 9 onward
e) Scoliosis arising from age 18 onward

Question 5

An 11-year-old girl has idiopathic scoliosis measuring 15°. How often should she be reseen in outpatient follow-up?

a) Every 2 months
b) Every 4 to 6 months
c) Every 8 to 10 months
d) Every 12 to 18 months
e) Every 18 to 24 months

Question 6

What is the long-term prognosis for a 21-year-old woman with idiopathic scoliosis measuring 60° with respect to her quality of life?

a) If she does not undergo surgery, it is more likely than not that she will be wheelchair-dependent by age 70.
b) If she does not undergo surgery, it is more likely than not that she will die of cor pulmonale by age 70.
c) If she undergoes surgery, it is more likely than not that she will be unable to bear children by spontaneous vaginal delivery.
d) If she does not undergo surgery, it is more likely than not that she will be unable to bear children by spontaneous vaginal delivery.
e) If she does not undergo surgery, her quality of life at age 40 will be practically unimpaired in comparison to that of women of the same age without scoliosis.

Question 7

What is the most common type of physiotherapy for scoliosis?

a) Schroth therapy
b) Craniosacral therapy
c) Spiral dynamics
d) Proprioceptive neuromuscular facilitation therapy
e) Meridian therapy

Question 8

How is the Risser stage determined?

a) After correction for any leg length inequality
b) While the patient bends forward
c) On postero-anterior and anteroposterior X-rays of the spine
d) On a lateral X-ray
e) In relation to the menarche

Question 9

How high is the probability that a 16-year-old boy with adolescent idiopathic scoliosis will suffer a neurological complication from corrective surgery?

a) <0.1%
b) 0.1% to 2%
c) 2% to 4%
d) 4% to 6%
e) >6%

Question 10

What can be said about preventing scoliosis?

a) Swimming prevents the development of scoliosis.
b) Swimming lessens the severity of scoliosis.
c) Bicycling on a low seat improves scoliosis.
d) There is no way to prevent the development of scoliosis.
e) The forward-bending test has a high predictive value when used to screen schoolchildren for scoliosis.

CONTINUING MEDICAL EDUCATION

Idiopathic Scoliosis

Per Trobisch, Olaf Suess, and Frank Schwab

eReferences

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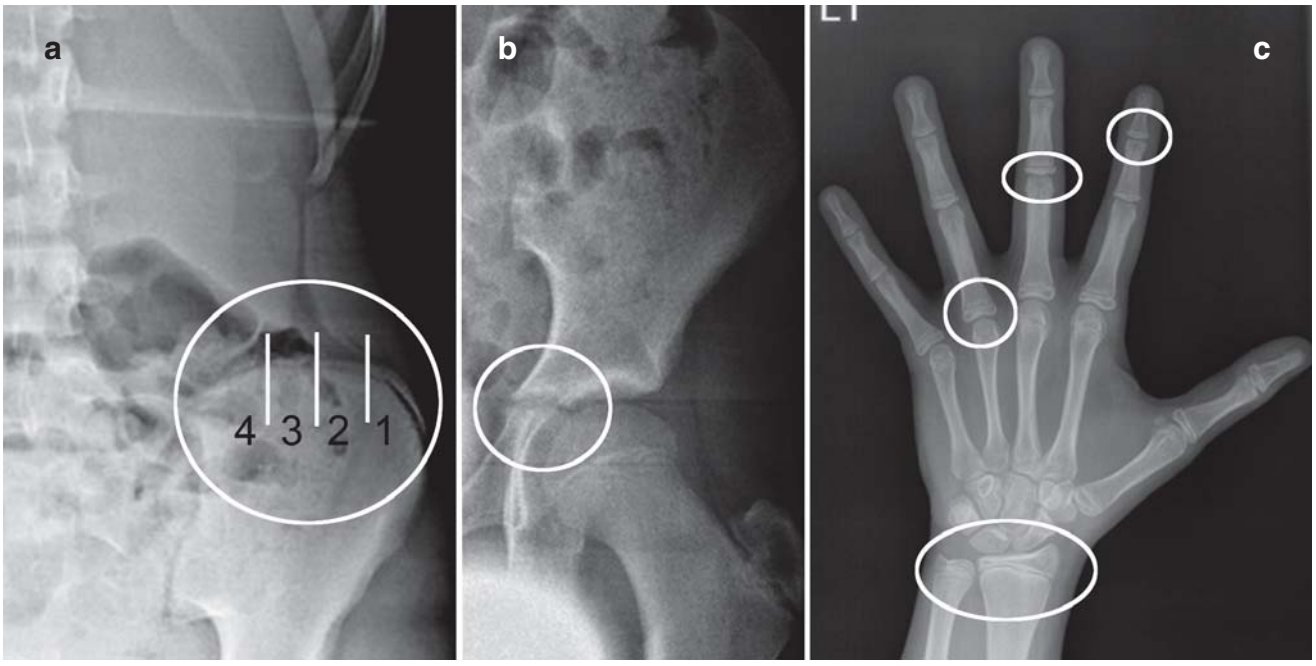
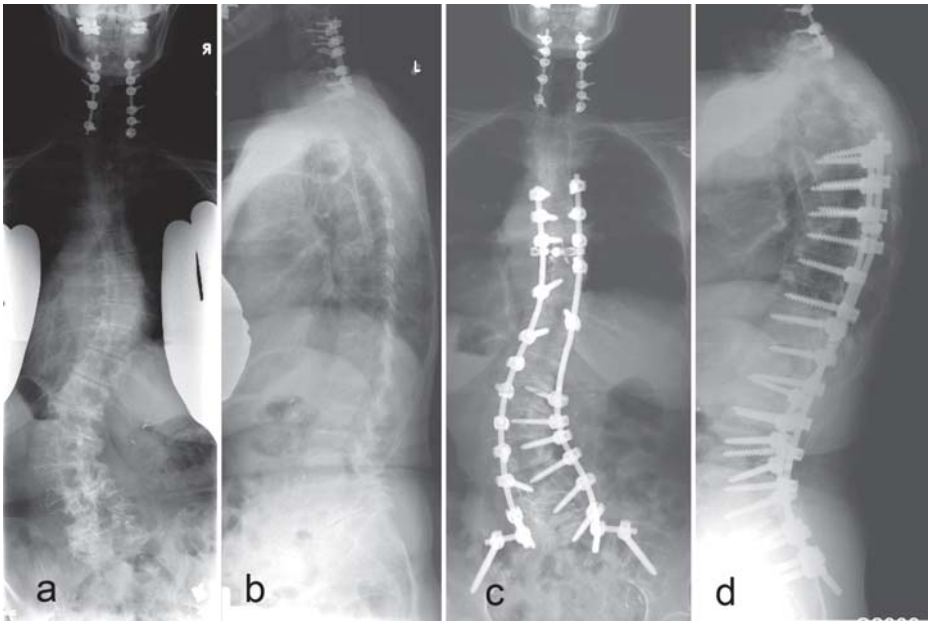


eFigure 1: X-ray images: a) Risser stages; b) not yet ossified triradiate cartilage; c) centers of ossification in the hand



eFigure 2:
X-ray of a 78-year-old woman with progressive scoliosis, which is probably due to a combination of initial adolescent scoliosis with degenerative changes that arose later on in life. She had undergone surgical stabilization of the cervical spine a few years previously because of degenerative changes; this indicates the patient's general propensity to develop spinal degenerative disease. Steadily worsening lumbar spinal nerve compression caused immobilizing pain that failed to respond to conservative measures. A nerve-decompression procedure alone would probably have yielded only temporary relief because of the likely continued progression of scoliosis. Instead, she underwent decompression of the lumbar spinal canal and neural foramina combined with stabilization of a long segment of the spine. Despite her advanced age, the operation markedly improved her quality of life.
a, b, preoperative images; c, d, postoperative images