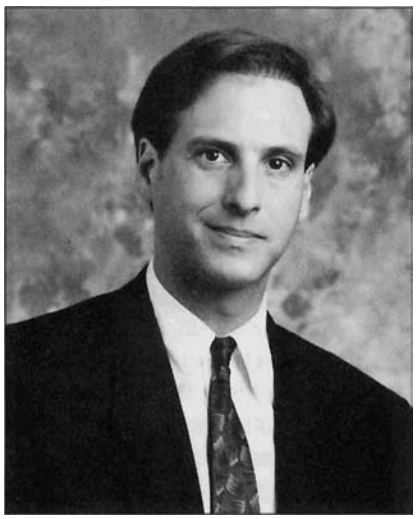
"Let's Get it Straight"

BACKTALK

Volume 24 / Number 1
April / May 2001

The Scoliosis Association, Inc., A National Information and Support Network

Adolescent Idiopathic Scoliosis



Robert S. Pashman, M.D.
Director, Scoliosis and Spinal Deformity Service
Cedars-Sinai Institute for Spinal Disorders
Los Angeles, California

Scoliosis is defined as curvature of the spine in the coronal (front view) plane. Idiopathic scoliosis should be conceptualized as a three dimensional deformity though; twisting of the spine is coupled with curvature producing deformity in both coronal and sagittal (side view) planes. As its name implies, adolescent idiopathic scoliosis occurs between the ages of 10 and 18 and to date, has no known cause. The magnitude of the curve is determined using the Cobb method (Figure 1) and conveyed in degrees. Curves measuring more than 10 degrees occur with an approximate worldwide incidence of 3% and are distributed equally between males and females. Curves greater than 20 degrees occur with an incidence of 0.3% and have a distribution of five females to every male. Because larger curves are both more likely to require treatment and occur more frequently among females, there is a common misconception that adolescent idiopathic scoliosis, in general, is more common in girls.

The exact etiology of idiopathic scoliosis is yet to be determined, but it is thought to be due to multiple factors. Although the exact genetics is unclear, the observation that idiopathic scoliosis is more common within families suggests the presence of an inherited trait. Research focusing on changes in muscles, the spinal column, rib cage and the chemistry of cartilage in discs suggests that these abnormalities are most likely secondary to the primary scoliosis and not a causative factor. The fact that most curves occur in common patterns, such as right thoracic or left lumbar, raises the possibility that other anatomical asymmetries such as the pulsatile beating of a leftsided heart, might have an influence on curve production and progression. Here at the Cedars Sinai Institute for Spinal Disorders, we are currently investigating with MRI the relationship between observed turbulent CSF (fluid surrounding the spinal cord) flow at curve apex, differential pressure on the spinal cord, and the influence of these factors on curve progression. For the reader who is interested in more information on the current state of knowledge and research into the etiology of idiopathic scoliosis, a recent Current Concepts Review (Journal of Bone and Joint Surgery, Volume 82A, No. 8, August 2000) will be helpful.

*The treatment of **patients** with idiopathic **scoliosis** begins with **an estimation of the probability for curve** progression.*

Adolescent idiopathic scoliosis curves are classified by their location in the spine. Curves can occur in the cervical, thoracic and lumbar spine in various combinations (figure 2). Structural curves are defined as those curves that incompletely straighten on side-bending. Compensatory curves straighten significantly on side-bending and function to produce spinal balance. The location of the ***structural curve*** determines the classification of the scoliosis. For example, a structural curve occurring in the thoracic spine with a lumbar compensatory curve is called thoracic adolescent idiopathic scoliosis. (Figure 3) Single curves, curves whose apex is at T12 or L1 may be defined as a thoracolumbar curve (Figure 4), and curves with apices at L2 or L3 are defined as lumbar curves. Structural curves in both the thoracic and lumbar spine are called double major curves. (Figure 5) The exact definition of the curve has implications for determining progression and treatment.

In California, as in many other states, law mandates middle school screening for scoliosis. Scoliosis is detected by observation of a rib prominence during a forward bending test (Figure 6). Girls and boys are most often screened in the 7th and 8th grades, respectively. School screening has effectively reduced both the number of patients requiring surgery and the magnitude of those curves at the time of surgery.

Continued on page 3

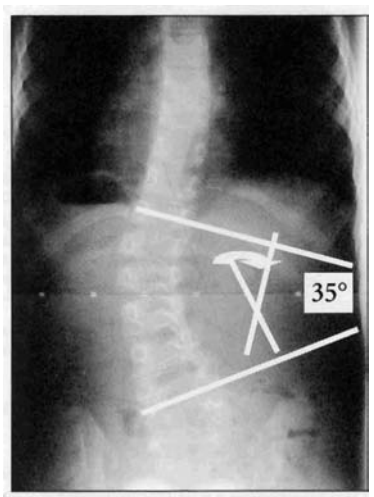


Figure 1. Cobb Method. All vertebra within the curve are included and the ends marked with lines. The angle of the intersection of these lines is defined as the Cobb Angle. This curve measures 35 degrees.

Adolescent Idiopathic Scoliosis

Continued from page 1

Once scoliosis is detected, the patient should be referred to an orthopaedic surgeon who specializes in spinal deformities. 36 x 14 inch scoliosis x-rays in the frontal and sagittal planes are obtained and measured according to the Cobb method. Idiopathic scoliosis rarely produces neurological findings, such as numbness or weakness in the extremities. Neurologic findings should suggest a non-idiopathic scoliosis and, in most cases, only then should be investigated with imaging modalities such as MRI. Studies have shown that routine MRI of patients with idiopathic scoliosis rarely uncovers intraspinal pathology and, therefore, is not cost effective.

The treatment of patients with idiopathic scoliosis begins with an estimation of the probability for curve progression. The two major determinants of curve progression are the patient's age (both chronological and bone development) and size of the curve. Secondary determinants include sex of the patient and rotation of the spine. Once these determinants are assessed, the treating physician can estimate the likelihood of curve progression and formulate a treatment strategy.

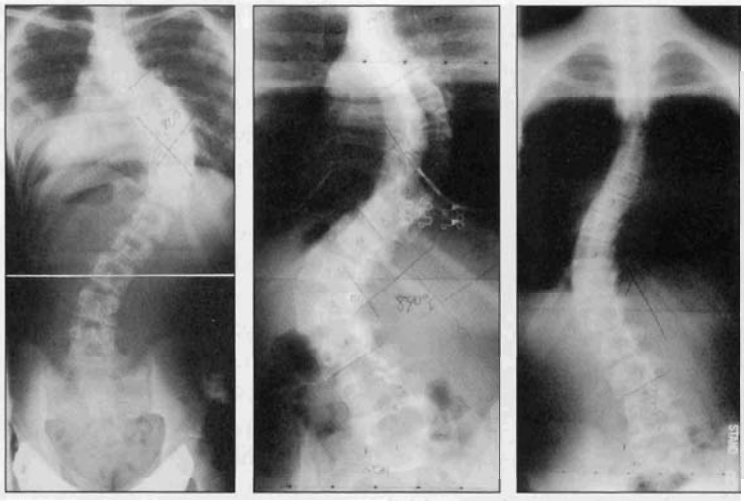
In general, the current treatment of adolescent idiopathic scoliosis is guided by certain general principles. First, small curves in older patients have less chance of progression than larger curves in younger patients. Second, adolescent curves greater than 40 degrees are difficult to control mechanically with braces. Third, adult curves greater than 50 degrees will continue to progress at an average rate of 1 degree per year. Taken together, the goal of treatment is to keep adolescent curves less than 40 degrees during growth, and at the end of growth to keep all curves less than 50 degrees. Finally, cosmetic considerations should only be a rare, primary indication for surgery.

Based on these considerations, the attached table summarizes current treatment of adolescent idiopathic scoliosis (Figure 7). Small curves measuring less than 20-25 degrees that do not require brace treatment should be observed during periodic examinations of four to six months or one year intervals, based on their size. Observation remains a form of treatment because any 5 degree increase in the size of the curve may change the course of treatment.

Although there is little controversy as to whether patients who meet certain criteria should be braced, the exact choice of brace type and duration of brace wear generates some debate. An excellent discussion of brace effectiveness was summarized in Dr. Winter's article in *Backtalk,* April 1999 (Volume 22 / Number 1). Three points emerge from his review. First, bracing alters

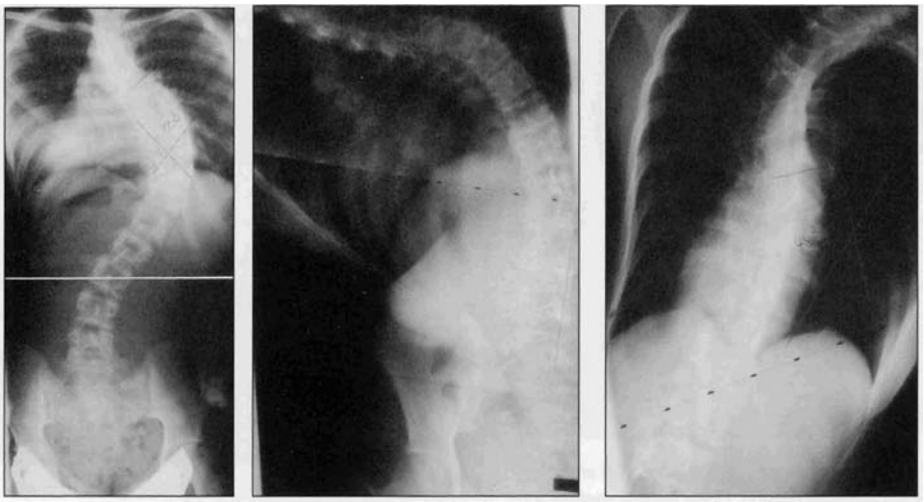
Continued on page 4

Figure 2



Thoracic *Double Major* *Thoracolumbar*

Figure 3



Right thoracic adolescent idiopathic scoliosis.

Left side bending - notice the lumbar curve straightens and therefore is compensatory.

Right side bending - the thoracic curve incompletely straightens and therefore is structural.

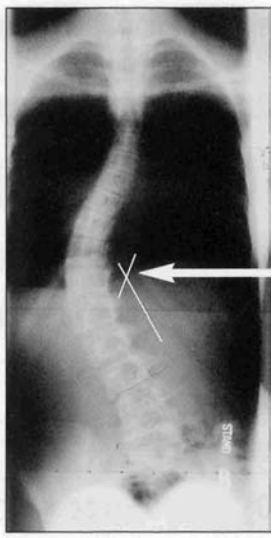


Figure 4
Apex of curve at T12. This curve is defined as Thoracolumbar Adolescent Idiopathic Scoliosis.

Adolescent Idiopathic Scoliosis

Continued from page 3

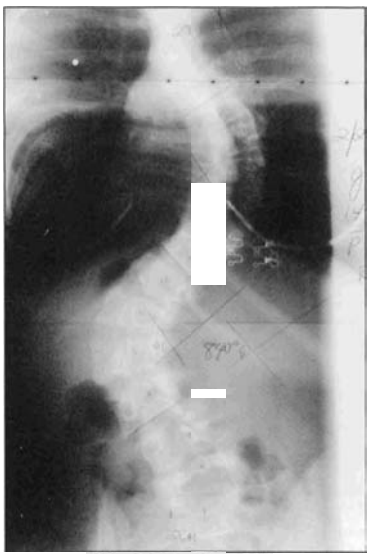


Figure 5
Two large structured curves are classified as a Double Major Curve.

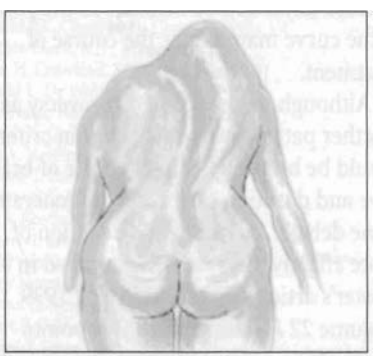


Figure 6
Forward bend test will detect the rib hump.

Adolescent Idiopathic Scoliosis
Treatment
Skeletally Immature Adolescent

Curve (degrees)	Treatment
<20°	Observation
>20°<25°	4 month x-rays
25°-30°, 5° documented progression	Brace
30°-40°	Brace
>40°	Consider Surgery

Figure 7

the natural history of curve progression. Second, bracing is "dose dependent," the more the brace is worn, the greater chance for it to be efficacious. Third, for the brace to be effective, it should be worn until impending skeletal maturity and then weaned slowly.

On the other hand, it is uncommon for braces to induce permanent correction and curves generally return to their pre-braced Cobb angle quickly after being discontinued. Moreover, for unknown reasons, certain curves progress despite brace treatment. Currently, we are unable to predict which curves will progress during brace treatment.

Those patients who have curves greater than 40 degrees at presentation and have progressive curves despite bracing should be considered for surgery. Curves between 40 and 50 degrees fall into a relative grey area for surgical indications, but any curve above 50 degrees in a growing child should be surgically stabilized.

The basic principle of surgery is to stop progression of the curve and to leave the patient balanced in a frontal and sagittal plane. Cessation of curve progression is achieved with bony fusion between the affected vertebrae while the correction is held and supported by spinal instrumentation until healing is complete. All structural curves need to be fused. Depending on the type of instrumentation, a brace may or may not be necessary subsequent to surgery.

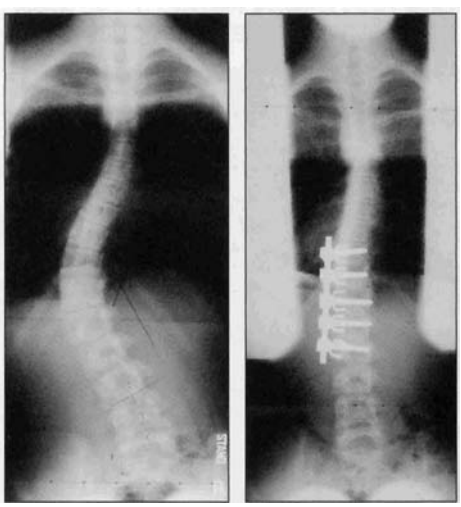
Although much attention has been focused on the various approaches to stabilizing curves in adolescent idiopathic scoliosis, certain principles are applicable to all of them. A minimum number of vertebrae should be fused to achieve a balanced spine. Secondly, the extent of the fusion into the lumbar spine may negatively impact the future occurrence of low back pain in the patient and, therefore, the fusion should attempt to preserve as many free lumbar segments as possible.

In general, either anterior or posterior spinal fusions are employed, based on surgeon preference and curve location. Only in very large curves is it necessary to operate on both sides of the spine. Some approaches clearly make more sense than others. For example, in this author's opinion a thoracolumbar curve fused through the front generally has a greater chance of preserving distal lumbar fusion levels than a similarly efficacious posterior fusion. (Figure 8)

Spinal instrumentation has revolutionized the surgical treatment of progressive curves in adolescent idiopathic scoliosis. Instrumentation serves to correct the curve while holding it stable until bone applied to

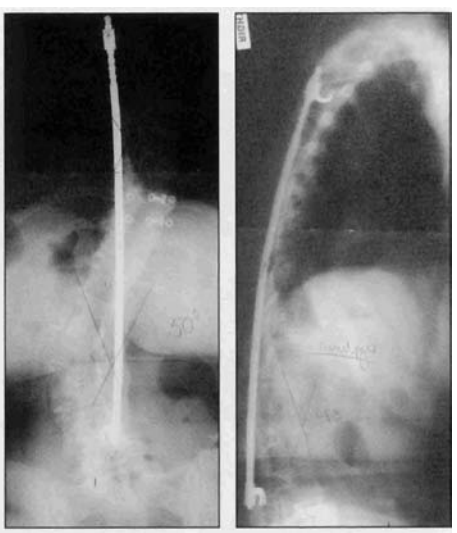
Continued on page 5

Figure 8



Preop thoracolumbar curve treated with anterior spinal instrumentation. Distal lumbar motion segments are preserved with this technique.

Figure 9



Harrington instrumentation produces distraction forces which may control the curve in the frontal plane (left x-ray), induce forward decompensation and flatback in the (sagittal) side view plane.

Adolescent Idiopathic Scoliosis

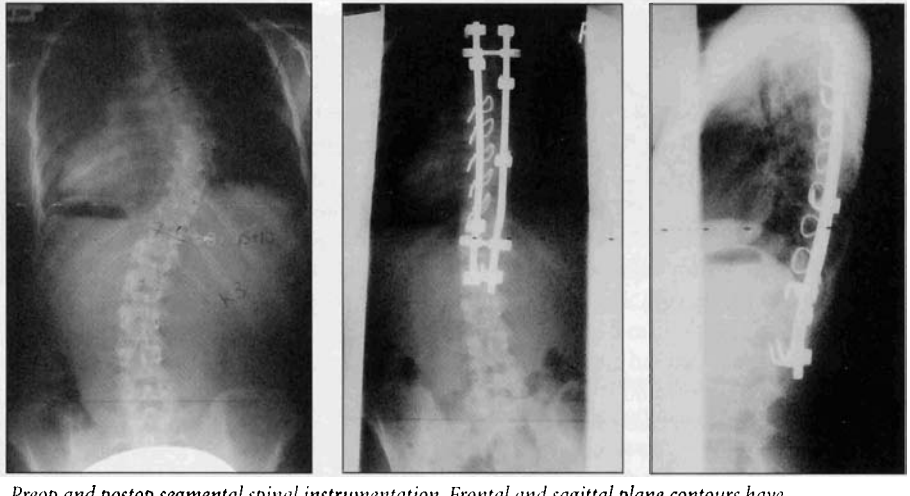
Continued from page 4

the spine heals (the fusion). Once the bony fusion occurs, the instrumentation has no function, although it rarely needs to be removed.

In the past, Harrington rods provided two points of fixation in the spine and therefore needed to be supplemented with a cast to hold the spine. Contemporary instrumentation techniques utilize segmental fixation which provides attachment to the spine at multiple points. Unlike the Harrington rod, segmental fixation techniques allow better correction of the curve in both the frontal and sagittal planes (Figure 9). (See Sagittal Balance of the Spine and Flat Back Deformity article by Robert S. Pashman, M.D. in *Backtalk*, June/July 1996.) New instrumentation techniques have, in many instances, proven to be so rigid that postoperative bracing is sometimes not necessary (Figure 10). The type of instrumentation, approach, and the use of postoperative braces are based on the surgeon's experience.

One exciting, potential advance in the surgical treatment of adolescent idiopathic scoliosis is the use of less invasive techniques, utilizing multiple small incisions for the placement of cameras to view and instruments to correct the scoliosis from the front of the thoracic or thoracolumbar spine. Currently, multi-center studies are under way to establish the safety and efficacy of this type of approach.

Figure 10



Preop and postop segmental spinal instrumentation. Frontal and sagittal plane contours have been controlled.