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## SCOLIOSIS A PRIMER FOR

**Pediatricians  
Orthopedic Surgeons  
Primary Care Physicians  
Allied Health Professionals**

### **Prevalence of Spinal Deformities**

The prevalence of all types of spinal deformity in the general population is generally considered to be approximately 4 to 10%, with a strong predisposition in the idiopathic variety. Spinal deformity or scoliosis can also occur in response to underlying disorders such as neuromuscular abnormalities, congenital bony anomalies, and as a result of spinal trauma or fractures.

The prevalence of scoliosis in males and females is approximately equal, with the presence of small curves being slightly greater among females than among males. However, as curves progress the proportion of females who are affected increases relative to males. Since females are more likely to develop large curves that require clinical treatment, the number of patients undergoing treatment is largely female.

### **Types of Spinal Deformity**

Spinal deformities include scoliosis (lateral curvature of the spine,) kyphosis (sagittal curvature of the spine seen most frequently in the thoracic region,) and thoracic lordosis. There are three categories of scoliosis: idiopathic, congenital, and neuromuscular.

### **Idiopathic Scoliosis**

If no recognizable etiology exists, the lateral curvature of the spine that occurs during a child's growing years is referred to as idiopathic scoliosis. This is the most common form of spinal deformity. The prevalence in the general population of idiopathic scoliosis greater than 10° of curvature is between 1.5 and 3%. If these patients are identified early and evaluated promptly, a large majority can be treated successfully by non-surgical means.

Idiopathic scoliosis is classified by the age of the child when first diagnosed"

- *Infantile Idiopathic Scoliosis* – 0 to 3 years of age
- *Juvenile Idiopathic Scoliosis* – 4 to 9 years of age
- *Adolescent Idiopathic Scoliosis* – 10 years of age to maturity

Adolescent idiopathic scoliosis is a structural curvature of the spine that occurs most frequently before the onset of puberty or menarche. It becomes apparent at this time because the curve progresses more rapidly as the child's rate of growth accelerates.

The types of curves include thoracic, lumbar, thoracolumbar, and double major (thoracic and lumbar.) Each curve has its own long-term prognostic factors.

### **Congenital Scoliosis**

Congenital scoliosis develops when an area of the vertebral body or one of the posterior elements, experiences a failure of segmentation or failure of formation, causing asymmetric growth of the vertebral column resulting in spinal deformity. It typically is a progressive deformity, occurring from an abnormal growth pattern or an anomaly of the spinal column. The majority of these cases do not respond to brace treatment.

## Neuromuscular Scoliosis

When cerebral palsy, muscular dystrophy, or other neuromuscular disorders place asymmetric stress on the developing spinal column, a curve may develop. For patients with some neuromuscular disorders, the incidence can be as high as 90%.

## Miscellaneous Causes of Scoliosis

Among the less common causes of scoliosis are tumors, infection, prior surgery, radiation treatment, neurofibromatosis, and myelomeningocele.

## Natural History and Etiology of Idiopathic Scoliosis

### Curve Progression

A child's spine tends to grow rapidly from birth to age five. The rate of growth decreases between the ages of six and ten. There is a second period of rapid spinal growth coinciding with the growth spurt of the adolescent years. During this time, if scoliosis is present, the curve tends to progress as spinal growth accelerates, as shown below:

**Risk of Curve Progression**  
(Correlated with magnitude of curve and age)

Curve Magnitude	Age 10-12 years	Age 13-15 years	Age > 15 years
<19°	20%	10%	5%
20-29°	50%	40%	10%
30-59°	90%	70%	30%
>60°	100%	90%	70%

The goal of treatment for adolescent idiopathic scoliosis is to restrict curve progression to less than approximately 40°-45° by the time of maturity. Most curves greater than 45° at maturity will continue to progress into adulthood. Prognostic factors for idiopathic scoliosis include the age of onset, the type of curve, the degree of skeletal maturity (RISSER stage) and, in females, the age of menarche.

## Problems Associated with Progressive Scoliosis

Scoliosis should be evaluated for treatment as soon as it becomes evident. Untreated scoliosis can result in several problems:

- *Back Pain* – Differences exist among studies concerning the incidence of back pain in scoliosis patients. It appears that the intensity and frequency of pain are more frequently associated only with particular curve patterns. Degenerative changes in the lumbar spine with increasing age into adulthood in the presence of scoliosis tends to predispose one to back pain.
- *Cardiopulmonary Function* – Scoliosis may reduce pulmonary function, primarily in very severe cases of curves greater than 90-100°, and may be related to right-sided heart failure (cor pulmonale.) Pulmonary dysfunction occurs primarily with thoracic lordosis.
- *Socioeconomic Factors* – Although the date is controversial, there are studies describing a wide range of problems associated with scoliosis, from relatively minor to profound: poor self-image, greater unemployment, and a lower marriage rate.

To help ensure successful treatment leading to a full range of adult lifestyles, early observation and prompt evaluation of children suspected of spinal deformity is vital. When the condition is identified, diagnosed, and treated in its earliest stages, its effects can be mitigated or avoided altogether.

## **Etiology**

While there are many theories concerning the etiology of this disorder, the precise causative factors remain unknown at this time. There is a known familial predisposition to this condition, with the hereditary aspects being multi-factorial. Factors having probable relationships with spinal deformity include environmental conditions, vestibular abnormalities, asymmetric growth, hormonal influences, and abnormal connective tissue development.

## **Spinal Deformity Screening**

The goal of screening is to detect spinal deformity in its earliest stages, when the curves are small enough to respond positively to treatment by simple and successful means. The diagnosis of spinal deformity is based on asymmetry in the standing/erect position. Two techniques are involved in identifying patients; a medical history and a physical screening, including the Adams Forward Bend Test.

## **The Spinal Deformity Medical History**

The parents of a child identified with a spinal deformity should complete a thorough medical history to ascertain the following information:

### Birth history:

- Full-term or premature delivery
- Spontaneous vaginal delivery or Cesarean section
- Any birth related complications

### Development milestones:

- Age when child first sat and walked
- Ability to keep up with other children in recreation and schoolwork
- Satisfactory coordination
- Family history of scoliosis

### Neuromuscular problems:

- Spasticity
- Toe walking
- Scissors gait
- Age of menarche for females
- Physical and skeletal maturity: signs of breast, gonadal, pubic hair development
- Amount of growth during previous 12 months (scoliosis tends to progress most rapidly during periods of rapid growth)

## The Spinal Deformity Physical Screening

Any of the characteristics listed below may be a subtle sign that spinal deformity exists:

*NOTE:* The patient should remove his/her outer clothing and wear only underwear during the examination:

Cutaneous manifestations:

- Hairy patches
- Café-au-lait spots
- Dimpling at base of spine

Decompensation

- Plumb line from C7 to the gluteal cleft

Asymmetry

- Shoulder height
- Rib prominence – anterior or posterior
- Waistline – asymmetry of waist and web space of arms
- Scapular (shoulder blades) prominence noted when patient is standing and is viewed from behind
- Asymmetry of anterior rib cage
- Asymmetry in shoulder height noted when patient is standing and is viewed from behind

## The Adams Forward Bend Test

*Procedure:* The observer stands behind the patient, who extends the arms forward in a diving position (figure A) and initiating a slow forward bend to 90° of lumbar flexion. Any degree of rib asymmetry (figure B) indicates the presence of scoliosis. To quantify the observation, a small ruler or a level known as a scoliometer can be placed along the rib hump. Similarly, the observer notes any lumbar or flank prominence.

The Scoliosis Research Society recommends using this test to screen girls age 10 and 12 and boys at age 13-14. If utilized in school screenings for scoliosis, this short and simple test may be used to screen 50 to 60 children in less than an hour.

## Further Evaluation for Children Exhibiting Curvature

A child exhibiting any spinal curvature in a scoliosis screening should be referred to an appropriate specialist for a thorough examination. This includes obtaining baseline x-rays to help identify the type of deformity and determine if it represents an idiopathic, congenital, or neuromuscular curve. The presence of pain in the child may necessitate considering other possible underlying pathology such as infection or tumor. Assessing the physiological and skeletal maturity of the child helps determine the risk of progression.

## Surgery

Surgical correction of curves is usually undertaken when curves progress beyond approximately 45°. Surgical techniques have advanced significantly over the last ten years. The original Harrington rod fixation has been replaced by segmental spinal fixation, which promotes greater correction and high fusion rates. Post-operative bracing is usually not required. Some curves do not require a posterior procedure and are amenable to an anterior procedure. Adults tend to have very rigid curves and will sometimes require both anterior and posterior procedures.

## **Spinal Deformity Screening**

### **Observation**

All patients identified with spinal deformities require an initial evaluation by a specialist. After baseline x-rays are obtained, follow-up treatment consists of office visits at appropriate intervals for clinical monitoring of curve progression. Serial x-rays are taken and charted against the patient's height and age. To minimize radiation exposure, posterior-to-anterior views are utilized, as well as special high-speed x-ray film to minimize response to developing breast tissue and gonads. The intervals between x-rays depend on the patient's age, growth rate, and curve progression.

### **Bracing**

The purpose of bracing is to limit the rate of curve progression and hopefully avoid the need for surgery. Bracing will not correct scoliosis but it can minimize the probability of curve progression. Each brace is custom fit to maximize comfort and the probability of success. Proper bracing treatment requires diligent fitting. A poorly fit brace promotes poor compliance for brace usage. To facilitate a successful outcome, thorough education, and follow-up of both patients and families is required. Every effort should be made not to over treat children with minor curves or curves whose natural history is historically known to be benign. Braces are generally used when curves greater than 20° undergo significant progression, when a child initially presents with a curve greater than 30° with appropriate growth remaining, and if the curve corrects approximately 50% on bending films.

### **Support Group**

Support groups exist for adult and adolescent scoliosis patients. Patients and families are encouraged to discuss their care and common concerns with patients who are also under treatment.