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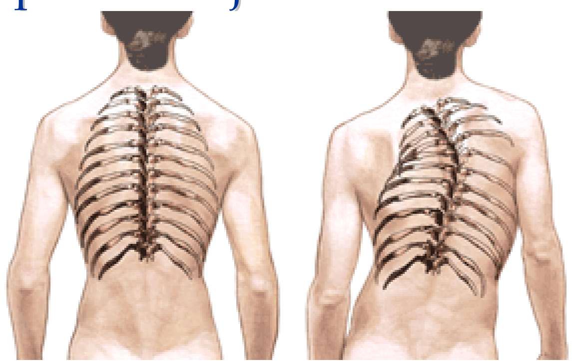

Scoliosis: What Every Chiropractic Orthopedist Needs to Know

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I was fortunate to have been one of the two first orthopedic residents in chiropractic at National University of Health Sciences in the mid 1970s. My true scoliosis training was obtained though at the Twin Cities Scoliosis Center in Minnesota in 1979 during a week long program (Scoliosis and Other Spinal deformities) under the tutelage of Drs. Winter, Bradford, Lonstein and Moe whom formulated the Scoliosis Research Society. Orthotic training was procured at Northwestern Medical School in Chicago in 1978 after battling for admission into the “Lower Extremity and Spinal Orthotics for Physicians and Surgeons” week long course. The advances in scoliosis management have changed significantly since I had formal training and especially in the last decade. The following compilation is offered, to my fellow orthopedists, in an effort to update our didactic training and encourage additional study in scoliosis.

Definition

Scoliosis is defined as a lateral curvature of the spine with torsion of the spine and chest as well as a disturbance of the sagittal profile. [1]

Etiology

The following four forms of scoliosis are the most common.

1. Idiopathic scoliosis (IS) is the most common of all forms of lateral deviation of the spine. By definition, it is a lateral curvature of the spine in an otherwise healthy child, for which a currently recognizable cause has not been found (idiopathic). Idiopathic scoliosis is broken down into four categories based on age:

A. Infantile - children ages 3 and under

B. Juvenile - 3-9 years old

C. Adolescent - 10-18 years old (AIS; most common form of scoliosis, representing approximately 80% of idiopathic scoliosis cases)

D. Adult - after skeletal maturity.

2. Congenital scoliosis is the result of osseous malformations of the spine. The process of formation of the spine is extremely complex. The vertebral formation process result in either a failure of formation of part of a vertebra (hemivertebra), failure of segmentation of a vertebra (two vertebra stuck together on one side or a unilateral bar), or some combination of the two. The result is essentially a growth disturbance of the spine that produces a curvature. No two cases of congenital scolioisis are the same, and each pattern requires careful assessment to determine the risk that a serious curve will occur and need treatment.

3. Neuromuscular scoliosis refers to curvature of the spine associated with a neurological condition like cerebral palsy or spina bifida. There are many other forms of neuromuscular scoliosis as well. Each form has its own unique natural history and risks for causing greater problems.

4. A difference in the length of the legs is quite common. Most patients can tolerate up to 1/2" of difference with very few side effects. The problem with a limb length difference is that it will cause a small scoliosis. These curves rarely get worse unless the limb length difference gets worse.

Less common but better defined etiologies of the disorder include scoliosis in neurofibromatosis, and mesenchymal disorders like Marfan's syndrome [2].

Epidemiology

Scoliosis affects 2% of women (growth spurt) and 0.5% of men in the general population. The prevalence of adolescent idiopathic scoliosis (AIS), when defined as a curvature greater than 10° according to Cobb, is 2–3%. The prevalence of curvatures greater than 20° is between 0.3 and 0.5%, while curvatures greater than 40° Cobb are found in less than 0.1% of the population. All etiologies of scoliosis other than AIS are encountered more rarely.[3]

Symptoms

Symptoms of scoliosis may include back pain, leg length discrepancy, an abnormal gait, and uneven hips. Patients with IS may have one shoulder higher than the other, a "prominent" shoulder blade and thoracic cage (razorback) when bending forward, head is not centered directly above the pelvis, changes in look or texture of skin overlying the spine (dimples, hairy patches, color changes) and visible curvature of the spine to one side. Often the first indication of AIS is when an adolescent or parent notices that clothes no longer fit correctly (for example, the legs of pants may seem uneven).

Most schools check children in the fifth or sixth grade. This should be a routine office protocol in the chiropractic orthopedist's office for children within this age group. The standard exam that is often used by pediatricians and in initial school screenings is called the Forward Bend Test (Adam's position). For this test, the patient is asked to lean forward with his or her feet together, bend 90 degrees at the waist with the arms hanging freely and the palm and finger tips together (fingers tips equal) . The examiner can then easily view (anteriorly and posteriorly) from these angles any asymmetry of the trunk or any abnormal spinal curvatures. It should be noted that this is a simple screening test that can detect potential problems, but cannot determine accurately the exact severity of the deformity.

It is important to provide IS management because progressive scoliosis, left untreated, can result in significant deformity. The deformity can cause marked psychological distress and physical disability, especially among adolescent patients. Additionally, the deformity can have serious physical consequences.
As the vertebrae rotate, the thoracic cage is affected, which in turn can cause heart and lung compromise (i.e. shortness of breath). When progressive scoliosis affects the lumbar spine the pain can be debilitating.

History

A focused history may include the following questions:

At what age was the spinal deformity first noted?
This information is important in determining the prognosis and severity of the scoliosis.

Who first noted the problem?
Parent? Teacher? Another doctor?

What is the patient's prenatal history?
Did the child experience any problems while still in his or her mother's womb? Was there anything unusual about the pregnancy?

Did the patient meet normal developmental milestones?
Walking? Talking?

Is there a family history of scoliosis or other spinal problems?

Are there other family members with scoliosis? If so, how did the scoliosis progress and what treatment was provided? If so, this patient is 20% more likely to develop scoliosis if someone in the family also has scoliosis.

Is the patient experiencing any back pain?
Generally speaking, scoliosis in children and adolescents is not painful. If pain exists, further tests should be conducted for tumors, herniated discs or other abnormalities.

In addition, the patient's age (record year and month), onset of puberty, and age at which a young woman has her first period, will assist in determining the number of years that remain before the child reaches skeletal maturity.

Physical Evaluation

The physical evaluation provides the chiropractic orthopedist with a "baseline" from which future curve progression can be measured. A typical examination may include the following:

Examination	Description
Inspection	The chiropractic orthopedist observes for asymmetry of the trunk such as uneven shoulders or hips, razorback (humpback), or listing to one side.
Cardiopulmonary	Testing of the function of the heart and lungs (vital capacity).
Forward Bending Test	The patient bends forward at the waist, with arms extended forward (see symptoms session). The chiropractic orthopedist looks for asymmetric thoracic prominence (such as the scapula or thoracic cage), or a lumbar prominence.
Leg length	Both legs are measured (from bony to bony prominence) with a tape measure and recorded to determine if they are of equal length.
Plumb line	A plumb line is "dropped" from the C7 spinous process and is allowed to hang below the buttocks. In scoliosis the line does not hang between the buttocks.
Range of motion	The chiropractic orthopedist measures the patient's ability to perform flexion, extension, bending, and rotation movements.
Palpation	The chiropractic orthopedist "feels" for abnormalities. Perhaps the ribs are more prominent on one side.
Neurological assessment	In addition to testing reflexes, the chiropractic orthopedist will want to know if the patient's symptoms include pain, numbness, tingling, extremity weakness or sensation, muscle spasm, and bowel/bladder changes.

Scoliosis specific diagnostics include the following:

Diagnostic Test	Description
Scoliometer	A scoliometer is used to measure shoulder height and rib hump (while the patient is bent at the waist).
Radiographs	X-rays should include an upright lateral view of the spine and lateral bending (flexibility of the curve). PA hand and wrist (bone age determination).

Cobb Angle Measurement	Calculate the angle of the curve(s). Record end points for serial measurements.
Risser Sign	Provides information about skeletal maturation. The Risser Sign looks at the iliac crest growth plate. The crest fuses with the pelvis at maturity.
Nash-Moe	A technique used to measure vertebral rotation. The rotation of the vertebral pedicle is measured by dividing the vertebral body into segments.
Lenke Classification	One of two classification schemes: King or Lenke. The Lenke Classification System (used mostly) helps surgeons to determine what levels of the spine to fuse and instrument.

Classifications

The anatomical level of the deformity has received attention from clinicians as a basis for scoliosis classification. The level of the apex vertebra (i.e., thoracic, thoracolumbar, lumbar or double major) forms a simple basis for description. In 1983, King and colleagues[4] classified different curvature patterns by the extent of spinal fusion required; however, recent articles have suggested that these classifications lack reliability. A new description has been developed by Lenke and colleagues[5]. This approach calls for clinical assessment of scoliosis and kyphosis with respect to sagittal profile and curvature components. Systems designed for conservative management include the classifications by Lehnert-Schroth[6] (functional three-curve and functional four-curve scoliosis) and by Rigo [7] (orthotic construction and application).

Treatment Considerations

Once it has been determined that a patient has scoliosis, there are several things to take into consideration when discussing treatment options:

1. Spinal maturity – is the patient's spine still growing and changing?

2. Degree and extent of curvature – how severe is the curve and how does it affect the patient's lifestyle?

3. Location of curve – according to the Scoliosis Research Society, thoracic curves are more likely to progress than thoracolumbar or lumbar curves.

4. Potential for progression – patients who have large curves prior to their adolescent growth spurts are more likely to experience curve progression.

Conservative Management Goals

The primary goal of scoliosis management is to stop curvature progression.[8] Improvement of pulmonary function (vital capacity) and treatment of pain are also of major importance. The first of three modes of conservative scoliosis management is based on physical medicine, including Méthode Lyonaise,[9] Side-Shift,[10] Dobosiewicz,[11] Schroth and others.[6] Although discussed from contrasting viewpoints in the international literature, there is some evidence for the effectiveness of scoliosis treatment by physical therapy procedures alone.[12]

It has to be emphasized that (1) physical therapy procedures for scoliosis is not just general exercises but rather one of the cited methods designed to address the particular nuances of spinal deformity, and (2) application of such methods requires therapists and clinicians specifically trained in those scoliosis specific conservative intervention methods.

The second mode of conservative management is scoliosis intensive rehabilitation (SIR), which appears to be effective with respect to many signs and symptoms of scoliosis and with respect to impeding curvature progression.[13]

The third mode of conservative management is brace treatment, which has been found to be effective in preventing curvature progression and thus in altering the natural history of IS.[14,15] It appears that brace treatment may reduce the prevalence of surgery,[16] restore the sagittal profile[17] and influence vertebral rotation.[18] There are also indications that the end result of brace treatment can be predicted.[19]

Electrostimulation has been used in some cases of mild scoliosis, but most studies have now reported that it does no better than observation in stopping progression.

Biofeedback has been investigated on the premise that being given a signal to improve one's posture when slumping may reduce spinal deformities in some cases. (Some experts believe that orthotics work only because the young patients self-correct their curves by retraining their posture to avoid the discomfort of the brace.)

There are numerous case reports that manipulation (chiropractic) of the spine may help stop progression of mild curves. However, no rigorous studies have been done to prove this. One small 2001 study reported no benefits from chiropractic manipulation in girls with spinal curves of less than 20 degrees. (About 80% of such curves will not progress significantly without any treatment.)

Observation

Observation is appropriate for small curves, curves that are at low risk of progression, and those with a natural history that is favorable at the completion of growth. These decisions are based on the expected natural history of a given curve. For example, if a child is diagnosed with a curve of 25 to 40 degrees and has completed growth (i.e., boys older than 18, girls older than 17), then observation is appropriate. Statistically, these curves are at low risk of progression and are not likely to cause problems in adulthood. Follow-up x-ray once per year for several years would then confirm that the curve is not progressing after completion of growth. As an adult, an x-ray every five years, or if there are symptoms, is sufficient.

Orthotics

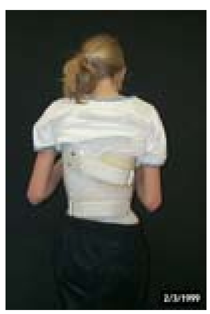
Orthotics (braces) are used to prevent further spinal deformity in children with curve magnitudes within the range of 25 to 40 degrees. If these children already have curvatures of these magnitudes and still have a substantial amount of skeletal growth left, then orthotic presxcription is a viable option. It is important to note, however, that the intent of bracing is to prevent further deformity; it is not to correct the existing curvature or to make the curve disappear.

There are several different types of orthotics prescribed for adolescents with scoliosis. The Milwaukee Brace (CTLSO) is quite common and is used particularly for high thoracic curves. The orthotic extends from the neck to the pelvis and consists of a plastic pelvic girdle and a neck ring connected by metal bars in the front and the back of the brace. Pressure pads push against the patient's curve, causing irritation forcing the patient to withdraw away, trying to prevent further deformity. The metal bars help extend the length of the torso, and the neck ring keeps the head centered over the pelvis.

Other types of orthotics include the TLSO (thoracic-lumbar-sacral orthosis). These orthotics are also called "low-profile" or "underarm" braces. They are not as large or bulky as the Milwaukee Brace, as the TLSO use plastic materials shaped to fit the patient's body.

The Boston Brace covers from below the breast to the beginning of the pelvic area in the front and from below the scapulae to the tail bone in the back. The brace's design forces the lumbar area to flex, which pushes in the abdomen and flattens the posterior lumbar curve. Pressure pads are also placed strategically along the curve.

Another orthotic option is the Charleston Bending Brace. This orthotic is molded to conform to the patient's body while he or she is bent against the curve (towards the convex portion of the curve). This orthotic is worn only at night while the patient is sleeping, thus "overcorrecting" the curve for eight hours per day.



Although studies support the use of orthotics in adolescents with curves at risk of progression, specialists disagree about what the appropriate indications for orthotics are, what the best type of orthotic is and how long the orthotic should be worn. Nonetheless, according to several large orthotic studies, using an orthotic is successful in stopping curve progression in about 80 percent of children with scoliosis.

Whereas a short period of adjustment is normal for juveniles and adolescents wearing orthotics for scoliosis, many studies show that these young people live very normal lives. They can participate in athletic functions and are able to easily interact socially, regardless of which type of orthotic they wear.

Systematic application of conservative treatment with respect to Cobb’s angle and maturity

Guidelines for conservative intervention are based on current information regarding the risk for significant curvature progression in a given period of time. Each case has its own natural history and must be considered on an individual basis, in the context of a thorough scoliosis specific clinical evaluation and patient history.[20] Estimation of risk for progression is based on small (n < 1000) epidemiological surveys in which children were diagnosed with scoliosis, and radiographed periodically to quantify changes in curvature magnitude over time.[21-43] Such surveys support the premise that, among populations of children with a diagnosis of idiopathic scoliosis, risk for progression is highly correlated with potential for growth over the period of observation. In boys, prognosis for progression is more favorable, with relatively fewer individuals having curves that progress to >40 degrees.

For most scoliosis guidelines, prognostic risk estimation is based on the calculation of Lonstein and Carlson.[32] This calculation is based on curvature progression observed among 727 patients (575 female, 152 male) diagnosed between 1974–1979 in the state of Minnesota school screening programs, and followed until they reached skeletal maturity.

I. Children (no signs of maturity)[20]

A. < 15° Cobb: Observation (6-12 month intervals)

B. Cobb angle 15-20°: Outpatient physical medicine procedures with treatment-free intervals (6-12 weeks without physical therapy for those patients at that time have low risk for curve progression). In this context, “Outpatient physical medicine” is defined here as exercise sessions initiated in the office, plus a home exercise program (two to seven sessions per week according to the physical therapy method being applied). After three months, one exercise session every two weeks may be sufficient.

C. Cobb angle 20-25°: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available. SIR includes a 3- to 5- week intensive program (4-6 hour training sessions per day) for patients with poor prognosis (orthotic indication, adult with Cobb angle of > 40°, presence of chronic pain).

D. > 25° Cobb: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available and orthotic wear (part-time, 12-16 hours)

Case example

This is a 13-year-old female who presented with a 30 degree lumbar scoliosis. She is skeletally immature, Risser 0, and therefore at significant risk of progression with growth. She was placed in an orthotic and demonstrates an in-orthotic correction of ~70 percent. Initial orthotic correction should be 50 percent or greater. Outpatient physical medicine and scoliosis intensive rehabilitation (SIR) was initiated.

The following section is based on progression risk rather than on Cobb angle measurement because of the changing risk profiles for deformity as the skeleton matures. The estimation of the prognostic risk to be used during pubertal growth spurt is based on Lonstein and Carlson.[32]

II. Children and adolescents, Risser 0–3, first signs of maturation, less than 98% of mature height

A. Progression risk less than 40%: Observation (3-month intervals)

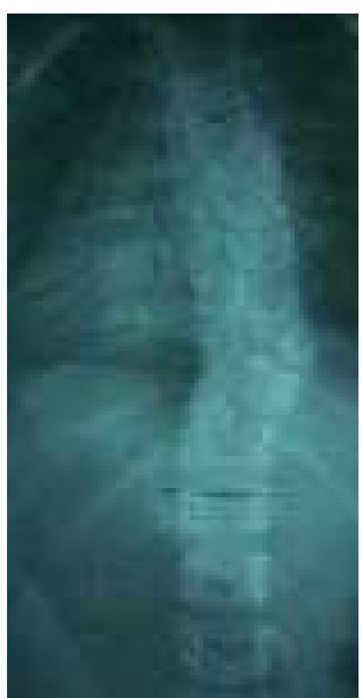
B. Progression risk 40%: Outpatient physical medicine

C. Progression risk 50%: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available

D. Progression risk 60%: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available + part-time orthotic indication (16 – 23 hours [low risk]).

E. Progression risk 80%: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available + full-time orthotic indication (23 hours [high risk])

Case example



This 14-year-old female presented from a school screening with a 14-degree right thoracic scoliosis. She had begun menstrual periods over a year ago, attained 82% in height and was Risser 3 in terms of skeletal maturity. The recommendation was observation, since the likelihood that her curve would progress was low.

III. Children and adolescents presenting with Risser 4 (more than 98% of mature height)

A. < 20° according to Cobb: Observation (6-12 Months intervals)

B. 20 – 25° according to Cobb: Outpatient physical medicine

C. > 25° according to Cobb: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available

D. > 35° according to Cobb: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available + orthotic (part time, about 16 hours are sufficient)

E. For orthotic weaning: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available + orthotic with reduced wearing time.

IV. First presentation with Risser 4–5 (more than 99.5% of mature height before growth is completed)

A. > 25° Cobb: Outpatient physical medicine

B. > 30° Cobb: Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available

V. Adults with Cobb angles > 30°

Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR), where available

VI. Adolescents and adults with scoliosis (of any degree) and chronic pain

Outpatient physical medicine, scoliosis intensive rehabilitation program (SIR) where available, with a special pain program (multimodal pain concept/behavioral + physical concept), orthotic treatment when a positive effect has been proven.[44]

The prognostic estimation and corresponding indications for treatment apply to the most prevalent condition, idiopathic scoliosis. In other types of scoliosis a similar procedure can be applied. Exceptions include those cases where the prognosis is clearly worse, for example in neuromuscular scoliosis where a wheelchair is necessary (early surgery for maintaining sitting capability may be required). Other reasons for the consideration of alternative treatments include:

- Severe decompensation

- Severe sagittal deviations with structural lumbar kyphosis (flatback)

- Lumbar, thoracolumbar and caudal component of double curvatures with a disproportionate rotation compared to the Cobb angle and with high risk for future instability at the caudal junctional zone

- Severe contractures and muscles shortening

- Reduced mobility of the spine especially in the sagittal plane

- Others to be individually considered [45]

Orthopedic Pearls

Predicting Curvature Progression - children and adolescents

Once a mild curve has been observed, the next step is more difficult: predicting whether the curve will progress into a more serious condition. Although as many as three in every 100 adolescents have a condition serious enough to need observation, progression is highly variable and individual. In a study of patients whose curves did progress after diagnosis, 34% progressed more than 10 degrees, 18% progressed more than 20 degrees, and 8% progressed more than 30 degrees. There are no definite risk factors for curve progression that help chiropractic orthopedists predict with any certainty which patients will need aggressive treatment. Some evidence suggests the following factors may help determine patients at lower or higher risk:

1. Being female, particularly if taller than average.

2. Being younger at the onset of scoliosis.

3. Having a greater angle of curvature. For example, at 20 degrees, only about 20% of curves progress. Young people diagnosed with a 30-degree curve, however, have a risk for progression of 60%; with a curve of 50 degrees, the risk is 90%.

4. Curvatures caused by congenital scoliosis. These may progress rapidly.

5. Treatment with growth hormone. (Studies are mixed on whether this treatment poses any significant risk, although strict monitoring is still essential in young patients being given growth hormone.)

Curvatures may be *less* likely to progress in girls whose scoliosis is located in the lumbar region and whose spine is *out of* balance by more than an inch. Height also comes into play. For example, a shorter-than-average girl of 14 with lumbar scoliosis of 25 to 35 degrees and whose spine is imbalanced by more than an inch would have almost no risk of progression. The same degree of curvature in the thoracic region of a tall 10-year-old girl whose spine was in balance, however, would almost certainly progress.

Predicting Curvature Progression - Adults

In rare cases, scoliosis may develop in adults who may have had unrecognized or untreated scoliosis in their youth.

1. Curvatures under 30 degrees almost never progress.

2. Predicting progression at curves around 40 degrees is not clear.

3. Curvatures over 50 degrees are at great risk for progression. The curve may continue to progress (one degree per year) throughout adulthood.

Osteoporosis, a serious problem in many older adults, is not a risk factor for new-onset scoliosis, but it can cause existing mild curvatures to progress. In most cases, however, it is not known why curves progress in adults.

Decision to Treat

Whether scoliosis is treated immediately or simply monitored is not an easy decision, however. The percentage of cases that will progress more than 5 degrees can be as low as 5% in certain cases or as high as 50% to 90%, depending on the severity of the curve or other predisposing factors:

Age

In general, the older the child the less likely the curve will progress. Scoliosis in a child under 10, for example, is more likely to progress than scoliosis in an adolescent. Experts estimate that curves less than 19 degrees will progress 10% in girls between ages 13 and 15 years and 4% in children older than 15. (In some rare, severe cases, a curve may worsen even after a child has received treatment and stopped growing because of the weight of the body pressing against the abnormal curve.)

Gender

Girls have a higher risk for progression than boys.

Location of the Curvature

Thoracic curves are more likely to progress than thoracolumbar curves or lumbar curves.

Severity of the Curvature

The higher the degree of curvature, the more likely the chance of progression and the more likely the lungs will be affected. Some experts argue that the degree of the curve alone may not identify patients with moderate and severe scoliosis who are at greatest risk for complications and therefore need treatment. For example, spinal flexibility and the extent of asymmetry between the ribs and the vertebrae may be more important than the curve degree in predicting severity in this group.

Presence of Other Risk Factors or Health Condition

Children in poor health may suffer more from stressful scoliosis treatments than other children. On the other hand, children who have existing conditions or risk factors that predispose to lung and heart problems may warrant immediate, aggressive treatment. For example, a young man of 18 who has a curvature of 30 degrees may require no treatment because his growth has probably almost stopped and his gender puts him at lower risk. A young girl of 10, however, with the same curvature requires immediate treatment.

Orthotics

Although orthotics are recommended for moderate curves and surgery for more severe ones, the choice may not be so straightforward in certain cases. Orthotics tend to be used in children with curvatures between 25 and 40 degrees who still will be growing significantly.

Surgery

Surgery is suggested for patients with curvatures over 50 degrees, for untreated patients, or for patients in whom orthotics have failed. In adults, scoliosis rarely progresses beyond 40 degrees, but surgery may be required if the patient is in a great deal of pain or if the condition is causing neurologic problems.

Heel Lifts

When secondary scoliosis is caused by differences in leg lengths, adding lifts to the heels or heel/sole combination may decrease a mild curvature. In one study it decreased by an average of 5.3 to 7.5 degrees. (All curvatures were less than 20 degrees.) Patients with the greatest curvature experienced some muscle pain, fatigue, and even nausea during the first few days they were using the lifts, but these symptoms eased within 10 days.

Conclusion

All chiropractic orthopedists were provided didactic training relating to spinal curvatures within their orthopedic diplomate program. This compilation demonstrates the need to upgrade our clinical acumen and incorporate evidence-influenced protocols into our practices. What I learned from the Research Scoliosis Society gurus 28 years ago, certainly is now antiquated and does not reflect current decision-making processes based on recent literature. Evaluation and management errors relating to idiopathic scoliosis can cause significant physical deformity, debilitating pain, and psychological distress to patients, parents and providers (legally). Thus, it is essential to be familiar with current evidence and make specific changes to our assessment protocols.

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The following literature review section includes abstract that should be read and studied by the chiropractic orthopedist as an upgrading of clinical knowledge and skills in this clinical entity. The abstracts are broken down into three categories; deformity, diagnostics and treatment.

Literature Review

Deformity

Surgeon Reliability in Rating Physical Deformity in Adolescent Idiopathic Scoliosis.

Spine. 32(3):363-367, February 1, 2007.
*Donaldson, Sandra BA *; Hedden, Douglas MD, FRCSC [S]; Stephens, Derek MSc +; Alman, Benjamin MD, FRCSC *; Howard, Andrew MD, MSc, FRCSC *+; Narayanan, Unni MBBS, FRCSC *+; Wright, James G. MD, MPH, FRCSC *+++*

Abstract:
Study Design. Cross sectional survey.

Objectives. To compare pediatric spine surgeons' relative rankings of the importance of surgical considerations, and their reliability of ratings of the physical deformity of patients with adolescent idiopathic scoliosis (AIS).

Summary of Background Data. Adolescents' appearance is a factor in surgical decision-making. Although the reliability of the Cobb angle has been extensively studied, less attention has been directed toward the reliability of surgeons' assessment of physical appearance.

Methods. Five surgeons ranked the relative importance of 13 surgical considerations. While viewing clinical photographs of 40 patients, surgeons rated the following: shoulder blades, shoulders, waist asymmetry, and the "overall appearance" of the back.

Results. "Severity of deformity" was consistently ranked the most important surgical consideration. Surgeons, however, varied widely in their reliability of their ratings of physical appearance: shoulder blades ([kappa] = 0.34), shoulders ([kappa] = 0.22), waist ([kappa] = 0.24), and overall appearance ([kappa] = 0.40).

Conclusion. Because patients' physical appearance is an important element of surgical decision-making, differences among surgeons could be contributing to inconsistent recommendations.

Editorial comment by Warren Jahn: The importance of using reliable protocols and serial measurements are highlighted in this article. Using statistical trends should be the mainstay for the chiropractic orthopedist when determining treatment options and not physical appearance.

A Clinical Impact Classification of Scoliosis in the Adult.

Spine. 31(18):2109-2114, August 15, 2006.
*Schwab, Frank MD *; Farcy, Jean-Pierre MD *; Bridwell, Keith MD +; Berven, Sigurd MD ++; Glassman, Steven MD [S]; Harrast, John MS [//]; Horton, William MD [P]*

Abstract:
Study Design. Multicenter, prospective, consecutive clinical series.

Objectives. To establish and validate classification of scoliosis in the adult.

Summary of Background Data. Studies of adult scoliosis reveal the impact of radiographic parameters on self-assessed function: lumbar lordosis and frontal plane obliquity of lumbar vertebrae, not Cobb angle, correlate with pain scores. Deformity apex and intervertebral subluxations correlate with disability.

Methods. A total of 947 adults with spinal deformity had radiographic analysis: frontal Cobb angle, deformity apex, lumbar lordosis, and intervertebral subluxation. Health assessment included Oswestry Disability Index and Scoliosis Research Society instrument. Deformity apex, lordosis (T12-S1), and intervertebral subluxation were used to classify patients. Outcomes measures and surgical rates were evaluated.

Results. Mean maximal coronal Cobb was 46[degrees] and lumbar lordosis 46[degrees]. Mean maximal intervertebral subluxation (frontal plane) was 4.2 mm (sagittal plane, 1.2 mm). In thoracolumbar/lumbar deformities, the loss of lordosis/higher subluxation was associated with lower Scoliosis Research Society pain/function and higher Oswestry Disability Index scores. Across the study group, lower apex combined with lower lordosis led to higher disability. Higher surgical rates with decreasing lumbar lordosis and higher intervertebral subluxation were detected.

Conclusions. A clinical impact classification has been established based on radiographic markers of disability. The classification has shown correlation with self-reported disability as well as rates of operative treatment.

Editorial comment by Warren Jahn: The chiropractic orthopedist should be fully cognizant of the perceptions of patients with scoliosis. The utilization of outcome assessment tools (OATS), especially with scoliotic curvatures with a lower apex combined with lower lordosis, is recommended since disability appears to be higher is this classification group.

Natural History of Progressive Adult Scoliosis.

Spine. 32(11):1227-1234, May 15, 2007.
*Marty-Poumarat, Catherine MD *; Scattin, Luciana MD +; Marpeau, Michele MD *; Garreau de Loubresse, Christian MD ++; Aegerter, Philippe MD, PhD [S]*

Abstract:
Study Design. A retrospective analysis of the progression of adult scoliosis.

Objective. To establish an individual prognosis.

Summary of Background Data. Most studies have investigated the adolescent scoliosis after skeletal maturity, but the results are discordant.

Methods. Two senior physicians measured all the radiographs of 51 adults who had a progressive scoliosis. The mean delay between the first and last radiograph was 27 years. For each patient, a diagram was established with the Cobb angle on the y-axis and the corresponding age on the x-axis. We noted the age and Cobb angle of the first radiograph showing a rotatory subluxation and the age of menopause. We used linear regression and the analysis of variance test.

Results. The mean number of radiographs per patient was 6. The linear test was significant in 46 patients. Two main types exist. Type A is an adolescent scoliosis that continues to progress after skeletal maturity, whereas type B appears or progresses late. There were 13 type A and 20 type B of which 11 progressed around menopause. Significant differences were noted between groups A and B regarding loss of body height (group A, 5 cm and group B, 9.5 cm; $P < 0.001$), rate of progression in lumbar single and thoracolumbar single curves (group A, 0.82[degrees]/y and group B, 1.64[degrees]/y; $P < 0.004$), Cobb first radiograph (group A, 37[degrees] and group B, 20[degrees]; $P < 0.0001$), age rotatory subluxation (group A, 42 years and group B, 56 years; $P < 0.0001$), and Cobb rotatory subluxation (group A, 52[degrees] and group B, 29[degrees]; $P < 0.0001$).

Conclusions. The originality of our study is the diagram. We demonstrated that the rate of progression was linear, and it can be used to establish an individual prognosis. The diagrams visualized 2 main distinct types. There was a significantly faster rate of progression in type B. In type A, rotary subluxation occurs during

progression of the curvature. In type B, it seems to be the initial event. Menopause is a period of deterioration in type B.

Editorial comment by Warren Jahn: The chiropractic orthopedist should utilize the diagram within this article to assist in progression prediction after skeletal maturity in the adult with scoliosis.

Diagnostics

Comparison of Cobb Angles in Idiopathic Scoliosis on Standing Radiographs and Supine Axially Loaded MRI.

Spine. 31(26):3039-3044, December 15, 2006.
*Wessberg, Per MD *; Danielson, Barbro I. MD, PhD +; Willen, Jan MD, PhD **

Abstract:
Study Design. Prospective, patient controlled.

Objective. To compare Cobb angles in idiopathic scoliosis between standing radiographs and a nonradiographic procedure.

Summary of Background Data. Repeated radiographic examinations at young age may increase the risk for breast cancer in adulthood. MRI images the spine satisfactorily but is cumbersome in standing. A harness supplying axial load to a lying subject simulates the standing radiograph appearance of the lumbar spine.

Methods. Thirty patients with idiopathic scoliosis greater than 20[degrees] performed a routine posteroanterior and lateral standing thoracolumbar spine radiograph and an MRI in supine position without and with axial loading.

Results. Mean Cobb angle for the major curve was 31[degrees] on standing radiographs, 23[degrees] on nonloaded supine MRI, and 31[degrees] on supine loaded MRI. Axially loaded, compared with nonloaded, MRI increased the Cobb angle by 8[degrees]. The mean difference between standing radiograph and supine axially loaded MRI was 0[degrees], with an intermethodologic variation(s) of 3.4[degrees]. Radiographic and MRI (axially loaded) Cobb angles correlated positively (r = 0.78).

Conclusions. Axial loading on supine MRI produces coronal Cobb angles similar to standing radiographs. This is a way to acquire reliable Cobb angles without radiation in the monitoring of idiopathic scoliosis.

Editorial comments by Warren Jahn: A chiropractic orthopedist realizes that serial x-rays to check for acceleration of curves adds an inherent risk to the patient. Here is a possible alternative (access to axial loaded MRI facilities is an issue) to reduce radiation exposure and cancer risk.

Comparison of Cobb Angle Measurement of Scoliosis Radiographs With Preselected End Vertebrae: Traditional Versus Digital Acquisition

Wills, Brian P. D. MD*; Auerbach, Joshua D. MD†; Zhu, Xiaowei MS‡; Caird, Michelle S. MD§; Horn, B

David MD†[//]; Flynn, John M. MD†[//]; Drummond, Denis S. MD†[//]; Dormans, John P. MD†[//]; Ecker, Malcolm L. MD†[//]

>From the *Department of Orthopedics and Rehabilitation, University of Wisconsin, Madison, WI; †Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, PA; ‡Department of Radiology and [//]Division of Orthopaedic Surgery, Children's Hospital of Philadelphia, Philadelphia, PA; and §Department of Orthopaedic Surgery, University of Michigan, Ann Arbor, MI.

Abstract

Study Design. Prospective study.

Objective. To compare variability in Cobb angle between digitally and traditionally acquired scoliosis radiographs.

Summary of Background Data. Previous studies have shown that the 95% confidence interval for Cobb angle can vary from 2.6° to 8.8°. No study directly comparing Cobb angles measured from traditional and digitally acquired radiographs has been reported.

Methods. A spine model simulating 25 single right thoracic curves (range, 20°–60°) was imaged using traditional and digital techniques. Traditional films and miniaturized printed digital films were each measured twice manually. Digital films were also measured twice using computer imaging software.

Results. Overall mean angle and (95% confidence interval) were 41.7° (39.1°–44.3°) for traditional, 40.6° (37.4°–43.8°) for digital, and 39.7° (36.3°–43.1°) for computer measurements. Overall correlation was 0.994 for traditional and digital, 0.987 for traditional and computer, and 0.993 for digital and computer. Fixed effect model analysis demonstrated that, although a statistically significant difference existed between the 3 methods of measuring the Cobb angle ($P < 0.0001$), the difference between methods was less than 2°.

Conclusions. Any of the 3 evaluated methods of measurement can be used to measure Cobb angles. Additionally, the methods can be used interchangeably.

Editorial comment by Warren Jahn: The authors cite several studies concluding that the 95% confidence interval for Cobb measurement is 2.6-8.8 degrees. They conclude that, on average, the error is actually about 5 degrees.

Based on this prospective study, the chiropractic orthopedist must be cognizant that in a case of a "16 degree curve", using 5 degrees of variation (95% CI), the actual curve could range between 11 degrees and 21 degrees, with chosen end-plate landmarks being the variable. With this error range, the importance of left and right recumbent bending and PA hand views must be emphasized to determine curve flexibility and bone age.

Reliability of Radiographic Parameters in Neuromuscular Scoliosis.

Spine. 32(6):691-695, March 15, 2007.
*Gupta, Munish C. MD *; Wijesekera, Shirvinda MD [//]; Sossan, Allen DO +; Martin, Linda MD +; Vogel,*

Lawrence C. MD [S]; Boakes, Jennette L. MD ++; Lerman, Joel A. MD ++; McDonald, Craig M. MD ++; Betz, Randall R. MD +

Abstract:
Study Design. Retrospective review of radiographic data.

Objectives. This study sought to define interoberserver and intraobserver variability to further delineate reliable means by which radiographs of patients with neuromuscular scoliosis can be examined.

Summary of Background Data. Previous studies analyzed the use of Cobb angles in the measurement of idiopathic and congenital scoliosis, but no study until now describes a critical analysis of measurement in evaluating neuromuscular scoliosis.

Methods. Forty-eight patients with neuromuscular scoliosis radiographs were reviewed. These were evaluated for Cobb angle, end vertebrae selection, Ferguson angle, apex of the curve, C7 balance, pelvic obliquity, Risser sign, status of the triradiate cartilage, kyphosis Cobb angle, endplate selection for kyphosis, and kyphotic index. Interclass and intraclass variability was examined with statistical analysis.

Results. Cobb angle had an intraobserver variability was 5.7[degrees] and the interobserver variability was 14.8[degrees]. The intraobserver and interobserver variability for Ferguson angle was 6.8[degrees] and 20.6[degrees], respectively. The kyphotic Cobb angle intraobserver variability was found to be 17.4[degrees], and the interobserver variability was 24.01[degrees].

Conclusions. Neuromuscular scoliosis radiographs can be reliably analyzed with the use of Cobb angle. Other forms of analysis, such as Ferguson angle, are not as reliable. Pelvic obliquity should be measured from the horizontal, as other methods are not as reliable. Kyphosis is best evaluated with the use of the kyphotic Cobb angle. Finally, it is felt that a separate anteroposterior pelvis radiograph should be used to assess skeletal maturity, as scoliosis films often truncate the vital anatomy necessary to determine skeletal maturity.

Editorial comment by Warren Jahn: The chiropractic orthopedist should continue to utilize the Cobb method when measuring the four most common forms of idiopathic scoliosis. This article suggests that an AP pelvis view be taken to evaluate the Risser classification for skeletal maturity. This in conjunction with a PA wrist and hand (left) film should provide the most reliable information to predict progression.

Factors of Thoracic Cage Deformity That Affect Pulmonary Function in Adolescent Idiopathic Thoracic Scoliosis.

Diagnostics

Spine. 32(1):106-112, January 1, 2007.
*Takahashi, Seiken MD *; Suzuki, Nobumasa MD, PhD +; Asazuma, Takashi MD, PhD ++; Kono, Katsuki MD *; Ono, Toshiaki MD, PhD *; Toyama, Yoshiaki MD, PhD **

Abstract:
Study Design. This clinical study examined the association between pulmonary function and thoracic cage deformities in scoliosis.

Objective. To determine the factors in spinal and thoracic cage deformities that affect pulmonary function in scoliosis.

Summary of Background Data. Pulmonary function in scoliosis has generally been evaluated in terms of lateral spinal curvature. No previous report has evaluated changes in pulmonary function taking into consideration measurements reflecting not only spinal curvature but also thoracic cage deformities, although scoliosis is a three-dimensional deformity.

Methods. A total of 109 patients (mean age, 14.2 years) with adolescent idiopathic right thoracic scoliosis (mean lateral spinal curvature, 37.7[degrees]) had full assessment of pulmonary function and a radiographic evaluation from radiographs of the whole spine, Moire topography, and thoracic computed tomography.

Results. Multiple regression analysis (stepwise method) was performed at each vertebral level from T3-T12 to identify the factor that most strongly affects %VC. The correlation coefficient was highest at T9 and next highest at T8, with values of 0.641 ($r^2 = 0.411$, $P < 0.0001$) and 0.625 ($r^2 = 0.390$, $P < 0.0001$), respectively. At T9, multiple regression analysis showed that the sagittal diameter of the thoracic cage and the total lung area were identified as factors that most strongly affect %VC. Similarly, the sagittal diameter of the thoracic cage and the rotation angle to the sagittal plane were identified at T8.

Conclusions. The factors that reduced %VC were the sagittal diameter of the thoracic cage, total lung area and vertebral rotation at the T8 and T9 levels.

Editorial comment by Warren Jahn: The assessment of vital capacity is an essential baseline measurement. This article identifies 3 deformities that in combination reduce vital capacity and should be added to the scoliosis assessment (record measurements) by the chiropractic orthopedist.

Maturity Assessment and Curve Progression in Girls with Idiopathic Scoliosis
James O. Sanders, MD1, Richard H. Browne, PhD2, Sharon J. McConnell, MS1, Susan A. Margraf, RN1, Timothy E. Cooney, MS3 and David N. Finegold, MD4

Background: Scoliosis progression during adolescence is closely related to patient maturity. Maturity has various indicators, including chronological age, height and weight changes, and skeletal and sexual maturation. It is not certain which of these indicators correlates most strongly with scoliosis progression. The purpose of the present study was to evaluate various maturity measurements and how they relate to scoliosis progression.

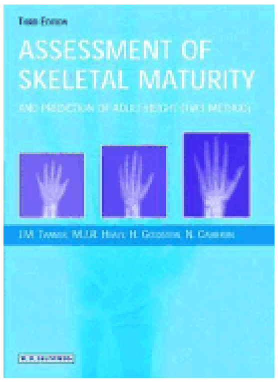
Methods: Physically immature girls with idiopathic scoliosis were evaluated every six months through their growth spurt with serial spinal radiographs; hand skeletal ages; Oxford pelvic scores; Risser sign determinations; height; weight; sexual staging; and serologic studies of the levels of selected growth factors, estradiol, bone-specific alkaline phosphatase, and osteocalcin. These measurements were then correlated with the curve-acceleration phase.

Results: The period and pattern of curve acceleration began during Risser stage 0 for all patients. Skeletal maturation scores derived with the use of the Tanner-Whitehouse-III RUS method, particularly those for the metacarpals and phalanges, were superior to all other indicators of maturity. Regression of the scores provided good estimates of maturity relative to the period of curve progression (Pearson $r = 0.93$). The initiation of this period occurred simultaneously with digital changes from Tanner-Whitehouse-III stage F to G. At this stage, curves also separated into rapid, moderate, and low-acceleration patterns, with specific curve types in the rapid and moderate-acceleration groups. The low-acceleration group was not confined to a specific curve type.

Conclusions: The curve-acceleration phase separates curves into various types of curve progression. The Tanner-Whitehouse-III RUS scores are highly correlated with timing relative to the curve-acceleration phase

and provide better maturity determination and prognosis determination during adolescence than the other parameters tested. Accurate skeletal maturity determination should be used as the primary maturity measurement in girls with idiopathic scoliosis.

Editorial Comment: There is more to assessing scoliosis than taking AP and lateral views and using the Cobb method to measure the curve. Curve acceleration from a risk management viewpoint must be considered and assessed. Every chiropractic orthopedist should purchase and refer to the Tanner book describing the Tanner-Whitehouse-III RUS method.



ISBN:

0702025119

Assessment of Skeletal Maturity and Prediction of Adult Height (Tw3) Method
by W. B. Saunders (Creator), James M. Tanner, Michael J. R. Healy

About this title: This book is a comprehensive and practical guide to assessing skeletal maturity and predicting adult height in children. It takes the reader through the main scoring systems and uses radiographs to illustrate the main stages of bone maturity in male and female children. The FREE CD-ROM contains a growth height prediction program, helping to predict growth height for each patient and storing data for comparison as the patient grows.

Treatment

Chiropractic manipulation in Adolescent Idiopathic Scoliosis: a pilot study

Dale E Rowe, Ronald J Feise, Edward R Crowther, Jaroslaw P Grod, J Michael Menke, Charles H Goldsmith, Michael R Stoline, Thomas A Souza and Brandon Kambach

Chiropractic & Osteopathy 2006, **14:**15   doi:10.1186/1746-1340-14-15

Published   21 August 2006

Abstract

Background

Adolescent idiopathic scoliosis (AIS) remains the most common deforming orthopedic condition in children. Increasingly, both adults and children are seeking complementary and alternative therapy, including chiropractic treatment, for a wide variety of health concerns. The scientific evidence supporting the use chiropractic intervention is inadequate. The purpose of this study was to conduct a pilot study and explore issues of safety, patient recruitment and compliance, treatment standardization, sham treatment refinement, inter-professional cooperation, quality assurance, and outcome measure selection.

Methods

Six patients participated in this 6-month study, 5 of whom were female. One female was braced. The mean age of these patients was 14 years, and the mean Cobb angle was 22.2 degrees. The study design was a randomized controlled clinical trial with two independent and blinded observers. Three patients were treated by standard medical care (observation or brace treatment), two were treated with standard medical care plus chiropractic manipulation, and one was treated with standard medical care plus sham manipulation. The primary outcome measure was Cobb, and the psychosocial measure was Scoliosis Quality of Life Index.

Results

Orthopedic surgeons and chiropractors were easily recruited and worked cooperatively throughout the trial. Patient recruitment and compliance was good. Chiropractic treatments were safely employed, and research protocols were successful.

Conclusion

Overall, our pilot study showed the viability for a larger randomized trial. This pilot confirms the strength of existing protocols with amendments for use in a full randomized controlled trial.

Editorial comments by Warren Jahn: The chiropractic orthopedist should realize that there are very few studies that demonstrate manipulation (chiropractic) as an effective procedure in the treatment of idiopathic scoliosis. This pilot highlights the need for many more RCTs.

Instrumentation alternatives for adolescent idiopathic scoliosis.

Current Opinion in Orthopedics. 18(3):234-247, May 2007.
Jones-Quaidoo, Sean M; Arlet, Vincent

Abstract:
Purpose of review: The focus of this paper is to review the different instrumentations utilized in adolescent idiopathic scoliosis.

Recent findings: Over the last hundred years the surgical treatment of adolescent idiopathic scoliosis has seen quite a dramatic evolution. In the 1990s the advent of pedicle screws was started and changed the paradigm of spinal instrumentation. At the beginning of this century thoracic pedicle screws used initially in the Far East became an accepted standard of care even if controversies persist as to their real safety and their real benefit/risk for each individual curve. The evolution of anterior spinal instrumentation has moved from the Dwyer cable to the semi-rigid Zielke anterior rod system and currently to the anterior rigid rod system. The anterior rigid rod system can be applied using one or two rods, though one rod only may be insufficient to prevent kyphosis especially at the thoracolumbar junction.

Summary: If the surgical treatment of adolescent idiopathic scoliosis has seen a dramatic evolution, the goals of surgery have remained the same over the last few decades: to obtain good correction and a solid fusion while

simultaneously preventing further deformity, to improve cosmesis, and to prevent the onset of back pain and pulmonary and cardiac problems.

Editorial comments by Warren Jahn: The need to study surgical interventions has always been emphasized within the chiropractic orthopedic diplomate program. Scoliosis patients will present with instrumentation correction and recognition of the surgical procedure and radiographic visualization is important to the chiropractic orthopedist. This review article is recommended as an update source reference.

Attribution

Ed Payne, FCER