Understanding Scoliosis

November 15th, 2011
Abstract

Scoliosis is a deformity of the spinal column that effects the growth and development of adolescents. Various types of scoliosis exist, and of these structural is the most debilitating form. If screening is used to detect scoliosis during its earliest stages, proper treatments can be prescribed in order to prevent scoliosis from debilitating the growth and development of the young people that it affects. Radiography has been proven to be the most accurate way to diagnose scoliosis. Considerations for treatment rely heavily on the degree of curvature present, as well as the patients’ skeletal maturity. As technology advances, scoliosis will be become better understood, more accurately diagnosed, and more effectively treated.
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Unlike a normal spine that is relatively straight in the sagittal plane, with thoracic kyphosis and lumbar lordosis in the coronal plane, “scoliosis is a disease that affects the three-dimensional shape of the spine, …” (Leone, Aulisa, Perisano, Re, Galli, 2010, p. 243). Characteristics that define scoliosis include both lateral and vertebral rotation of the spine. The effects that scoliosis has on the body are manifested internally causing superficial indicators.

**Indicators**

Superficial indicators largely depend on the type, cause, and pattern of scoliosis present. Two distinct types of scoliosis are structural and nonstructural. As Larson (2011) describes, nonstructural scoliosis is classified as a structural normal spine with no spinal rotation but lateral curvature. It is important to note that nonstructural scoliosis corrects with forward bending, “and is usually caused by a leg length discrepancy with pelvic obliquity” (Fabry, 2009, p. 1416). On the other hand, structural scoliosis entails both spinal rotation and curvature. Structural scoliosis can be caused by, “neuromuscular diseases such as cerebral palsy, poliomyelitis, or muscular dystrophy, birth defects such as hemivertebra, injury, infections, tumors such as neurofibromatosis, metabolic factors, connective tissue disorders, and rheumatic diseases” (Taft & Francis, 2003, as cited in Larson, 2011, p. 392). If the indications of scoliosis are inconsistent with the causes previously mentioned it is considered idiopathic scoliosis (IS). IS can be further classified as infantile, juvenile, and adolescent depending on the age of onset. “Likewise, IS is also referred to as “early onset” and “late onset” scoliosis. (See Fig. 1)

<table>
<thead>
<tr>
<th>Classification of scoliosis</th>
<th>Child’s age at onset</th>
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<tbody>
<tr>
<td>Infantile</td>
<td>≤3 years</td>
</tr>
<tr>
<td>Juvenile</td>
<td>4-9 years</td>
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<tr>
<td>Adolescent</td>
<td>&gt;10 years</td>
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<tr>
<td>Early onset scoliosis</td>
<td>&lt;10 years</td>
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<tr>
<td>Late onset scoliosis</td>
<td>≥10 years</td>
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Fig. 1 Classification of scoliosis according to age of onset.

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Patterns of scoliosis are described by the curvature region of the spine, right or left curve convexity, and if single or multiple curves are present. (See Fig. 2)

Internal changes that are consistent in scoliosis include rib displacement and deviation of the spinoeus process. Rib placement and growth are affected due to the curve of the spine and vertebral rotation associated with scoliosis.

Rotation or deviation toward a side is classified as the concave curve and on the contrary, rotation or deviation from a side marks the convex curve. Ribs on the convex curve are widely separated and pushed posteriorly, whereas ribs attached to the concave curve are close together and pushed anteriorly (Scoliosis, 2008). The spineous process deviates to the concave side as the vertebral bodies rotate. (See Fig. 3) These changes create crucial indicators for the screening of scoliosis.

**Screening**

The gold standard for scoliosis screening is the Adam’s forward bend test. During the test the child bends forward with feet together and knees straight while dangling their arms. “Any imbalance in the rib cage or other deformities along the back could be a sign of scoliosis”
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(Leone et al., 2010, p. 241). An imbalance in the rib cage due to the elevation of ribs or lumbar muscles caused by rotation is known as a gibbus. According to Fabry (2009) a gibbus is not always very prominent and the use of a scoliometer may be needed. (See Fig. 4) In addition to the Adam’s test Larson (2011) suggests performing it in the sitting position to account for any compensatory curves. Fabry adds that after the Adam’s test is performed range of motion should be checked, “forward and backward bending should be smooth, without hesitation, deviation, or limitation” (p. 1415).

Timing plays a key role in when screening tests should be performed. “Scoliosis is present in 3-5% of the children in the adolescent age group…” (Busscher, Wapstra, Veldhuizen, 2010, p. 1), therefore screening is crucial. Females should be screened for scoliosis two times at the ages 10 and 12 due to higher incidence rate, whereas males only need to be screened once around age 13 or 14 (Richards & Vitale, 2008). The child’s primary care physician should monitor indications of scoliosis prior to later screenings, beginning at birth.

Screening is a simple yet effective way to aid in the diagnosis of scoliosis. Techniques previously mentioned are easily performed and low in cost. Red flags caught in screenings lead to earlier recognition of the disease, often times decreasing the demand for surgery and potential prevention of progression.

**Radiographic Assessment**
If a curve is discovered during screening, radiographs may be ordered. Radiographs are the most common procedure to evaluate scoliosis, where lateral and posterior-anterior x-rays are taken. (See Fig. 5) Radiographs of the entire spine help to determine “the presence of scoliosis and the degree of curve by evaluation of the Cobb angle” (Larson, 2011, p. 395).

Since 1948 the Cobb angle has set a high standard for quantification of scoliosis. (See Fig. 6) The greater the Cobb angle, the greater the degree of scoliosis. Although it is difficult to fully describe a three-dimensional deformity with a two-dimensional radiograph, the Cobb angle still has the advantage of being simple to calculate and understand and remains the preferred method for quantifying both primary and secondary curves and is also an indicator for curve progression (Taft & Francis, 2003, Charles et al., 2006, Goldberg et al., 2008, Tan, Moe, Vaithinathan, & Wong, 2009 as cited in Larson, 2011, p. 395).

In order to maintain the accuracy of the Cobb measurement, certain steps should be followed when measuring the angle. The
first step in ensuring accuracy of the Cobb method is to decide on the “end vertebrae” of the curve. These vertebrae will serve as the upper and lower limits of the curve that tilts, “most severely toward the concavity of the curve” (Scoliosis, 2008, p. 1). After selecting the upper and lower limits, “a line is then drawn along the upper endplate of the upper body and along the lower endplate of the lower body” (Scoliosis, 2008, p. 1). From those lines, perpendicular lines to the first two lines are then constructed. Where these lines intersect is the measure of angle of curvature of the spine. It is critical to report what method was used when measuring the angle as well as the “end vertebrae”, allowing for better accuracy when comparing follow-up films.

“Measurements obtained…should be precise and reproducible because the magnitude of the curve is a major factor in the clinical decision-making process” (Malfair et al., 2010, p. 9).

**Treatment Factors**

Depending on the severity of the case, radiographs may be initiated every 6-12 months to monitor progression. Treatment for curves less than 20 degrees requires no treatment, but observation is required. “Conservative treatment such as casting and/or bracing is indicated for curves greater than 20 or 25 degrees and surgical intervention is indicated for curves greater than 40 or 45 degrees in skeletally immature patients” (Charles et al., 2006; Kim et al., 2009; Taft & Francis, 2003, as cited in Larson, 2011, p. 398). In addition to curve magnitude, growth must be closely monitored since the progression of the curve is highly affected by it.

Risk of curve progression depends on the magnitude of the curvature and the skeletal maturity. Skeletal maturity may be indicated by radiographs of the hand/wrist but most commonly determined by looking at the degree of ossification of iliac apophysis; which is convenient since the iliac crests are usually presented on a scoliosis study. Risser stages refer to the amount of ossification present in the iliac apophysis seen on a radiograph. “In Risser stage 0,
the apophysis is not present. In Risser stages I, II, III, and IV, the apophysis covers 25%, 50%, 75%, and 100% of the iliac wing respectively. Stage V is the adult pelvis” (Malfair et al., 2010, p. 14). When apophyses meet the sacroiliac junction and firmly seal to ilium, maturation is nearly complete.

**Treatments**

Once a better knowledge of curvature degree and skeletal age has been reached, different treatment options are taken into consideration. As previously mentioned curves greater than 20 or 25 degrees are treated conservatively with casting and or bracing in skeletally immature patients. Bracing has limited effectiveness, but as Malfair et al., (2010) reports, bracing has successfully shown 75% prevention in curve progression as well as a 50% reduction of curve when wearing the brace. It is important to make clear that bracing does not correct but rather prevents curve progression.

Curves greater than 40 or 45 degrees will be treated surgically. Goals of surgery as stated by Kao-Chen and Chiu (2008) include: prevention of progression, correction of deformity, preservation of balance and cosmetics. Some surgical options that may be considered are growing rods, Vertical expandable prosthetic

**Fig. 7 Surgical options.**

titanium rib (VEPTR) and intervertebral stapling. (See Fig. 7)

**Advancements**

All aspects of scoliosis rely heavily on radiography. Enormous advancements in the field are currently and will continue to change how we attend to scoliosis. Oversized images, such as the entire spine, may have to be taken in multiple images. Image stitching, however, allows for the entire spine to be imaged in one exposure, per view, and then “stitched” together. This works through an assembly of three imaging plates placed end to end of one another in the same image receptor case. Once the exposure is made the plates are then disassembled from each other, reconstituting their separateness. The plates are then developed separately and electronically “stitched” together. This allows the spine to be seen in its entirety rather than with two separate images, making it easier to determine the angle of the spine and consequently treatment.

A more recent advancement playing a role in scoliosis imaging is known as the EOS imager, a new ultra low dose 2D/3D digital x-ray system (Jensen, 2011). (See Fig. 8) The capabilities of this technology are unprecedented. “This system allows for the simultaneous acquisition of two orthogonal planar images in a vertical scanning mode” (Busscher et al., 2010, p. 4). This machine is made up of two image detectors as well as x-ray tubes that are supported by a mobile C-arm. “This C-arm moves vertically using a linear scanning technique. The patient is positioned at the intersection of the two x-ray beams…. A single scan will simultaneously produce both AP and lateral images.
of the patient” (Busscher et al., 2010, p. 5). From the biplane images a 3D weight bearing visualization is provided with the capabilities of automatic calculations according to clinical parameters. Advantages of this system include the elimination of image “stitching”, continuous images and reduction in patient radiation exposure. The EOS imager “creates a contiguous scan of the entire body using as little as 1-1000th of radiation absorbed during a traditional CT scan” (Jensen, 2011, p. 1).

**Conclusion**

The effects of scoliosis on the body may be detrimental. Proactively screening youth, especially between the ages of 10-14, can dramatically change the outcome of the patient’s health. Indicators found by preforming the Adam’s test lead to close monitoring or diagnostic imaging. Radiography allows for the confirmation of scoliosis as well as an accurate measurement of curve, rotation, and growth factors taken into account for proper treatment. Treatment options vary and are appropriate for the age and degree of scoliosis the patient presents. Advancements in radiography have been proven effective in better comprehending scoliosis, therefore leading to better treatment and overall patient care.
References


