Treatment of Adolescent Idiopathic Scoliosis

I sincerely appreciate this editorial opportunity to present some thoughts and suggestions regarding the treatment of children with adolescent idiopathic scoliosis (AIS). Biomechanical analysis and orthotic design for AIS treatment have been close to my heart since the beginning of my O&P career at Gillette Children's Specialty Healthcare, when I had the extraordinary opportunity to work with so many of those youngsters and learn from several of the pioneering giants in pediatric spine orthopedics.

Over the years I have felt considerable frustration and even despair regarding much of what represents the mainstream of AIS orthotic treatment. Several issues of concern to me and a number of my colleagues may be rooted in how we measure the severity of scoliosis to evaluate progress and outcomes of orthotic treatment. The quality of our treatment protocol and designs are, I believe, limited by the validity of our measurement tool. Cobb angle measurements, useful as they are, have two significant shortcomings.

The first of those shortcomings is simply a matter of geometry. An increase in lateral misalignment of the spine above a given curve, in the direction of the curve apex, has the effect of decreasing the Cobb angle of that curve. So, in such a case, the Cobb angle *decreases* even as the deformity progresses. This is best illustrated by an example.

The radiograph of Figure 1A shows a left thoracolumbar curve of 29°. The girl returned about 6 months later, and Figure 1B is her new radiograph. When we look at her spine alignment in the two radiographs relative to the central sacral line (CSL), it is clear that the deformity has progressed. The entire spine has drifted farther leftward. The leftward deviation, even at the L2 level has increased from 28 mm to 38 mm, but the Cobb angle measurement has *decreased* from 29° to 23°. (Incidentally, please note how the CSL helps us quickly appreciate changes in lateral deviation at *all* spine levels.)

The second problem associated with Cobb angle measurements cannot be described so simply. It has to do with the fact that those measurements relate to *individual* curves.

We can probably agree that, in North America, the primary goal of orthotic treatment of AIS is to prevent the youngster's spine deformity from becoming severe enough to trigger a decision for surgical fusion. Within the realm of that goal, our aim should be to minimize and stabilize the deformity in an optimally compensated and aligned configuration to achieve the best cosmetic result for the youngster. An optimum cosmetic result is definitely *not* most directly served by minimizing the Cobb angle of each and every curve to the extent orthotically possible. The Cobb angle is a quick, easy way to measure the magnitude of individual scoliosis curves, but it is poorly suited to the assessment of cosmetic factors.

The pioneers in effective orthotic treatment of AIS recognized spine alignment qualities they called "compensation" and "balance." Optimal compensation and balance in the frontal plane would be head and shoulders centered over the sacropelvic complex. Level, centered shoulders help shirts, blouses, and dresses drape evenly. When well balanced, even sizable double curves cause no significant cosmetic problem. Dr. Blount focused much of his attention on overall alignment "balance." He knew that a certain amount of "compensation" was beneficial and sometimes encouraged development of a compensatory curve. He assiduously taught others to note and manage those aspects of AIS deformity.

The most experienced orthopedic managers of AIS treatment are able to keep "compensation" and "balance" in mind and combine those with the quantitative Cobb angle numbers to arrive at a wise evaluation on individual cases in front of them. However, those qualitative factors are difficult to bring into our research,

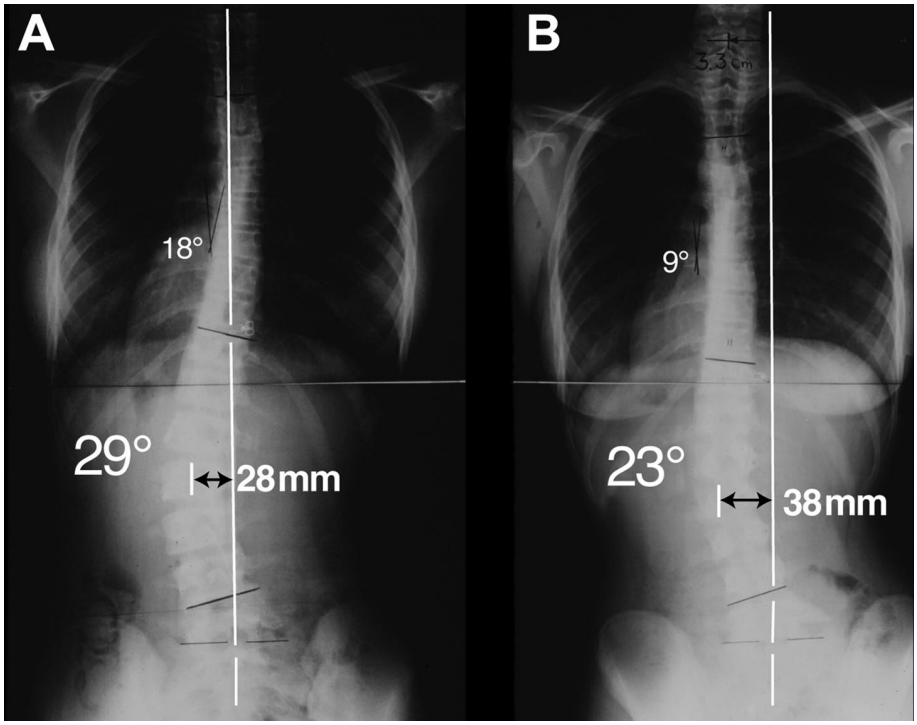

Figure 1. This pair of radiographs illustrate a serious defect in the Cobb Angle as a spine deformity measure. (B) was taken about six months after the presenting radiograph (A). In spite of obvious significant progression of the deformity, highlighted by the central sacral line, the Cobb Angle measurements indicate an improvement.

teaching, discussion, and writings as long as those factors are not subjected to a quick, objective measurement. This tends to keep the Cobb angle in the bull's eye and the cosmetic spine alignment variables on the fringes of the target. Yes, we often see a plumb bob dropped from C7 to gauge misalignment at that level. That measurement can be helpful, but it falls quite short of being an adequate objective measurement of the overall alignment considerations Dr. Blount observed and managed.

Some of us feel that as AIS treatment has become more and more dispersed, attention to these compensation/balance factors has declined. There seems to be a creeping tendency to maximize correction of each and every curve—to treat curves, instead of patients. For instance, we see scientific program or instructional course presentations that show radiographs of supposedly successful orthotic treatment in which cosmetic factors are clearly overlooked or ignored. Three examples:

1. A left thoracolumbar curve is treated with both a left lumbar pad and a right thoracic pad, resulting in an 80% Cobb angle reduction. The treating orthotist was oblivious to the fact that his aggressive right thoracic pad *increased* leftward misalignment of the patient's thorax, neck, and head.

2. A right thoracic and left lumbar curve combination are both aggressively treated. "Good" correction is achieved on the right thoracic curve and "magnificent" correction on the left lumbar curve. No comment is made regarding the creation of a new high left thoracic curve, a high left shoulder, and a leftward misalignment of C7.

3. A right thoracic, left lumbar curve presenting with the entire C-T-L spine misaligned leftward of the CSL. An orthoses with a combination of left lumbar and right thoracic forces did dramatically reduce both Cobb angles, but the right thoracic force dominated alignment. The treating orthotists made no comment about the fact that leftward misalignment of the entire C-T-L spine was worse in the orthoses than before treatment.

The Conference on "Clinical Standards of Practice on the Orthotic Treatment of Idiopathic Scoliosis" in 2002 and an article by Keith Smith in the January 2004 issue of JPO, stimulated me to look back at my old notes and diagrams on lateral

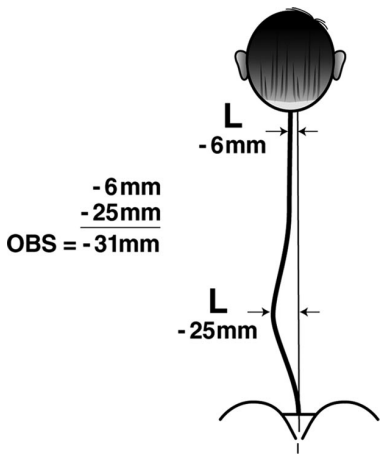

Figure 2. Illustration of how to measure and calculate the Overall Balance Summation (OBS) for a single curve.

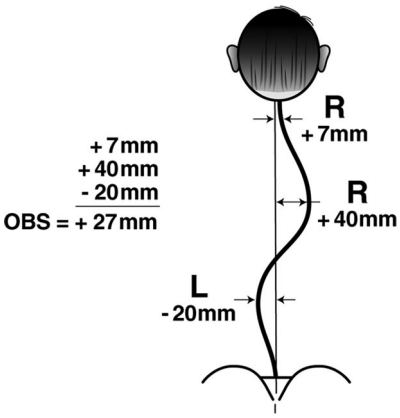

Figure 3. Overall Balance Summation (OBS) determination for a double curve deformity.

deviation from midline (LDM). Those things inspired me to invite a small number of fellow orthotists to come to St. Paul for a focused discussion. The invitation was extended to Tom Gavin, Keith Smith, Tom Colburn, Don Katz, Miguel Gomes, Kevin Meade, Katie Voss, and Carol Hentges. Everyone attended the 2-day meeting at the St. Paul Hotel except Tom Gavin, who was unable to attend because of illness. The subject of this editorial was a major topic of discussion at that conclave. I am indebted to those participants for the invaluable experience and thoughtfulness brought to bear on the topics of that 2-day meeting.

We came away from that discussion meeting early in 2005 convinced we should further explore a more valid way to quickly measure and objectively evaluate cosmetic alignment (the compensation/balance component). If we can develop and teach a more valid measurement, orthotic designs and treatment decisions will naturally evolve to better serve the AIS patient.

This topic became the subject of a debate format session "Trends in Adolescent Idiopathic Scoliosis Concerning Cobb Angle vs. Overall Balance" at the AAOP annual meeting in Chicago in March 2006. During the introduction to that forum, a proposal was put forth describing a procedure to quantify the alignment-compensation-balance aspect of AIS spine deformity.

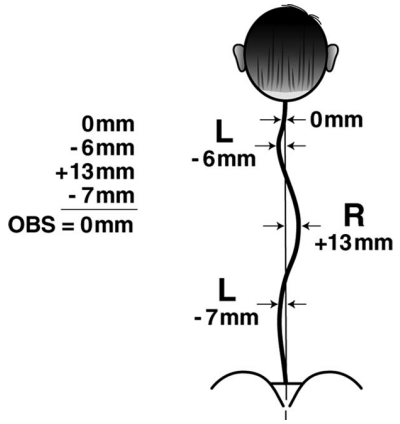

Figure 4. Overal Balance Summation (OBS) for a triple curve.

1. Align the P-A radiograph vertically in the view box.

2. Use a "T" square (crossbar against the bottom edge of the view box) to draw a vertical line, on the radiograph, from the center of the sacrum upward to at least the level of C7. This is the CSL.

3. Measure the lateral deviation (rightward + or leftward –) of the vertebral bodies at each curve apex and at C7 (or the most appropriate cervical level, if different). For example, let us say those measurements are –22 mm at L1, +20 mm at T8, and –3 mm at C7.

4. Those three values could be added (–22 mm + 20 mm – 3 mm = –5 mm) to yield a single number that conveys a fairly accurate sense of how well that spine is balanced/aligned. This process requires about the same amount of time as measuring the Cobb angles.

Let us go through a few examples: Figure 2 diagrams the measurements and summation relative to a single curve. The overall balance summation (OBS) is the algebraic (net) sum of those several measured values. In this example of a single curve pattern, C7 is misaligned 6 mm leftward. The apical vertebral body of the lumbar curve is misaligned 25 mm leftward of the CSL. Both measurements get a minus sign because they are leftward. So the OBS is –31 mm.

Figure 3 represents the measurement and calculation for a double curve. The algebraic (net) sum of +7 mm, +40 mm, and –20 mm is 27 mm. The major right thoracic curve, in addition to being very large, is not well balanced by the compensatory left lumbar curve.

A triple curve pattern (Figure 4) would have a four-measurement summation. In this example, we see a well-compensated set of curves with misalignments measuring 0 mm, –6 mm, +13 mm, and –7 mm. The OBS is 0 mm.

It is interesting to note that the sum of the absolute values of the lateral deviation from midline (LDM) gives a number consistent with the collapsing aspect of a scoliosis deformity. In the final example above (Figure 4), what we might call the absolute collapsing summation (ACS) is 26 mm (0 + 6 + 13 + 7). It may or may not be appropriate to include the C7 misalignment in this summation. I would argue that the OBS measurement/value is at least as useful as the one, two, or three Cobb angle numbers.

Reliability and sensitivity of this proposed measurement have not yet been established. However, the shortcomings of the use of the Cobb angle should urge us to search for a more valid way to measure and assess idiopathic scoliosis. As we endeavor to improve our treatment, it should be axiomatic that a measurement that more accurately relates to severity will point us more directly toward better designs, protocols, and patient outcomes.

It must be recognized that this overall balance summation is appropriate for assessment of standing P-A radiographs of patients with *idiopathic* scoliosis. It is of little or no value in evaluating radiographs of recumbent or seated patients. In fact, it is probably not at all useful for neuromuscular scoliosis.

J. Martin Carlson, CPO, FAAOP
Tamarack Habilitation Technologies, Inc.
Blaine, Minnesota