

# To Brace or Not to Brace:

## The Three-Dimensional Nature and Growth Considerations for Adolescent Idiopathic Scoliosis



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### Introduction

Simply defined, idiopathic scoliosis (IS) is a lateral deviation of the spine with a Cobb angle greater than 10 degrees.<sup>1</sup> A more comprehensive definition of IS addresses the three-dimensional (3D) nature of the condition and the basic components of the scoliotic deformity:

lateral inclination, intervertebral lordosis, and axial rotation. Scoliosis is more currently defined as a multifactorial, 3D deformity of the trunk and the spine, which appears and can progress during any of the rapid periods of growth in otherwise healthy children.<sup>2</sup>

### Growth Potential and Progression of IS

There is a direct correlation between growth potential and the progression of IS. For example, the greater the remaining growth, the greater the potential that IS will progress. This progression is directly related to the size of the Cobb angle, rotation, and structural flatback, or hypokyphosis, as well as curve history, menarche in girls, change in voice in boys, chronological age, Risser sign, and previous failed treatments (e.g., failed traction-chair treatment, poor-quality bracing, or incorrect brace design).

Table 1 demonstrates the four stages of postnatal growth: infancy, childhood, the juvenile period, and adolescence.<sup>3</sup> Infancy ends at 36 months of age. Childhood begins at the end of infancy and continues until the brain reaches its total weight—typically around seven years of age.<sup>4</sup> The juvenile

Four Stages of Growth	Chronological Age	Growth Spurts	Risser Sign	Highest Risk	Lowest Risk
Infancy	0 to 36 months		Risser 0	Immature patients >30 degrees	Cobb >20 degrees
Childhood	3 to 7 years	End of childhood before juvenile period	Risser 0	Untreated curves of 30 degrees during a pubertal spurt could be 40–90 degrees at the end of growth.	
Juvenile/Prepuberty Period	7 to 9–10 years/start of puberty		Risser 0		
Adolescent/Puberty	Begins with puberty	Most intense spurt is the pubertal spurt at 10–11 in girls 12–13 in boys	Tanner 2 Risser 0 to 5 Risser 1 occurs a few months after menses	Progression depends on growth remaining and growth velocity.	Risser 4 to 5 end of growth.

**Table 1.** There are four stages of postnatal growth until reaching maturity. Further progression of idiopathic scoliosis may occur during any rapid growth period, and there is a direct correlation between growth potential and progression of idiopathic scoliosis.

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period, also called the prepubertal period, ends at the onset of puberty. Human adolescence begins when visible signs of puberty, identified by the onset of secondary sexual characteristics such as pubic hair, breast development, or voice and body habitus changes, appear. This is well established by Tanner stage two.<sup>5</sup> IS may progress during any rapid growth period.

There are two recognized growth spurts or periods of accelerated growth. The first is at the end of childhood, before the

pubertal growth spurt or adolescence (growth peak height velocity),<sup>6</sup> followed by a deceleration phase until maturity. Both growth spurts occur earlier in girls than in boys—on average at ten to 11 and 12 to 13 years of age, respectively.<sup>4</sup>

The highest risk for progression in adolescent idiopathic scoliosis (AIS) coincides with the acceleration phase of growth observed during puberty. Duval-Beaupere established

a clear relationship between scoliosis progression and growth peak height velocity.<sup>6</sup> Potential for progression not only depends on the growth remaining but also on growth velocity. Assessment of skeletal age is essential in establishing these two factors for progression. The skeletal age can be determined by using an atlas of skeletal maturity<sup>7</sup> or by bone-specific scoring techniques of the wrist or hand.<sup>8</sup>

Among scoliosis specialists, the Risser sign<sup>9</sup> is still the most popular and reliable method used to establish bone maturity.<sup>4</sup> The Risser grading scale rates the child's skeletal maturity on a continuum from zero to five. In girls and boys, rapid growth occurs during Risser sign zero to one. A Risser sign of four to five indicates that the child has stopped growing.

From a practical point of view, the three most important factors to consider are the beginning of the pubertal spurt, the end of the pubertal spurt, and cessation of growth. AIS progressing over a 30-degree Cobb angle during the pubertal spurt will reach a final Cobb angle between 40 degrees and 90 degrees at cessation of growth, while AIS that remains less than a 30-degree Cobb angle at the end of the pubertal spurt is a sign that the final Cobb angle will remain under 40 degrees when the patient reaches maturity.<sup>10</sup>

To ensure that the growth peak height velocity has finished, the best practice is to combine menarche status as well as some indicator of bone maturation.<sup>4</sup> Menses is an important indicator in girls, and usually a few months postmenarche, Risser sign one is recognizable. Therefore, both menarche and Risser sign one are good markers to establish the end of the pubertal spurt in girls. However, it is more difficult to identify the start of puberty in boys. The change of



Patients of Align Clinic, San Mateo, California, are fit for their new Wood-Cheneau Rigo brace by the author. Patient on the left went from 24 degrees Cobb pre-brace to 12 degrees Cobb out of brace. Patient on the right went from 42 degrees Cobb pre-brace to 20 degrees Cobb in-brace.

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voice in boys is an equivalent of the start of menses in girls. Therefore, if this can be fixed in time, it would be possible to note the start of puberty in a boy.<sup>4</sup>

In both girls and boys, Risser sign five identifies skeletal maturity or the end of growth. In an AIS patient there is a total fusion of the iliac apophysis with the iliac crest (i.e., no proliferative chondrocytes). This usually occurs at 16 years of age in girls and Risser sign five, as well as 15 years of age in patients with digital skeletal age (DSA) stage III and Risser sign four, two years post-menses.<sup>11</sup>

At Risser sign zero and the beginning of puberty,<sup>12</sup> Bunnell found the risk of progression to be 20 percent, 60 percent, and up to 90 percent in curves with Cobb angles of 10 degrees, 20 degrees, and 30 degrees, respectively. At Risser sign two to four, during the final stage of puberty, the risk of progression is significantly reduced to approximately two percent, 20 percent, and 30 percent in curves with Cobb angles of 10 degrees, 20 degrees, and 30 degrees, respectively.

Maturity and the magnitude of the Cobb angle are the main indicators for predicting the risk of progression. However, the patient's clinical presentation also plays an important role in determining the risk of progression. For example, the risk of progression increases with the severity of hypokyphosis and axial rotation at diagnosis of IS.

Once a patient has reached skeletal maturity, Risser sign four or five, or two to two-and-a-half years post-menarche, the risk of IS progression decreases. However, in adults, IS may progress from progressive bony deformities and collapsed spine to even larger curves and more severe scoliosis, especially in patients with severe scoliosis and curves greater than a 50-degree Cobb angle.

### Indications for Scoliosis Bracing

Scoliosis professionals determine the proper bracing method for a patient after a complete clinical evaluation. The patient's growth potential, age, maturity, and scoliosis (Cobb angle, rotation, and sagittal profile) are also considered. Immature patients who present with Cobb angles less than 20 degrees should be closely monitored. Immature patients who present with Cobb angles of 20 degrees to 29 degrees should be braced according to the risk of progression by considering age, Cobb angle increase over a six-month period, Risser sign, and clinical presentation. Immature patients who present with Cobb angles greater than 30 degrees should be braced (Table 2). However, these are guidelines and not every patient will fit into this table. For example, an immature patient with a 17-degree Cobb angle and significant thoracic rotation or flatback could be considered for nighttime bracing. On the opposite end of the growth spectrum, a 29-degree Cobb angle and a Risser sign three or four might

**Table 2.**

Degree of Cobb Angle	Immature Patient
>20	Monitor.
20–29	Braced according to risk.
>30	Braced.

Adults >50 Consideration for bracing (reduce pain and collapsing of spine).  
Adults <50 Consideration for bracing depending on pain.

not need to be braced because there is reduced potential for progression.

Surgery is indicated by the Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) at 45 degrees to 50 degrees<sup>13</sup> and by the Scoliosis Research Society (SRS) at a Cobb angle of 45 degrees (Table 3).<sup>14</sup> SOSORT uses the 45-degree to 50-degree threshold as a result of the well-documented, plus

**Table 3.**

Surgery indications	
Degree of Cobb Angle	Society
50 or greater	SOSORT
45 or greater	SRS

or minus five degrees measurement error that can occur while measuring Cobb angles.<sup>15</sup>

### Conclusion

When considering brace treatment for scoliosis patients, it is imperative to completely understand the correlation between growth potential and the progression of IS. There are many important factors to consider, including the magnitude of the Cobb angle, rotation, sagittal profile, clinical presentation, as well as the curve history, onset of menses in girls, maturity, chronological age, Risser sign, and previous failed treatments. ■

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