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Nonoperative treatment for adolescent idiopathic scoliosis

Suken A. Shah, MD[a,b,*]

[a]*Spine and Scoliosis Center, Nemours/Alfred I. duPont Hospital for Children, 1600 Rockland Rd, Wilmington, DE 19803*
[b]*Department of Orthopaedic Surgery, Sidney Kimmel Medical College of Thomas Jefferson University, Philadelphia, PA*

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ABSTRACT

Since scoliosis affects up to 3–4% of the population and is the most common spinal deformity among children and adolescents, many practitioners are faced with decision making regarding these patients. However, since only a fraction of patients with scoliosis have the severe, progressive form of the condition and require surgery, practitioners require a foundation of nonoperative treatment modalities and alternatives. The treatment of any condition should take into account the short- and long-term outcomes as well as the complications of that treatment modality. The 3 generally accepted (and evidence-based) treatment options for scoliosis are observation, use of a brace, and surgical stabilization. Others have proposed that treatment modalities such as electrical muscle stimulation, postural exercises, chiropractic manipulation, nutritional supplementation, and magnet therapy have a role in the care of scoliosis, but evidence to support these modalities is lacking. This article will focus on the evidence-based nonoperative modalities of scoliosis treatment such as school screening, observation, and bracing.

Early detection and school screening programs are widespread in North America; although these programs are mandated by many states and deeply rooted in tradition, recent studies have cast some controversy over their effectiveness. The objective of school screening is, ideally, to detect scoliosis in patients in whom brace treatment may alter the course of the disease early, rather than leave surgery as the only option.[1] A valid screening program must have a screening tool that is valid, cost-effective, ethical, and acceptable to the subjects, providing a diagnosis of a disease about which we have knowledge and appropriate treatment interventions.[2]

Currently, knowledge of the disease seems to be well-accepted, for example, curve progression is known to be most likely for skeletally immature girls (Risser 0 and 1) with curves measuring 30° or greater.[3] However, there is paucity of data on small curves—their progression potential and at what degree they constitute a serious health problem. The screening test used most widely is the Adams forward bending test, which, when performed properly, is sensitive for coronal plane curvatures with concomitant axial plane rotation. An inclinometer is frequently used to provide some objective measure of the rib prominence. A positive screen is applied to anyone with truncal asymmetry on this test and referred to a specialist. Viviani et al. tested the ability of trained nurses in the use of the Adams forward bend test. They found the overall sensitivity for curves greater than 10°

* *Correspondence address*: Spine and Scoliosis Center, Nemours/Alfred I. duPont Hospital for Children, 1600 Rockland Rd, Wilmington, DE 19803.
E-mail address: sshah@nemours.org

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to be 73.9%, the specificity 77.8%, and the positive predictive value 12.4%. The sensitivity for curves over 20° was 100% with a specificity of 91%.[4] Beausejour et al. studied a population of patients referred to a Canadian scoliosis clinic in a community without school screening and found that of the 489 suspected cases of AIS, 206 (42%) had no significant deformity (Cobb angle <10°) and could be considered as inappropriate referrals. In subjects with confirmed AIS, 91 patients (32%) were classified as late referrals with regard to brace treatment indications.[5]

Opponents of school screening cite concerns about the low predictive value of screening and the cost-effectiveness of referral. Additional factors are the possibility of unnecessary treatment, including the use of a brace and the effects of radiation exposure due to X-rays. Costs involved with scoliosis screening are relatively low on a societal level and may justify the possibility of preventing surgery in adolescents with scoliosis.[6] Patients without significant spinal deformity referred to specialists do not require X-rays, and for those who do, it is important to note that current radiographic techniques involve significantly less radiation exposure than in the past.

Montgomery et al., in 1993, supported school screening and demonstrated an 8-fold decrease in the relative risk of progression into the surgical range. The authors concluded that screening decreased the demand for surgery, since smaller curves would be detected and braced at an earlier age, therefore having a better prognosis.[7] Conversely, Yawn et al.[8] concluded that the positive predictive value of routine screening was low. Morais et al.[9] stated that the prevalence of scoliosis was too low to benefit from screening and had concerns about radiation exposure following clinical screening.

To date, no level 1 evidence studies have been performed for scoliosis screening in school; unfortunately, such a study is unlikely to be performed in the future. In addition, until recently, there were no level 1 evidence studies showing effectiveness of bracing. Therefore, the US preventative task force had recommended eliminating school screening.[6] Definitive conclusions about the effectiveness of screening cannot be made from the current body of literature. However, a recent study by Dolan et al.[10] in 2007 sought to examine professional opinion regarding the effectiveness of bracing relative to observation for AIS by polling-experienced clinicians. Although there was variability in opinion among experts, the overall panel stance was that bracing would decrease the risk of progression in premenarchal patients by 20–30%. Thus, it appears that many of those who most commonly treat scoliosis in addition to the major subspecialty societies perceive a potential positive effect of bracing.[6] Therefore, it is important to identify these patients early, either to begin bracing in a window when bracing is a viable option or to allow surgical treatment earlier in severe deformities.

The goal of brace treatment of moderate scoliosis in growing children is to limit further progression and, ideally, to avoid surgery. Curves that are 20° or less before skeletal maturity are considered mild and are re-evaluated at 6-month intervals. Curves that progress 5°–10° or are 30° at presentation are moderate and are usually recommended treatment with a brace, as early, full-time bracing is considered to prevent progression and obviate the need for surgical intervention in most cases. Curves less than 30° rarely progress after maturity, but larger curves, especially in the thoracolumbar or lumbar region, can increase during the life of the patient.[11] Fusion with instrumentation is indicated for curves greater than 45° in growing children, for curves greater than 50° at maturity, or for those curves that continue to progress after cessation of brace treatment.

It is thought that brace correction occurs by molding of the spine, trunk, and rib cage during growth, specifically by using transverse forces to correct the curve with end point control. Transverse force application and curve correction have an additive effect in improving critical load and stabilizing the curve.[12] Full-time bracing instituted early by a well-fitting brace may reduce the size of the curve during the treatment period, but this correction rarely persists long after bracing is discontinued at skeletal maturity. The consensus among centers with a long track record of bracing is that the best outcome of bracing is prevention of further deformity. The literature is confounded by the wide variety of brace designs, wearing schedules, and length of treatment philosophies. It seems that there are as many types of braces as there are ports-of-call.

The Milwaukee brace was developed by Blount and Moe in the late 1940s as a substitute for postoperative casting and then adapted for use in the nonoperative treatment of neuromuscular and idiopathic scoliosis. This cervical–thoracic–lumbar–sacral orthosis (CTLSO) consisted of a molded pelvic girdle that was attached to a metal superstructure, which supported lateral pads, trapezial pads, and axillary slings (for curves with an apex above T7). An occipital attachment and throat mold were used to stabilize the head and create traction forces; however, the effectiveness of this component was later disproven.[13]

The Boston brace system was developed at Children's Hospital, Boston, in the 1970s and consisted of 6 standard prefabricated polypropylene pelvic and thoracolumbar modules, lined with foam polyethylene. Based on X-rays, the pelvic module was trimmed, and pressure pads are added at the apex of the curve(s). Lumbar lordosis is reduced by flexing the lumbar spine. For high apex curves, an axillary support can be added on the concave side with lateral pressure from a convex pad. Today, this is the most commonly used brace for AIS worldwide with over 16 prefabricated modules available. Advantages of the Boston brace include its rapid fabrication time, curve correction of 50% in the brace, and better patient acceptance than the Milwaukee brace.[14]

The Wilmington brace was developed Bunnell et al.[15] at the Alfred I. duPont Hospital for Children in Delaware, also as an alternative to the Milwaukee brace. Fashioned from Orthoplast, the total-contact custom jacket is made from a custom mold of the patient with his/her curve corrected on a Risser table with transverse, derotation, and traction forces. In the mold, transverse forces are applied at the apices of the curves, spinal balance is sought and curve correction of 50% is attempted. Trim lines are cut high in the axilla and low over the pelvis, but still allow the patient to sit. An opening is cut in the front with an overlap that allows the patient to don and doff the brace himself/herself over a cotton or synthetic