AAOS American Academy of Orthopaedic Surgeons
American Association of Orthopaedic Surgeons

Position Statement

Screening for the Early Detection of Idiopathic Scoliosis in Adolescents

This Statement was developed as an educational tool based on the opinion of the authors. It is not a product of a systematic review. Readers are encouraged to consider the information presented and reach their own conclusions.

The Scoliosis Research Society (SRS), American Academy of Orthopaedic Surgeons (AAOS), Pediatric Orthopaedic Society of North America (POSNA), and American Academy of Pediatrics (AAP) believe that there has been additional useful research in the early detection and management of adolescent idiopathic scoliosis (AIS) since the review performed by the United States Preventive Services Task Force (USPSTF) in 2004. This information should be available for use by patients, treating health care providers, and policy makers in assessing the relative risks and benefits of the early identification and management of AIS.

The AAOS, SRS, POSNA, and AAP believe that there are documented benefits of earlier detection and non-operative management of AIS, earlier identification of severe deformities that are surgically treated, and incorporation of screening of children for AIS by knowledgeable health care providers as a part of their care.

Introduction

Scoliosis is a three-dimensional spine deformity characterized by lateral and rotational curvature of the spine. The most common form is idiopathic scoliosis, which usually becomes evident in the early adolescent years in approximately 3 percent of children under age 16 and has a genetic tendency although the specifics of the genetic influence have not been completely determined. Curve progression is related to the age of the child and the magnitude of the deformity. The majority of children do not display progressive curves, although a subset of children with adolescent idiopathic scoliosis may exhibit rapid progression. Weinstein et al. reported in the *New England Journal of Medicine* that there were more than 3,600 hospital discharges related to AIS surgery in the year 2009 based on the Healthcare Cost and Utilization Project Kids' Inpatient Database (HCUP KID).[1] This spinal disorder can have a significant impact on the physical and psychosocial health of affected individuals. Scoliosis may also be the initial presenting sign of underlying conditions such as heritable collagen diseases, neurologic conditions, or skeletal dysplasia that may have been undetected until adolescence.

Prevention of severe scoliosis is a major commitment of physicians caring for spinal deformities. Beginning in 1984, the AAOS and the SRS formally endorsed the early detection of scoliosis in children whose deformities may have gone unnoticed. In 2007, AAOS, SRS, POSNA, and AAP endorsed an informational statement that explained the pertinent aspects of the issue of screening for scoliosis.[2] This statement disagreed with the recommendations of the USPSTF, which in 2004 recommended against the routine screening of asymptomatic adolescents for idiopathic scoliosis, citing a low predictive value of screening, a relatively small percentage of children who progress, and the possibility of unnecessary treatment including brace use.[3] Although AAOS, SRS, POSNA, and AAP recognized that support for scoliosis screening has limitations, the informational statement claimed that potential benefits that patients with idiopathic scoliosis receive from early treatment of their deformities can be substantial. The joint statement concluded that "…if scoliosis screening is undertaken, the AAOS, SRS, POSNA, and AAP agree that females should be screened twice, at 10 and 12… and boys once, at age 13 or 14 …."

In addition, the AAOS, SRS, POSNA, and AAP statement expressed the importance of educating screening personnel to minimize unnecessary referrals and to optimize the appropriate use of spine radiographs, as not all children referred as a result of screening require radiographs. If radiographs were needed, physicians were advised to take necessary precautions to limit the patient's exposure to radiation.

This updated position paper will provide further information to support the continued evaluation of adolescents for scoliosis. In addition, we urge the USPSTF to reconsider their 2004 recommendation regarding screening for scoliosis.

Screening for Scoliosis—The Current Evidence

Routine clinical screening for scoliosis continues to be controversial. Previous studies have both supported[4, 5] and discouraged routine screening.[6, 7, 8] To date, no prospective, randomized, controlled studies have been performed on population screening for scoliosis. We believe that such a study is unlikely to be performed at the current time. This concern was recognized in the 1996 USPSTF report, which concluded that there was insufficient evidence to make a recommendation for, or against, screening programs for AIS.[9] However, in 2004, the USPSTF changed their earlier opinion and recommended against routine screening of asymptomatic adolescents for scoliosis largely based on a change in methodology without new evidence to indicate that screening was not effective.[10]

There have been several publications on screening for scoliosis since 2007 that include a systematic review of the literature and large retrospective studies. In 2013, Labelle et al. published a consensus statement developed by an international task force of the SRS regarding screening for AIS.[11] The task force performed a systematic review of the literature through 2012 and used a modified Delphi process following the framework of the World Health Organization to reach consensus on the validity of a screening program. The panel reached consensus on the five domains studied, with four of the domains—technical efficacy, clinical, program, and treatment effectiveness— supportive of screening, but there was insufficient evidence to make a statement with respect to cost effectiveness.

Screening examinations for spine deformity vary in different locations, from a purely visual examination to a physical examination, scoliometer reading, and surface topographic measures during an annual health services examination. The clinical examination of chest and trunk for asymmetry is considered a proxy for spine deformity.

The forward bend Adams test with the use of a scoliometer (a specialized inclinometer) was agreed upon by the SRS task force as an effective quantitative measure with 5 to 7 degrees of deformity as a threshold for positive screening. The task force did not reach agreement on the need for topographic measurement. Since females reach puberty about two years before males and are afflicted with a magnitude of scoliosis requiring treatment three to four times more frequently than males, the task force recommended that screening be performed twice for females at age 10 and 12 years in order to capture variation in maturity. Males could be screened once at age 13 to 14 years.

AAOS, SRS, POSNA, and AAP believe that screening examinations for spine deformity should be part of the medical home preventive services visit for females at age 10 and 12 years, and males once at age 13 or 14 years.

The clinical effectiveness of screening for the detection of curves greater than 20 degrees was supported in a large retrospective study by Luk et al. of 115,190 adolescents followed until the age of 19 years.[12] In their study, 2.8 percent of adolescents were referred for a radiograph. At final follow up, the positive predictive value for spinal curvature greater than 20 degrees was 43.8 percent and 9.8 percent for treatment. Sensitivity was near 90 percent for both diagnosis and treatment. Conversely, Yawn et al. reported on a population-based school screening program in Rochester, Minnesota.[6] In this retrospective cohort study, 4.1 percent (92/2242) of children screened positively and were referred for evaluation. The positive predictive value was low (.05) and they concluded that roughly 450 children would need to be screened for every child who subsequently received treatment as a result of screening. The discrepancy in these studies points out the need for effective screening systems as inappropriate false positive screening may lead to unnecessary referrals and radiographs with higher population cost. Although well done population screening may be an effective means to capture all children at risk, many communities may not have sufficient resources to carry out these programs. In all communities, primary care providers serve as an important source for screening. Education of primary care providers in the clinical examination for early detection of scoliosis and the use of a decision algorithm has been shown to be effective in the reduction of referrals to specialty care.[13] Documentation of the screening and discussion of a positive screening result with a parent/guardian is important. After a child has an abnormal scoliosis screening evaluation, a clinician should confirm a possible diagnosis of spinal deformity and consider obtaining a spine radiograph if indicated. There are no peer-reviewed reports comparing rates of early and late detection of scoliosis in communities with and without population screening or community provider based screening programs.

AAOS, SRS, POSNA, and AAP believe that effective screening programs must have well trained screening personnel who can utilize forward bending tests and scoliometer measurements to correctly identify and appropriately refer individuals with AIS for further investigation.

The cost of population-based screening programs has been raised as a concern. In 2000, Yawn and Yawn published a study that examined issues related to charges in a population screening program, including the primary care visit, orthopaedist visit, and radiographs. The total costs were estimated to be $34.40 per child screened, $4,198.67 per case identified, and $15,115.20 per child treated.[7] Lee et al. used the data from the Hong Kong program to give a more detailed estimate of cost (in 2005 US dollars) for each segment of the screening and subsequent care.[14] The cost per student for screening was $17.94; for screening plus diagnostic tests, it was $20.02. In addition, they calculated the cost of brace treatment until age 19 to be $8,018 while the cost of surgery and care to age 19 was at least $27,538, as this estimate did not take into account any subsequent revision surgery, which is reported to occur in 5 to 10 percent of patients.[15, 16] There are no similar studies that establish the cost of screening in the medical home model.

Concerns have previously been raised about radiation exposure in children who screen positive and receive a radiograph, but are not found to have scoliosis.[8] All studies of screening programs show that there is a significant rate of false positives that are further referred for evaluation and possible spinal imaging.

Current techniques of shielding, patient positioning, use of special films, the institution of digital radiography, and newer low dose imaging systems using slit scanning have significantly reduced the radiation exposure. Luo et al. noted that current imaging techniques have reduced radiation exposure to radiosensitive breast tissue to 1/100th of that used in patients reported by Doody et al. in the US Scoliosis Cohort study.[17]

***AAOS, SRS, POSNA, and AAP believe that the principles of ALARA (as low as reasonably allowable) should be applied in the diagnostic imaging of children to decrease radiation exposure from spinal imaging for AIS.*[18]**

Treatment for Those Detected in Scoliosis Screening

Effective treatment of patients referred from scoliosis screening should be able to reduce the risk of a curve progressing to a point where surgery is indicated or, for severe curves, to be able to identify patients who would benefit from surgery before the deformity progresses to a degree that increases the risks associated with surgery.

Brace treatment for scoliosis has been the most prescribed non-operative method of treatment over the past 40 years. In recent years, refinements have been made in identifying which patients with idiopathic scoliosis may benefit most from this treatment.[19]

The two most common parameters used to assess the effectiveness of non-operative treatment of scoliosis have been defined as the ability to prevent curve progression to the point of surgery or to show a difference in the likelihood of curve progression of greater than 5 degrees by the time a patient has finished growth. Katz et al. demonstrated the efficacy of bracing in a non- controlled population where 82 percent of patients who wore a brace for greater than 12 hours per day had less than 5 degrees of curve progression compared to only 31 percent of those who wore the brace for less than 7 hours per day.[20] An important feature of this study was that brace wear compliance was monitored by a temperature sensitive data recorder imbedded in the spinal orthosis.

In 2013, the results of a multi-center National Institutes of Health (NIH) funded, randomized clinical trial of the effectiveness of bracing to prevent progression of scoliosis were published.[1] The Bracing in Adolescent Idiopathic Scoliosis Trial (BrAIST) included patients randomized to brace wear or no brace wear and a patient preference cohort. The inclusion criteria were skeletal immaturity and a moderate scoliosis of 20 to 40 degrees. The primary outcome was curve progression to 50 degrees or more (treatment failure) or reaching skeletal maturity without curve progression to 50 degrees (treatment success). The study was concluded prior to full enrollment by the NIH Data Safety and Monitoring Board due to the interim analysis that showed that braced patients had a significantly better rate of treatment success than non-braced patients. In the randomly assigned group, 75 percent of braced patients versus 42 percent of observational patients successfully reached skeletal maturity with a curve magnitude of less than 50 degrees (surgical range). This was a 56 percent reduction in relative risk of progression to a surgical level of scoliosis. The success rate of bracing was highly correlated to the number of hours of brace wear, based on a temperature data recorder compliance monitor. The number of patients needed to treat (NNT) in order to prevent one surgery was three. No difference was found in patient reported quality of life or adverse effects in the braced or observational patients. An independent study by Sanders et al. supported the results of BrAIST with a similar NNT of three.[21]

Other means for non-operative treatment of scoliosis have also been studied. Scoliosis specific exercises used to supplement brace wear or prevent progression in mild curves have been reported. A randomized clinical trial of patients with mild scoliosis of 10 to 20 degrees has shown that scoliosis specific exercises may prevent progression to the level of deformity that would result in brace treatment.[22]

These high quality studies have established that non-operative treatment with bracing or scoliosis specific exercises may reduce the number of patients progressing to a surgical level. To be effective, these treatments need to be applied to smaller curves prior to skeletal maturity. This places emphasis on the need for earlier detection of scoliosis. Early detection by screening programs that identify adolescents at risk for progression will offer patients and families the opportunity to seek effective, non-operative treatments. The patient preference of non-operative brace treatment rather than observation was noted in the patient preference arm of BrAIST, where there was a 2:1 ratio for selection of bracing over observation. Non-operative therapies are most effective in curves of lesser magnitudes, thus supporting the value of early detection.

AAOS, SRS, POSNA, and AAP believe that recent high quality studies demonstrate that non-operative interventions such as bracing and scoliosis specific exercises can decrease the likelihood of curve progression to the point of requiring surgical treatment.

Educational resources that provide more specific instruction and guidelines for conducting screening examinations for scoliosis are listed below.

AAOS.org; SRS.org; POSNA.org; healthychildren.org

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Opinion Statement Number: 1122

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