

ACR–SPR–SSR PRACTICE PARAMETER FOR THE PERFORMANCE OF RADIOGRAPHY FOR SCOLIOSIS IN CHILDREN

Revised 2024 (Resolution 29)

The American College of Radiology, with more than 30,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

PREAMBLE

Radiologists, medical physicists, non-physician radiology providers, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Facilities and their responsible staff should consult with the radiation safety officer to ensure that there are policies and procedures for the safe handling and administration of radiopharmaceuticals in accordance with ALARA principles. These policies and procedures must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by applicable state, local, or other relevant regulatory agencies and accrediting bodies, as appropriate. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol, using body habitus or other customized method when such guidance is available.

Nationally developed guidelines, such as the [ACR's Appropriateness Criteria](#)[®], should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently[®] for children (www.imagegently.org) and Image Wisely[®] for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Skeletal Radiology (SSR).

Scoliosis is defined as a lateral curvature of the spine of 10° or more, usually with a rotary component [1-4]. It can be classified according to its etiology: congenital, idiopathic, traumatic, degenerative, or as part of a generalized disease or syndrome [3,5,6]. Radiography is a proven and useful procedure to confirm the presence of scoliosis, characterize and classify the spinal deformity, and assess response to treatment [2-5,7].

This practice parameter outlines the principles for performing high-quality radiography of the spine for scoliosis in children.

Radiography for scoliosis in children should be performed only for a valid medical reason and with the minimum radiation dose necessary to achieve a diagnostic-quality study. Additional views or specialized examinations may be required. Although it is not possible to detect every abnormality associated with scoliosis, adherence to this practice parameter will maximize the probability of detection.

All radiographic examinations should be performed in accordance with the [ACR–AAPM–SIIM-SPR Practice Parameter for Digital Radiography](#) [8].

II. INDICATIONS

Indications for radiography of the spine for scoliosis include, but are not limited to, the following:

1. Alterations in normal spinal alignment on physical examination
2. Alterations in normal spinal alignment detected on other imaging studies
3. Evaluation of spinal curvature progression
4. Follow-up of treatment (orthotic or surgical)
5. Evaluation of individuals with a history of scoliosis in immediate family members
6. Evaluation of individuals at risk for scoliosis (eg, cerebral palsy, Duchenne muscular dystrophy, thoracic surgery, and radiation therapy) [9,10].

In the absence of clinical progression, scoliosis radiography is not needed more frequently than once a year [11]. However, when risk of progression is highest (eg, during puberty), more frequent imaging may be needed, but not more than every six months.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR–AAPM–SIIM-SPR Practice Parameter for Digital Radiography](#) [13]. In addition, the interpreting physician should be familiar with the proper technique and assessment of scoliosis radiographs [1,14-16].

IV. SPECIFICATIONS OF EXAMINATION

The written or electronic request for a radiograph for a scoliosis evaluation should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. (ACR Resolution 35, adopted in 2006 – revised in 2016, Resolution 12-b)

A. Scoliosis Survey

The number of views required for complete evaluation of scoliosis varies with the clinical indications. For

scoliosis screening, a posteroanterior (PA) radiograph of the spine obtained in the upright position may be sufficient [3,15]. The field of view should extend from the cervicocranial junction to the proximal femurs. [1,3,7,15,17,18]. PA positioning of the patient decreases radiation dose to the thyroid and breast [3,4]. A supine (anteroposterior) view will suffice if the patient is unable to stand (eg, the very young child, neuromuscular or paralysis patients) [7]. For these patients who are unable to stand, a spine chair made of radiolucent plastic (eg PVC) can be used to position and secure the patient against the wall bucky for both AP and lateral views. An upright lateral radiograph facilitates assessment of sagittal deformity (abnormal kyphosis and lordosis), sagittal balance [3], and spondylolisthesis. Spondylolysis may be detected, although this is best evaluated with dedicated images when relevant. Multiple studies have shown that there is a decrease in radiation dose with digital imaging systems compared with conventional radiography. These systems should be preferentially employed for imaging of known or suspected scoliosis [19].

The patient should stand (preferably) or sit before a vertical grid. When standing, the knees are placed together in full extension with feet slightly apart. In the lateral position, arms should be placed straight in front of the patient rather than above the patient's head to prevent hyperextension of the spine. When possible, the PA image of the thoracolumbar spine should be obtained at a minimum source-to-receptor distance of 6 ft (180 cm) and an image size of either 14 in × 17 in or 14 in × 36 in. With computed radiography and digital radiography, some vendors provide software to "stitch" 2 or 3 images into one [18,20-22]. Comparison of the source images with the stitched image is helpful to determine if any artifacts were generated during stitching and to confirm overlap or "missing" levels between original source images [23,24]. For X-ray systems that are not able to "stitch" images, it is acceptable to perform 2 or 3 exposures with the patient in unchanged position to capture the full length of the spine (eg, upper and lower images of spine).

Studies have also evaluated the use of a slot scanning device and a dynamic flat-panel detector [25,26]. Although the study found higher skin doses and similar dose area product for the dynamic flat-panel detector compared with the slot scanning device, other investigators have found that the dose savings are comparable to an appropriately filtered beam [26]. Image quality for the slot scanning device was also found to be comparable to the flat-panel detector [27]. Slot scanning systems with orthogonal x-ray tubes may be used to generate 3-D models to obtain measurements, such as the Cobb angle [26].

On the initial examination, the thoracic cage and pelvis may be imaged for correlation with clinical findings (eg, shoulder elevation, trunk shift, rib cage deformities, and congenital rib abnormalities). On the follow-up examinations, the x-ray beam should be collimated to the spine to increase image quality (because of the reduction of scattered radiation) and reduce the area of the patient exposed to radiation. Methods to decrease radiation exposure may include the use of lead-acrylic filters, increased beam filtration, use of size specific protocols, and low-dose imaging systems. [3,4,7,28-30].

In accordance with the 2019 American Association of Physics in Medicine Position Statement on the Use of Patient Gonadal and Fetal Shielding (PS 8-A), gonadal shielding should be discontinued as a routine practice but may be used to comply with individual patient requests or local regulations [31,32].

B. Additional Imaging Evaluation

For patients who are being assessed or clinically treated for scoliosis, additional images may include the following:

1. Right and left lateral bending images. These are usually obtained with the patient supine [7,15]. They are used to determine the flexibility of the curve(s) and to differentiate between structural and nonstructural curves [7,33].
2. Hyperextension and hyperflexion upright views to determine the flexibility of kyphosis and lordosis, respectively [7]
3. Images in an orthosis [34]
4. PA examination of the hand and wrist may also be performed to determine bone age.
5. Supine radiographs

V. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings \[35\]](#).

V. DOCUMENTATION

A. Imaging Analysis Of Scoliosis

1. General: Reports can be tailored to accommodate ordering provider practice, but may include:
 - a. Spine enumeration with attention to possible transitional anatomy.
 - b. Vertebral abnormalities, such as fractures, scalloping, and congenital anomalies (eg, hemivertebrae, segmentation anomalies, dysraphism)
 - c. Abnormalities of other osseous structures
 - d. Evaluation of extraosseous structures included in the examination (eg, chest and abdomen)
 - e. Note can be made of the presence of a brace, shoe lift, or other orthosis if this is known to the radiologist [18].
 - f. Reporting should also include whether the patient is imaged standing, sitting, or supine.
 - g. Imaging should include the triradiate cartilages [36].
2. Curve analysis may include the following (see appendix for definitions of terms):
 - a. Presence and number of curves. If there is more than one curve, they can be referred to as "major" and "minor" (or "compensatory") based on their Cobb measurements [16,37]. The terms "primary curve" and "secondary curve" should be avoided because these refer to chronology of development, which cannot be determined from a single study [3,6]. If lateral bending images are obtained, the curves can be further classified as "structural" or "nonstructural" [7,18,37].
 - b. Curve pattern (cervical, thoracic, lumbar, cervicothoracic or thoracolumbar)
 - c. Location of apical vertebra(e)
 - d. Curve length
 - e. Curve measurement. The ends of the curve can be identified and are the basis for the Cobb angle. This corresponds to the superior (cephalad) and inferior (caudad) end plates of the vertebrae, respectively [7,15,16,18,38]. If the end plates are poorly visualized, the pedicles can be used instead [7,39,40].
 - f. Vertebral rotation. After identifying the apical vertebra, the degree of axial rotation can be estimated using any of several established techniques, including those of Nash and Moe [3,7,15,16,41] and Perdriolle [3,7,38,42].
 - g. Evaluation of lordosis and kyphosis. End vertebrae are identified according to the Cobb technique, using the lateral view. On occasion, the upper end vertebra is not well visualized; in this case, the superior end plate of T3 or T4 may be used [37].
 - h. Several parameters can be combined to create a classification to guide surgical management for adolescent idiopathic scoliosis [3,16,18]. These include those devised by King et al [43] or Lenke et al [44], the latter being more widely used [16].
 - i. Central sacral vertical line and C7 plumb line may be generated to determine sagittal and coronal balance of scoliosis [45-48].
 - j. Pelvic tilt and rotation
3. Additional measurements may be obtained in special cases, such as the rib-vertebral angle in infantile idiopathic scoliosis [3,49].
4. Determination of skeletal age. This can be accomplished using the Risser classification, Greulich and Pyle atlas, Sanders scale, or other skeletal maturation assessment tool [50-53].
5. Lateral radiographs of the spine, though not routinely performed at many institutions, can assist in evaluation of other suspected anomalies, such as kyphosis, spondylolysis, or spondylolisthesis.

VI. EQUIPMENT SPECIFICATIONS

Equipment performance monitoring should be in accordance with the [ACR–AAPM Technical Standard for](#)

[Diagnostic Medical Physics Performance Monitoring of Radiographic Equipment \[54\]](#).

Radiographic images shall be exposed only with equipment having a beam-limiting device with rectangular collimators.

Imaging options include a wall-mounted device that accommodates a 14 in × 17 in or a 14 in × 36 in image receptor or a digital radiography system capable of stitching 2–3 images into a single image. A low-dose biplane x-ray imaging system is another method for imaging scoliosis, which can provide lower dose studies of the spine and has the advantage of 3-D reconstructions [55-59].

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Nationally developed guidelines, such as the [ACR's Appropriateness Criteria](#)[®], should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Facilities should have and adhere to policies and procedures that require ionizing radiation examination protocols (radiography, fluoroscopy, interventional radiology, CT) to vary according to diagnostic requirements and patient body habitus to optimize the relationship between appropriate radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used, except when inappropriate for a specific exam. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently[®] for children (www.imagegently.org) and Image Wisely[®] for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (<https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement>).

ACKNOWLEDGEMENTS

This practice parameter was revised according to the process described under the heading *The Process for*

Developing ACR Practice Parameters and Technical Standards on the ACR website (<https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards>) by the Committee on Practice Parameters – Pediatric Radiology of the ACR Commission on Pediatric Radiology, the Committee on Body Imaging (Musculoskeletal) of the ACR Commission on Body Imaging, and the Committee on Practice Parameters – General, Small, Emergency, and/or Rural Practice of the ACR Commission on General, Small, Emergency, and/or Rural Practice, in collaboration with the SPR and the SSR.

Writing Committee – members represent their societies in the initial and final revision of this practice parameter

ACR

Samet, Jonathan D MD, Chair
Lai, Hollie A MD
Pachon, Jan MS
Rohling, Nathan J. DO

SPR

Breen, Michael MD
Chauvin, Nancy A MD
Collins, Lee K MD
Sagar, Pallavi MD

SSR

Goldschmiedt, Judah MD
Kamel, Sarah I MD
Wong, Tony MD

Committee on Practice Parameters – Pediatric Imaging

(ACR Committee responsible for sponsoring the draft through the process)

Levin, Terry L MD, Chair
Amodio, John B MD
Blumfield, Einat MD
Goldman-Yassen, Adam MD
Lala, Shailee V MD
Laufer, Adina MD
Maloney, John A MD
Shah, Summit MD
Vatsky, Seth DO

Alizai, Hamza MD
Betz, Bradford W MD
Collard, Michael MD
Lai, Hollie A MD
Lasiacka, Zofia M MD, PhD
Li, Arleen MD
Noda, Sakura MD
Trout, Andrew T MD

Barth, Richard MD, Chair, Commission on Pediatric Radiology

Larson, David B MBA, MD, Chair, Commission on Quality and Safety

Comments Reconciliation Committee

Kagetsu, Nolan MD - CSC, Co-Chair
Amodio, John B MD
Breen, Michael MD
Collins, Lee K MD
Goldschmiedt, Judah MD
Lai, Hollie A MD
Levin, Terry L MD
Rohling, Nathan J. DO
Samet, Jonathan D MD
Wong, Tony MD

Shah, Gaurang MD - CSC, Chair
Barth, Richard MD
Chauvin, Nancy A MD
Crummy, Timothy MD, MHA - CSC
Kamel, Sarah I MD
Larson, David B MBA, MD
Pachon, Jan MS
Sagar, Pallavi MD
Schoppe, Kurt MD - CSC

REFERENCES

1. Cassar-Pullicino VN, Eisenstein SM. Imaging in scoliosis: what, why and how? *Clinical radiology* 2002;57:543-62.
2. Musson RE, Warren DJ, Bickle I, Connolly DJ, Griffiths PD. Imaging in childhood scoliosis: a pictorial review. *Postgraduate medical journal* 2010;86:419-27.
3. Van Goethem J, Van Campenhout A, van den Hauwe L, Parizel PM. Scoliosis. *Neuroimaging clinics of North America* 2007;17:105-15.
4. Coley BD. Chapter 13 Scoliosis. In: Coley B, ed. *Caffey's Pediatric Diagnostic Imaging*. 13th ed. Philadelphia, Pa: Mosby Elsevier; 2019:1309-15.
5. McAlister WH, Shackelford GD. Classification of spinal curvatures. *Radiologic clinics of North America* 1975;13:93-112.
6. Winter RB. Classification and Terminology. In: Lonstein JE, Bradford DS, Winter RB, Ogilvie JW, ed. *Moe's Textbook of Scoliosis and Other Spinal Deformities*. 3rd ed. Philadelphia, Pa: W.B. Saunders; 1995:39-43.
7. Lonstein JE. Patient evaluation. In: Lonstein JE, Bradford DS, Winter RB, Ogilvie JW, ed. *Moe's Textbook of Scoliosis and Other Spinal Deformities*. 3rd ed. Philadelphia, PA: W.B. Saunders; 1995:56-70.
8. American College of Radiology. ACR–AAPM–SIIM–SPR Practice Parameter for Digital Radiography Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Rad-Digital.pdf>. Accessed January 13, 2023.
9. Interiano RB, Kaste SC, Li C, et al. Associations between treatment, scoliosis, pulmonary function, and physical performance in long-term survivors of sarcoma. *J Cancer Surviv* 2017;11:553-61.
10. Paulino AC, Fowler BZ. Risk factors for scoliosis in children with neuroblastoma. *Int J Radiat Oncol Biol Phys* 2005;61:865-9.
11. Ng SY, Bettany-Saltikov J. Imaging in the Diagnosis and Monitoring of Children with Idiopathic Scoliosis. *Open Orthop J* 2017;11:1500-20.
12. American College of Radiology. ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf>. Accessed January 13, 2023.
13. American College of Radiology. ACR–AAPM–SIIM–SPR practice parameter for digital radiography. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Rad-Digital.pdf>. Accessed August 15, 2022.
14. Crockett HC, Wright JM, Burke S, Boachie-Adjei O. Idiopathic scoliosis. The clinical value of radiologists' interpretation of pre- and postoperative radiographs with interobserver and interdisciplinary variability. *Spine* 1999;24:2007-9; discussion 10.
15. De Smett AA. Radiographic evaluation. In: De Smett AA, ed. *Radiology of Spinal Curvature*. St. Louis, Mo: CV Mosby Company; 1985:25-58.
16. Kim H, Kim HS, Moon ES, et al. Scoliosis imaging: what radiologists should know. *Radiographics : a review publication of the Radiological Society of North America, Inc* 2010;30:1823-42.
17. Thomsen M, Abel R. Imaging in scoliosis from the orthopaedic surgeon's point of view. *European journal of radiology* 2006;58:41-7.
18. Malfair D, Flemming AK, Dvorak MF, et al. Radiographic evaluation of scoliosis: review. *AJR. American journal of roentgenology* 2010;194:S8-22.
19. Oetgen ME, Matthews AL, Martin BD, Hanway J, Kelly S, Blakemore L. Radiographic Resource Utilization in the Initial Referral and Evaluation of Patients With Adolescent Idiopathic Scoliosis. *J Am Acad Orthop Surg* 2018.
20. Berliner L, Kreang-Arekul S, Kaufman L. Scoliosis evaluation by direct digital radiography and computerized post-processing. *Journal of digital imaging* 2002;15 Suppl 1:270-4.
21. Gramer M, Bohilken W, Lundt B, Pralow T, Buzug TM. An algorithm for automatic stitching of CR X-rays. In: Buzug TM, ed. *Advances in Medical Engineering*. Vol 114. Berlin: Springer-Verlag; 2007:193-98.
22. Gooßen A, Pralow T, Grigat R. Automatic stitching of digital radiographies using image interpretation. In: Campilho A, Kamel M, ed. *Proceedings of the 5th International Conference on Image Analysis and Recognition*. Berlin: Springer Verlag; 2008:854-62.
23. Supakul N, Newbrough K, Cohen MD, Jennings SG. Diagnostic errors from digital stitching of scoliosis images - the importance of evaluating the source images prior to making a final diagnosis. *Pediatric radiology* 2012;42:584-98.
24. Walz-Flannigan A, Magnuson D, Erickson D, Schueler B. Artifacts in digital radiography. *AJR. American*

- journal of roentgenology 2012;198:156-61.
25. Yvert M, Diallo A, Bessou P, Rehel JL, Lhomme E, Chateil JF. Radiography of scoliosis: Comparative dose levels and image quality between a dynamic flat-panel detector and a slot-scanning device (EOS system). *Diagn Interv Imaging* 2015;96:1177-88.
 26. Luo TD, Stans AA, Schueler BA, Larson AN. Cumulative Radiation Exposure With EOS Imaging Compared With Standard Spine Radiographs. *Spine Deform* 2015;3:144-50.
 27. Damet J, Fournier P, Monnin P, et al. Occupational and patient exposure as well as image quality for full spine examinations with the EOS imaging system. *Med Phys* 2014;41:063901.
 28. Butler PF, Thomas AW, Thompson WE, Wollerton MA, Rachlin JA. Simple methods to reduce patient exposure during scoliosis radiography. *Radiologic technology* 1986;57:411-7.
 29. Gray JE, Hoffman AD, Peterson HA. Reduction of radiation exposure during radiography for scoliosis. *The Journal of bone and joint surgery. American volume* 1983;65:5-12.
 30. Hansen J, Jurik AG, Fiirgaard B, Egund N. Optimisation of scoliosis examinations in children. *Pediatric radiology* 2003;33:752-65.
 31. Marsh RM, Silosky M. Patient Shielding in Diagnostic Imaging: Discontinuing a Legacy Practice. *American Journal of Roentgenology* 2019;212:755-57.
 32. American Association of Physics in Medicine (AAPM). American Association of Physics in Medicine (AAPM) Position Statement PS 8-A: Available at: <https://www.aapm.org/org/policies/details.asp?type=PP&id=2552>. Accessed April 12, 2023.
 33. Kwan MK, Chiu CK, Chan TS, Abd Gani SM, Tan SH, Chan CYW. Flexibility assessment of the unfused thoracic segments above the "potential upper instrumented vertebrae" using the supine side bending radiographs in Lenke 5 and 6 curves for adolescent idiopathic scoliosis patients. *Spine J* 2018;18:53-62.
 34. Ogilvie JW. Orthotics. In: Lonstein JE, Bradford DS, Winter RB, Ogilvie, JW, ed. *Moe's Textbook of Scoliosis and Other Spinal Deformities*. 3rd ed. Philadelphia, Pa: W.B. Saunders; 1995:95-115.
 35. American College of Radiology. ACR Practice Parameter for Communication of Diagnostic Imaging Findings. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf>. Accessed January 13, 2023.
 36. Ryan PM, Puttler EG, Stotler WM, Ferguson RL. Role of the triradiate cartilage in predicting curve progression in adolescent idiopathic scoliosis. *Journal of pediatric orthopedics* 2007;27:671-6.
 37. Scoliosis Research Society. SRS Terminology Committee and Working Group on Spinal Classification Revised Glossary of Terms. Available at: <https://www.srs.org/professionals/online-education-and-resources/glossary/revised-glossary-of-terms>. Accessed April 12, 2023.
 38. Asher MA. Scoliosis evaluation. *The Orthopedic clinics of North America* 1988;19:805-14.
 39. Mehta SS, Modi HN, Srinivasalu S, et al. Interobserver and intraobserver reliability of Cobb angle measurement: endplate versus pedicle as bony landmarks for measurement: a statistical analysis. *Journal of pediatric orthopedics* 2009;29:749-54.
 40. Michael N, Carry P, Erickson M, et al. Spine and Thoracic Height Measurements Have Excellent Interrater and Intrarater Reliability in Patients With Early Onset Scoliosis. *Spine* 2018;43:270-74.
 41. Nash CL, Jr., Moe JH. A study of vertebral rotation. *The Journal of bone and joint surgery. American volume* 1969;51:223-9.
 42. Yazici M, Acaroglu ER, Alanay A, Deviren V, Cila A, Surat A. Measurement of vertebral rotation in standing versus supine position in adolescent idiopathic scoliosis. *Journal of pediatric orthopedics* 2001;21:252-6.
 43. King HA, Moe JH, Bradford DS, Winter RB. The selection of fusion levels in thoracic idiopathic scoliosis. *The Journal of bone and joint surgery. American volume* 1983;65:1302-13.
 44. Lenke LG, Betz RR, Harms J, et al. Adolescent idiopathic scoliosis: a new classification to determine extent of spinal arthrodesis. *The Journal of bone and joint surgery. American volume* 2001;83-A:1169-81.
 45. Sangole A, Aubin CE, Labelle H, et al. The central hip vertical axis: a reference axis for the Scoliosis Research Society three-dimensional classification of idiopathic scoliosis. *Spine* 2010;35:E530-4.
 46. Derman PB. Radiographic Measurements of Spinal Alignment: Which Are Clinically Relevant? *Contemporary Spine Surgery* 2018;19:1-7.
 47. Murtagh RD, Quencer RM, Uribe J. Pelvic Evaluation in Thoracolumbar Corrective Spine Surgery: How I Do It. *Radiology* 2016;278:646-56.
 48. Tambe AD, Panikkar SJ, Millner PA, Tsirikos AI. Current concepts in the surgical management of adolescent idiopathic scoliosis. *The Bone & Joint Journal* 2018;100-B:415-24.

49. Corona J, Sanders JO, Luhmann SJ, Diab M, Vitale MG. Reliability of radiographic measures for infantile idiopathic scoliosis. *The Journal of bone and joint surgery. American volume* 2012;94:e86.
50. Sanders JO, Khoury JG, Kishan S, et al. Predicting scoliosis progression from skeletal maturity: a simplified classification during adolescence. *The Journal of bone and joint surgery. American volume* 2008;90:540-53.
51. Sitoula P, Verma K, Holmes L, Jr., et al. Prediction of Curve Progression in Idiopathic Scoliosis: Validation of the Sanders Skeletal Maturity Staging System. *Spine* 2015;40:1006-13.
52. Minkara A, Bainton N, Tanaka M, et al. High Risk of Mismatch Between Sanders and Risser Staging in Adolescent Idiopathic Scoliosis: Are We Guiding Treatment Using the Wrong Classification? *Journal of pediatric orthopedics* 2018.
53. Vira S, Husain Q, Jalai C, et al. The Interobserver and Intraobserver Reliability of the Sanders Classification Versus the Risser Stage. *Journal of pediatric orthopedics* 2017;37:e246-e49.
54. American College of Radiology. ACR-AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Radiographic Equipment. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/RadEquip.pdf>. Accessed January 13, 2023.
55. Al-Aubaidi Z, Lebel D, Oudjhane K, Zeller R. Three-dimensional imaging of the spine using the EOS system: is it reliable? A comparative study using computed tomography imaging. *Journal of pediatric orthopedics. Part B* 2013;22:409-12.
56. Geijer H, Beckman K, Jonsson B, Andersson T, Persliden J. Digital radiography of scoliosis with a scanning method: initial evaluation. *Radiology* 2001;218:402-10.
57. Glaser DA, Doan J, Newton PO. Comparison of 3-dimensional spinal reconstruction accuracy: biplanar radiographs with EOS versus computed tomography. *Spine* 2012;37:1391-7.
58. Mok JM, Berven SH, Diab M, Hackbarth M, Hu SS, Deviren V. Comparison of observer variation in conventional and three digital radiographic methods used in the evaluation of patients with adolescent idiopathic scoliosis. *Spine* 2008;33:681-6.
59. Wade R, Yang H, McKenna C, Faria R, Gummerson N, Woolacott N. A systematic review of the clinical effectiveness of EOS 2D/3D X-ray imaging system. *European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society* 2013;22:296-304.

APPENDIX

Cobb measurement of angle: the "end vertebrae" are identified. The end vertebrae are the vertebrae tilted maximally toward the concavity of the curve. Parallel lines are drawn along with superior endplate of the upper end vertebra and the inferior endplate of the lower end vertebra or through the pedicles if the endplates are indistinct. Lines are constructed perpendicular to these endplate lines. The angle subtended by these lines is the angle of curvature.

Scoliosis Research Committee Terminology – Selected Terms [37]:

Apical vertebra (apex): in a curve, the vertebra most deviated laterally from the vertical axis that passes through the center of the sacrum

Caudal end vertebra: the first vertebra in the caudal direction from a curve apex whose inferior surface is tilted maximally toward the concavity of the curve

Cephalad end vertebra: the first vertebra in the cephalad direction from a curve apex whose superior surface is tilted maximally toward the concavity of the curve

Cervical scoliosis: a scoliosis with its apex at a point between C1 and the C6–7 disc

Cervical-thoracic scoliosis: a scoliosis having its apex at C7, T1, or the intervening disc space

Compensatory curve: a minor curve above or below a major curve that may or may not be structural

End vertebrae: the vertebrae that define the ends of a curve in a frontal or sagittal projection

Hyperkyphosis: a kyphosis greater than the normal range

Hyperlordosis: a lordosis greater than the normal range

Idiopathic scoliosis: a lateral curvature of the spine = 10° with rotation; of unknown etiology

Lumbar scoliosis: a scoliosis with its apex at a point between the L1–L2 disc space and the L4–L5 disc space

Major curve: the curve with the largest Cobb measurement on an upright radiograph of the spine

Minor curve: any curve that does not have the largest Cobb measurement on an upright radiograph

Nonstructural curve: a measured curve in the coronal plane in which the Cobb measurement corrects past zero on a supine lateral side-bending radiograph

Pelvic inclination: deviation of the pelvic outlet from the vertical, measured as an angle between the line from the top of the sacrum to the top of the pubis, and a horizontal line perpendicular to the lateral edge of the standing radiograph

Structural curve: a measured curve in the coronal plane in which the Cobb measurement fails to correct past zero on a supine radiograph with maximal voluntary lateral side-bending

Thoracic scoliosis: a scoliosis with its apex at a point between the T2 vertebral body and the T11–T12 disc

Thoracolumbar scoliosis: a scoliosis with its apex at T12, L1, or the intervening T12–L1 disc.

Vertebral axial rotation: transverse plane angulation of a vertebra. One method of measurement is with the Perdriolle technique (in degrees).

The recommended measurement of thoracic kyphosis from a lateral radiograph is the angle between the superior endplate of the highest measurable thoracic vertebra, usually T2 or T3, and the inferior endplate of T12.

The recommended measurement of lumbar lordosis from a lateral radiograph is the angle between the superior endplate of L1 and the superior endplate of S1.

Normal range for thoracic kyphosis: 20–50 degrees

Normal range for lumbar lordosis: 20–60 degrees

*Practice parameters and technical standards are published annually with an effective date of October 1 in the year in which amended, revised, or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Practice Parameter

2004 (Resolution 7)

Amended 2006 (Resolution 17, 35)

Revised 2009 (Resolution 32)

Revised 2014 (Resolution 15)

Revised 2019 (Resolution 7)

Revised 2024 (Resolution 29)