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The American College of Radiology will periodically define new practice guidelines 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 guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline 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, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines 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 guideline and technical standard by those entities not providing these services is not authorized.

Revised 2009 (Res. 32)*

PRACTICE GUIDELINE FOR THE PERFORMANCE OF RADIOGRAPHY FOR SCOLIOSIS IN CHILDREN

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a

successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was revised collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

Scoliosis is a 3-dimensional curvature of the vertebral column with alteration in alignment. Radiography is a proven and useful procedure to confirm the presence and location of spinal curvature, to measure the degree of curvature, and to define the type of scoliosis (e.g., congenital, juvenile idiopathic, syndromic). This guideline 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. While it is not possible to detect every abnormality associated with scoliosis, adherence to this guideline will maximize the probability of detection.

All radiographic examinations should be performed in accordance with the [Practice Guideline for General Radiography](#).

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.

For the pregnant or potentially pregnant patient, see the [ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#).

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [Practice Guideline for General Radiography](#).

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's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

A. Scoliosis Survey

The initial or screening examination consists of posteroanterior (PA) and lateral radiography of the spine obtained in the upright position. PA positioning of the patient decreases radiation dose to the thyroid and breast. The lateral radiograph facilitates assessment of kyphosis, lordosis, and spondylolisthesis. Spondylolysis may be detected, although this is best evaluated with dedicated images when relevant.

The number of images required for complete evaluation of scoliosis varies with the clinical indications. The patient should stand (preferably) or sit before a vertical grid. When standing, the knees are placed together in full extension. In the lateral position, arms should be placed straight in front of the patient rather than above the patient's head in order to improve the visibility of the scoliosis. When possible, the PA image of the thoracolumbar spine should be obtained at a minimum source-to-receptor distance of 6 feet and an image size of either 14" x 17" or 14" x 36". It is also acceptable to perform 2 exposures with the patient in unchanged position. The field of view should include the entire thoracolumbar spine from angles of the mandible to the greater trochanters.

On the initial examination, the thoracic cage and pelvis may be imaged for correlation with clinical findings (e.g., 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 decrease dose to the patient and scatter radiation, which may decrease the quality of the image. Methods to decrease radiation exposure may include the use of lead-acrylic filters, breast shields (especially for anteroposterior (AP) examinations), increased beam filtration, high-speed films and screens, and beam collimation. For patients unable to stand or sit before a vertical grid, a supine AP image may be obtained, in which case a shorter source-to-receptor distance may be used.

Gonadal shielding should be used in boys and may be used in girls when the area of curvature does not include the sacrum.

B. Additional Imaging Evaluation

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

1. Right and left lateral bending images. Preoperative studies may often include bilateral bending images in the frontal projection of both the thoracic and lumbar spine curves.
2. Images in a back brace.
3. PA examination of the left hand, including the wrist, to determine bone age.

V. DOCUMENTATION

A. Radiographic Analysis of Scoliosis

Radiographic analysis should identify the presence, direction, vertebral level, and/or apex of the primary curvature and if present, any secondary curvature. Evaluation includes a description of any vertebral or paraspinal abnormalities and the presence of pelvic

inclination (tilt). Note should be made of the presence of a brace, or of a shoe lift if this is known to the radiologist. The degree of scoliosis, kyphosis/lordosis, and/or axial rotation may be measured and quantified using established techniques. Evaluation should include the extraosseous structures included in the examination (e.g., chest and abdomen).

It is important that new images be compared with prior examinations and/or other pertinent studies that may be available. If the study is a follow-up examination, any progression of the curvature(s) should be described.

B. Determination of Skeletal Maturity

Determination of skeletal maturity may be helpful in assessing scoliosis. Skeletal maturity may be evaluated by analyzing the development of the iliac crest apophysis, as described by Risser, and/or analyzing a PA radiograph of the left hand and wrist according to standardized methods, such as the atlas-matching method of Greulich and Pyle.

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

VI. EQUIPMENT SPECIFICATIONS

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

A wall-mounted device that accommodates a 14" x 17" or a 14" x 36" receptor device must be available.

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR

Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

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 elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Radiographic and Fluoroscopic Equipment](#).

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Suggested Reading

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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 (SRS) Terminology – Selected Terms:

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

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

Hyperkyphosis – a kyphosis greater than the normal range.

Hyperlordosis – a lordosis greater than the normal range.

Lumbar scoliosis – a scoliosis that has its apex at a point between the L1-L2 disc space and the L4-L5 disc space.

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.

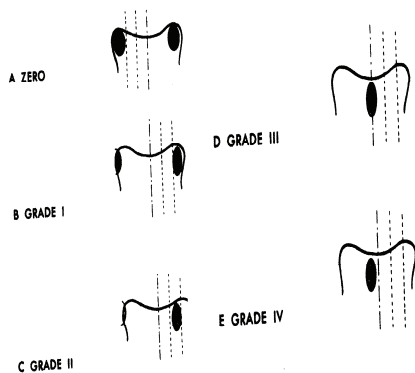
Thoracic scoliosis – a scoliosis that has its apex at a point between the T2 vertebral body and the T11-T12 disc.

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).

Measurement of Rotation

Nash and Moe method:

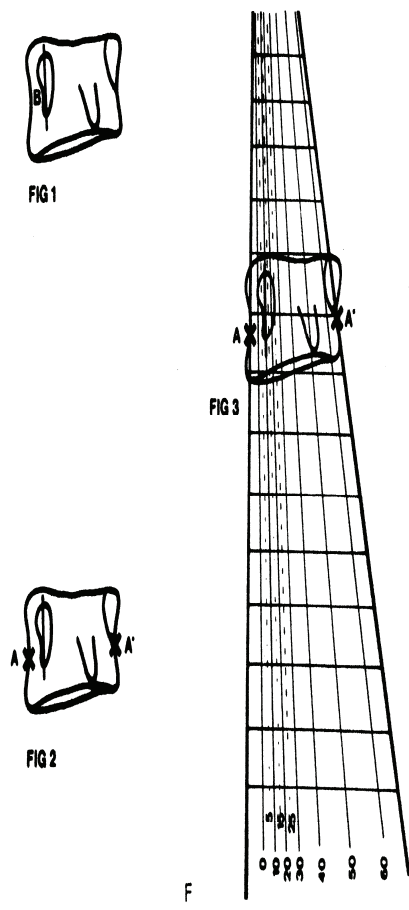


A. Zero rotation. The pedicles are equidistant from the lateral margins of the vertebral body.

- B. Grade I rotation. The pedicle on the convexity has moved from the edge of the vertebral body.
- C. Grade II rotation. Rotation intermediate between Grade I and Grade III.
- D. Grade III rotation. The pedicle is close to the center of the vertebral body.
- E. Grade IV rotation. The pedicle is past the center of the vertebral body.

From: Nash C, Moe J. A study of vertebral rotation. *J Bone Joint Surg* 1969; 51:223–229.

Perdriolle method:

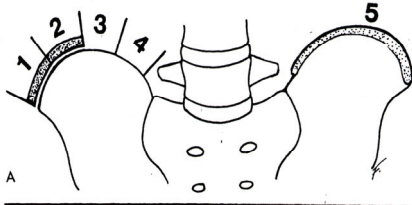


The measurement of vertebral rotation is made from the pedicle situated at the convexity of the apical vertebra under consideration. Fig. 1: mark the greatest diameter of the pedicle (B). Fig. 2: mark a reference at the waist of each lateral border of the vertebra (A and A'). Fig 3: superimpose the torsionmeter on the vertebra so that the edges of the rule are at the sides of the vertebral body. The amount of rotation of the pedicle line is read from the rotation scale, 10 degrees in this example. (Redrawn from

Pedriolle R: La Scoliose, Maloine, SA editeur, Paris, 1979.)

Risser grading of iliac apophysis maturity:

Risser grade 0 = no apophysis seen



Kyphosis and Lordosis: measurement and normal ranges:

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

*Guidelines and 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 guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

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