Scoliosis and Spine Imaging

Radiographers understand the importance of getting the most diagnostic information from as few radiographs as possible. And in the world of pediatric scoliosis imaging, pediatric orthopedic surgeons, radiologists and orthotists must obtain more than just spine data from each and every radiograph.

Texas Scottish Rite Hospital for Children (TSRHC) is a pediatric orthopedic hospital in Dallas, Texas. Upon diagnosis of scoliosis in a child, the hospital staff assures the patient and parents that, although scoliosis can be inherited, it is not uncommon, not contagious and usually not painful. TSRHC staff also help patients and parents understand that they did not cause the scoliosis and they could not have prevented its occurrence.

With 7 pediatric orthopedic surgeons at TSRHC requesting more than 12,000 scoliosis films a year, our pediatric radiographers take the time needed to produce excellent radiographs, maximize radiation protection and support patients and parents.

This article is a follow-up to the Directed Reading titled “Spinal Curves and Scoliosis,” by Susan M Anderson, MAEd, R.T.(R), in the September/October issue of Radiologic Technology. I will expand on Anderson’s article by discussing the different protocols for imaging babies, children, preteens and teens.

Scoliosis

The most common type of scoliosis is idiopathic scoliosis, which usually occurs in preteen and teen girls. Girls have scoliosis 8 times more often than boys do.

Congenital scoliosis, or early-onset scoliosis, is a frequent reason for imaging the spine of babies and young children. As a rule, children with congenital scoliosis will have missing vertebrae, fused vertebral bodies or a combination of these.

Infants and Young Children

The major directive a radiographer obtains from orthopedic surgeons concerning spine imaging is to have the patient stand with equal weight on both feet (no shoes). Nevertheless, in a pediatric imaging setting, the radiographer must be prepared to image all age groups from newborn to teens, as well as children who may have cerebral palsy, muscular dystrophy, autism, spina bifida, obesity, casts, braces or other physical limitations. Leaded markers (see Box 1), such as right, left, standing, sitting, supine and bending, must clearly reflect how each scoliosis exam was performed.

For babies younger than 1 year, anteroposterior (AP) and lateral images of the entire spine are performed supine with breast/gonadal shielding in place. This should be the only age group in which a routine scoliosis series is performed supine.

Once a toddler can stand, every attempt is made to do a standing AP scoliosis exam with breast/gonadal shields in place and a standing lateral scoliosis exam with 1 breast shield in place. At TSRHC, we do not use gonadal shielding with the lateral spine view because we believe it does not protect the gonads effectively. It can be a challenge to do this study if the toddler cannot cooperate. Sometimes it is easier to manage a small child in the AP and lateral position, and it may require 2 to 3 people to control the child’s arms, legs, head and feet (see Box 2).

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Box 1
Sample Protocol for Markers To Label Spine Films

- RIGHT and LEFT.
- STANDING, SITTING, SUPINE and CTL.
- BENDING and arrow (⇒) for bending films.
- Do not use UPRIGHT or ERECT markers; use STANDING or SITTING markers instead.
- Annotate patient information as needed.
As soon as the child can follow instructions (4 to 6 years of age), a radiographer can turn the child around and do the standing scoliosis series posteroanterior (PA) and lateral (see Boxes 3 and 4). To determine which lateral (right or left) to perform, the radiographer must review the AP or PA radiograph. If a radiographer needs to perform a scoliosis series “off” protocol, the orthopedic surgeon and radiologist must be notified. An easy method would be to annotate this information on the spine radiograph. Some common annotations are “shoes and ankle splints on,” “3-cm block under left foot,” “patient standing on left tip toes” or “patient wearing a right prosthesis.”

**Preteen and Teens**

Preteen and teen spine imaging protocols are the same as those for children who can follow instructions. If the female patient is 10 to 17 years old, her parent or legal guardian must complete and sign a pregnancy screening form. Women aged 18 years or older will complete and sign their own pregnancy screening form. Radiographers will then review and sign this form, as well as verbally question the patient about a chance of pregnancy.

When applicable, orthopedic surgeons and orthotic staff will decide whether the spine studies will be done “in brace” or “out of brace.” The orthopedist will dictate whether the “in brace” spine studies require the patient to stand (all day brace) or be supine (night brace only). Also, some centers have protocols on how long a patient must be in the brace or out of the brace before the scoliosis series is performed. TSRHC does not have such protocols.

For preteens and teens, the use of breast and gonadal shields continues to be mandatory and every patient must be reminded of the significance of standing tall and straight. Allowing the patient to sag, twist or slouch even 5˚ during the spine study can interfere with the physician's treatment plan. Accurate measurements are crucial because physicians must choose the most appropriate treatment from several different options, including taking a “wait and see” approach, having the patient wear a brace or preparing for spine surgery.

Additionally, it is essential that every radiographer in the radiology department follow the same scoliosis series protocol for each age group. To follow the progression of the scoliotic curve, every scoliosis image must be performed in a consistent manner as compared to previous scoliosis images. Children might have follow-up radiographic exams over the course of 5, 10 or 20 years. Thus, the scoliosis series protocol concerning patient positioning, shield placement and patient instructions must be reliable and reproducible.

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**Maximizing Diagnostic Information**

Pediatric orthopedic surgeons and radiologists...
above the areola of the breasts. This can help determine which body landmarks should be used when positioning the breast shields correctly, regardless of whether the patient is standing, sitting or supine.

Gonadal shields for girls and women should be placed from the pubic symphysis (PS) on up (see Figure 2). Male shielding should be over the testicles from the PS on down (see Figure 3). To determine how to palpate the PS for the AP/PA radiograph, practice by placing leaded BBs over the PS. After reviewing several exams, radiographers can learn which patient landmarks work best to place the gonadal shield properly.

**Cassettes and Filters**

The 2 customary size cassettes for imaging the entire spine are 14 in x 36 in grid cassettes with film and computed radiography (CR) grid caddies with 15 in x 34 in CR cassettes. Grid cassettes with film will strive to obtain more facts from spine images than whether the spine is normal or abnormal. With each scoliosis series, physicians can do the following: assess the patient for scoliosis; draw Cobb angles; gauge bone maturity by evaluating the iliac crest apophysis (Risser) and triaradate cartilages; assess torsion of the spine, ribs and pelvis; and rule out other abnormalities such as kyphosis, spondylolisthesis, hyperlordosis, leg length discrepancy, hemi-vertebrae, fused vertebral bodies, infection, rod placement, rod breakage and tumors. For complex spine cases, myelograms, computed tomography and magnetic resonance spine exams might be ordered to better view small bony details, help with treatment and surgery planning and assess the spinal cord.

In addition, orthotists use spine studies to develop a treatment plan, design and fit braces and encourage patient compliance. Thus, it might be necessary to consult with the orthotic department to determine any specific requirements for imaging and measuring the spine.

**Shield Placements**

It can be difficult to place breast and gonadal shields properly during a scoliosis series study. If this is an issue in your department, you might try creating a mini-research project. On the AP or PA view, breast shields should cover the outer half of the lungs without overlapping the scoliotic spine. A research project could be done by reviewing images taken with small leaded BBs placed above the areola of the breasts. This can help determine which body landmarks should be used when positioning the breast shields correctly, regardless of whether the patient is standing, sitting or supine.

**Figure 1. Standing lateral scoliosis film with entire spine from C1 to femoral heads visualized, parallel humeri and breast shield in place. Image provided courtesy of Texas Scottish Rite Hospital for Children in Dallas.**

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### Box 4

**Sample Protocol for Arms, Legs and Feet Positioning**

- Standing PA should include arms down and slightly away from hip joints. Legs and knees should be straight. Feet (no shoes) should be slightly apart, flat on the floor and facing forward.
- Standing lateral should include humeri parallel to the floor with elbows bent. Legs and knees should be straight, and feet should be slightly apart, flat on the floor and facing forward.
- Note that the arms on lateral view should never be fully extended from the shoulders because this can mimic kyphosis or hyperlordosis.
- Sitting AP should include arms down and knees apart to visualize hip joints.
- Sitting lateral should include humeri parallel to the floor with elbows bent.
require a scoliosis wedge filter with the thin part of the wedge over the patient’s diaphragm and the thicker end of the wedge over the cervical spine. This wedge filter attaches as a magnet to the tube housing.

The CR cassette with grid caddy sits on a special cassette holder on the wall Bucky. Because of special CR algorithms, CR cassettes do not need wedge filters unless the patient is very obese. If you notice that the cervical spine image is too dark (especially on the lateral radiograph), a magnetic cervical spine wedge filter or cervical collar should be used (see Figure 4).

**Timing and Types of Imaging**

Although each orthopedic surgeon will have his or her own imaging protocol, the following is a typical sequence of spine imaging. On the patient’s first visit, a scoliosis series (PA/AP and lateral) of the entire spine is ordered. Surgeons try to reduce the dose of radiation to the patient as much as possible by ordering fewer films on the follow-up studies. A follow-up exam for a patient with scoliosis would be a PA/AP scoliosis film. If the patient has kyphosis, the follow-up exam would be the lateral scoliosis view, and if the patient has spondylolisthesis, the follow-up exam would be a standing lateral spot of L5-S1 only.

Preoperative films for a patient with scoliosis can include a scoliosis series (PA/lateral) and supine AP stress right/left bending spine films. Preoperative films for a patient with kyphosis would be a scoliosis series (PA/lateral) and a cross-table lateral with the patient in a backbend position over a bolster.

Postoperative scoliosis/kyphosis surgery exams generally are a scoliosis series (PA/AP and lateral) approximately 1 month, 6 months, 1 year, 2 years and 5 years postsurgery. All of the above scoliosis exams are performed according to the protocol for patient’s age and limitations.

**False Positives and False Negatives**

There are 2 big cautions to keep in mind when performing spine imaging. The first is a false-positive report, which can occur when a patient with a straight back somehow twists his or her spine or bends his or her knees during the exam. This could be interpreted incorrectly as a spine with scoliosis. The second caution is a false-negative report, which can occur when a patient is allowed to adjust for a limitation, thereby creating a normal spine image. A good example of this is when a boy with leg length discrepancy is permitted to stand on the tip of the toes on his short leg during the spine exam. The final radiograph could show this child to have a level pelvis and straight spine when, in actuality, his pelvis is tilted and his spine curved when he stands with his feet flat on the floor.

**Conclusion**

It is critical that every imaging department establish a scoliosis series protocol. As a rule, this protocol should include directions for breast/gonadal shield placement, correct body positioning, proper patient instructions and directives that the entire spine, pelvis and femoral heads be visible. It also is important to ensure that the top collimation does not go above the chin on AP or PA view to protect the patient’s eyes. The top collimation of the lateral should not be much above C-1. The bottom collimation on both images should stop just below the femoral heads.

For radiation safety, it is best if the radiographer reviews the patient’s previous scoliosis exam. This might give the radiographer key information about the patient’s spine and hardware position and previous
breast/gonadal shield placement to keep the exams consistent.

The author would like to thank Molly Dempsey, MD, medical director of radiology at Texas Scottish Rite Hospital for Children in Dallas, and M Jeannie Smith, RIS administrator at Texas Scottish Rite Hospital for Children, for their help with this article.

Figure 3. A. Positioning of a male patient with head true PA, arms down, legs and spine straight, breast shadow shields over outer half of lungs and male gonadal shadow shield in place. B. PA scoliosis film of a male patient with chin up to include lower cervical spine; thoracolumbar spine, iliac crests/Risser's and femoral heads visualized; breast shields over outer half of lungs; and gonadal shield in place. Note surgical implants at L-4/L-5 level and R/L flip. Images provided courtesy of Texas Scottish Rite Hospital for Children in Dallas.

Figure 4. Sample scoliosis supplies are cervical spine collar filter (1), breast shadow shields (2), wedge filters (3), contact gonadal shields (4) and shadow gonadal shields (5).