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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 2011 (Resolution 54)\*

## **ACR–SPR PRACTICE GUIDELINE FOR SKELETAL SURVEYS IN CHILDREN**

### **PREAMBLE**

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiation oncology 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).

Radiographic skeletal surveys are used for a variety of clinical problems in children. A common clinical indication is suspected child abuse [1-7]. Skeletal injury is common in infants and young children who suffer abuse at the hands of those entrusted with their care. The skeletal survey is frequently critical to diagnosis of child abuse and is often presented as critical evidence in care and protection cases, criminal proceedings, and other types of litigation. Skeletal surveys are also performed to assess for skeletal dysplasias, syndromes, and metabolic disorders. Certain neoplastic and neoplastic-like conditions may also be evaluated with radiographic skeletal surveys [8-10].

### **II. DEFINITION**

A skeletal survey is a systematically performed series of radiographic images that encompasses the entire skeleton or those anatomic regions appropriate for the clinical indications.

### III. GOAL

The goal of the skeletal survey is to accurately identify focal and diffuse abnormalities of the skeleton, including healing fractures of varying ages, and to differentiate them from developmental changes and other anatomic variants that may occur in infants and children [3].

### IV. INDICATIONS

Indications for skeletal surveys include, but are not limited to:

- A. Known or suspected physical abuse in infants and young children.
- B. Known or suspected skeletal dysplasias, syndromes, and metabolic disorders.
- C. Known or suspected neoplasia and related disorders.

### V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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

In addition:

- The physician should understand the utility of alternate imaging techniques such as ultrasonography, computed tomography, nuclear medicine, and magnetic resonance imaging in order to fulfill a consultative role and to interpret pediatric skeletal surveys in the context of other available imaging results.
- The technologist should have training and experience in performing radiographic examinations in infants and children. In particular, the technologist should be familiar with positioning and patient restraint, as well as customary measures to minimize radiation exposure. The technologist should be aware of the unique circumstances created when children with suspected abuse are brought to the radiology department by caretakers, guardians, and child protective service representatives.

### VI. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for radiographic skeletal surveys 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)

The skeletal survey examination should be performed in accordance with traditional principles of high-quality diagnostic radiography. These include proper technique factors, positioning, collimation, image identification, restraining methods, and patient shielding.

The imaging protocol for the skeletal survey will depend on the particular clinical indication.

- A. Known or suspected Child Abuse

Each anatomic region (see Skeletal Survey Table) should be imaged with a separate radiographic exposure to ensure uniform image density and maximize image sharpness. A single radiograph (babygram) of the entire infant should not be performed. Each extremity should be radiographed in at least the frontal projection. Radiographs of the axial skeleton should be obtained in two projections. Additionally right and left posterior oblique views of the entire rib cage should be acquired [11-12]. Additional views as needed should be obtained to fully document suspected abnormalities and may include: a Towne view of the skull and lateral views of selected joints. The examination should be reviewed by a qualified physician as defined in section V.

In infants, the entire examination should be performed with a suitable high-detail imaging system that may use either conventional screen-film or digital radiographic technique. In the toddler and older child, dosage considerations may require that a general medium-speed system, usually employing a moving grid, may be used for imaging the larger body regions. Peak kilovoltage should be set at a sufficiently low level to provide adequate subject contrast.

When a digital radiographic system is used, it should have high spatial resolution and exhibit optimal dose efficiency characteristics. If these systems have a multiple resolution mode capability, the high resolution mode should be used. The higher resolution mode may require an increase in mAs to maintain the signal-to-noise ratio and to optimize visualization of skeletal structures. Digital processing

menus and image display parameters should be selected to enhance bone detail [13-21].

**B. Skeletal Dysplasias, Syndromes, and Metabolic Disorders**

1. Skeletal dysplasias and syndromes  
Imaging of skeletal dysplasias, including those in children with disproportionate stature and a wide variety of syndromes, including many dysmorphic disorders and some endocrineopathies, should conform to the standard skeletal survey protocol (see the Skeletal Survey Table below) with the following exceptions.
  - a. Entire arms and legs can be exposed on a single film, when the size of the child permits.
  - b. In newborns and young infants, whole-body anteroposterior (AP) and lateral radiographs may be appropriate, but separate views of the skull (frontal and lateral), hands posteroanterior (PA), and feet (AP) are advisable. Lateral views of the feet and ankles may be useful in selected cases.
  - c. As previously noted, review by a qualified physician is essential, with additional views obtained as required (e.g., flexion and extension lateral views of the cervical spine for certain skeletal dysplasias).
  - d. In selected cases the regions encompassed and radiographic projections obtained will depend on the differential diagnoses being considered.
2. Metabolic disorders  
In general it is not necessary to survey the entire bony skeleton for metabolic disorders. A targeted examination focusing on the appropriate anatomic regions of interest is recommended.

**C. Neoplasia and Related Conditions**

A protocol similar to that in section VI.A should be used. Additional orthogonal projections of areas suspected to be abnormal on clinical or other imaging grounds should be obtained.

**COMPLETE SKELETAL SURVEY TABLE**

<b>APPENDICULAR SKELETON</b>
Humeri (AP)
Forearms (AP)
Hands (PA)
Femurs (AP)
Lower legs (AP)
Feet (AP)

<b>AXIAL SKELETON</b>
Thorax (AP, lateral, right and left obliques), to include ribs, thoracic and upper lumbar spine
Pelvis (AP), to include the mid lumbar spine
Lumbosacral spine (lateral)
Cervical spine (lateral)
Skull (frontal and lateral)

**VII. DOCUMENTATION**

An official interpretation (final report) of the examination should be included in the patient’s medical record. The report should provide a concise description of all sites of definite and suspected abnormality. When a constellation of radiographic findings is sufficient to raise strong suspicion of abuse, this should be so stated in the radiology report and communicated to the referring physician, and this communication should be documented in the final report. A physician diagnosing suspected child abuse is often legally required to notify local child protection authorities. Thus, if the attending physician does not report the case, the radiologist may still be required to do so.

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

**VIII. EQUIPMENT SPECIFICATIONS**

Radiographic equipment should include a general-purpose radiographic unit having a small focal spot.

The quality of a skeletal system survey is a function of the resolution of the imaging system. Attention to contrast and resolution should be addressed when selecting the film/screen combination or digital imaging equipment.

**IX. RADIATION DOSE**

Optimal use of high-resolution imaging systems will result in an increase in radiation dose compared to typical low-dose systems widely used for general pediatric imaging. When judiciously applied for appropriate indications, this increased dose is justifiable in order to obtain superior skeletal detail. When modern high-detail imaging systems are coupled with meticulous radiographic technique, the patient dose remains well within accepted levels, and the associated risks are extremely small. Appropriate collimation and patient shielding should be used to limit radiation exposure to the anatomic area of interest.

The kVp range employed in skeletal survey imaging is 55 to 70, which is generally used for all images of the

appendicular skeleton, skull, and spine of infants. In the toddler, the kVp is increased as necessary when imaging the skull and spine. The mAs are adjusted according to the kVp, imaging system, and type of X-ray generator (single/three-phase). The focus-to-film distance is 101.6 cm (40 inches). Skeletal survey images in infants are usually performed on the tabletop. In toddlers and older children, dose considerations may require a change of imaging system from a slow, high-resolution screen/film combination to a medium-speed, general-purpose, lower-resolution system. The use of the under table cassette slot in conjunction with a moving antiscatter grid is likely to produce optimal results in larger patients. Meticulous positioning and collimation over each anatomic region are essential. Both joints are included in all long-bone images. Chest imaging uses bone detail technique.

## **X. 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)

## **XI. 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 web site (<http://www.acr.org/guidelines>).

A comprehensive quality control program should be documented and maintained at the facility. The program should help to minimize radiation risk to the patient, facility personnel, and the public, and to maximize the

quality of diagnostic information. Facility personnel must adhere to radiation safety regulations. Radiology departments should carefully select their digital radiographic systems with particular attention to high diagnostic efficiency, and optimize technical factors and processing parameters suitable for the demanding application of skeletal survey for suspected child abuse [4,14,22].

The lowest possible radiation dose consistent with acceptable diagnostic image quality should be used particularly in pediatric examinations. Radiation doses should be determined periodically based on a reasonable sample of pediatric examinations. Technical factors should be appropriate for the size and the age of the child and should be determined with consideration of parameters such as characteristics of the imaging system, organs in the radiation field, lead shielding, etc. Guidelines concerning effective pediatric technical factors are published in the radiological literature.

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Collaborative Committee – members represent their societies in the initial and final revision of this guideline

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