AIUM Practice Guideline for the Performance of an

Ultrasound Examination of the Neonatal Spine

Guideline developed in collaboration with the American College of Radiology, the Society for Pediatric Radiology, and the Society of Radiologists in Ultrasound.
The American Institute of Ultrasound in Medicine (AIUM) is a multidisciplinary association dedicated to advancing the safe and effective use of ultrasound in medicine through professional and public education, research, development of guidelines, and accreditation. To promote this mission, the AIUM is pleased to publish, in conjunction with the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU), this AIUM Practice Guideline for the Performance of an Ultrasound Examination of the Neonatal Spine. We are indebted to the many volunteers who contributed their time, knowledge, and energy to bringing this document to completion.

The AIUM represents the entire range of clinical and basic science interests in medical diagnostic ultrasound, and, with hundreds of volunteers, the AIUM has promoted the safe and effective use of ultrasound in clinical medicine for more than 50 years. This document and others like it will continue to advance this mission.

Practice guidelines of the AIUM are intended to provide the medical ultrasound community with guidelines for the performance and recording of high-quality ultrasound examinations. The guidelines reflect what the AIUM considers the minimum criteria for a complete examination in each area but are not intended to establish a legal standard of care. AIUM-accredited practices are expected to generally follow the guidelines with recognition that deviations from these guidelines will be needed in some cases, depending on patient needs and available equipment. Practices are encouraged to go beyond the guidelines to provide additional service and information as needed.
I. Introduction

The clinical aspects contained in specific sections of this guideline (Introduction, Indications/Contraindications, Specifications of the Examination, and Equipment Specifications) were developed collaboratively by the American Institute of Ultrasound in Medicine (AIUM), the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU). Recommendations for physician requirements, written request for the examination, procedure documentation, and quality control vary between the 4 organizations and are addressed by each separately.

This guideline has been developed to assist practitioners performing a sonographic examination of the neonatal and infant spine. In some cases, an additional or specialized examination may be necessary. While it is not possible to detect every abnormality, following this guideline will maximize the detection of abnormalities of the infant spine. Sonographic examination of the pediatric spinal canal is accomplished by scanning through the normally incompletely ossified posterior elements. Therefore, it is most successful in the newborn period and in early infancy. In infants older than 6 months, the examination can be very limited, although the level of termination of the cord may be identified.

In experienced hands, ultrasound imaging of the infant spine has been shown to be an accurate and cost-effective examination that is comparable to magnetic resonance imaging for evaluating congenital or acquired abnormalities in the neonate and young infant.

II. Qualifications and Responsibilities of Personnel


III. Indications/Contraindications

A. Indications

The indications for sonography of the neonatal spinal canal and its contents include but are not limited to:

1. Lumbosacral stigmata known to be associated with spinal dysraphism, including but not limited to:
   a. Midline or paramedian masses;
   b. Skin discolorations;
   c. Skin tags;
   d. Hair tufts;
   e. Hemangiomas;
   f. Pinpoint midline dimples; and
   g. Paramedian deep dimples;
2. The spectrum of caudal regression syndrome, including patients with sacral agenesis and patients with anal atresia or stenosis;

3. Evaluation of suspected defects such as cord tethering, diastematomyelia, hydromyelia, and syringomyelia;

4. Detection of sequelae of injury, such as:
   a. Hematoma after spinal tap or birth injury;
   b. Sequelae of prior instrumentation, infection, or hemorrhage; and
   c. Posttraumatic leakage of cerebrospinal fluid (CSF);

5. Visualization of fluid with characteristics of blood products within the spinal canal in patients with intracranial hemorrhage;

6. Guidance for lumbar puncture; and

7. Postoperative assessment for cord retethering.

Infants with simple, low-lying sacrococcygeal dimples typically have normal spinal contents; for them, the examination has a low diagnostic yield. On the other hand, atypical dimples, such as those larger than 5 mm, located greater than 2.5 cm above the anus, or seen in combination with other lesions, are at higher risk of occult spinal dysraphism. A sacral dimple or congenital sinus that is leaking CSF will need further assessment with magnetic resonance imaging, and sonography is therefore not a mandatory first examination in this circumstance.

B. Contraindications

1. Preoperative examination in patients with open spinal dysraphism; and

2. Examination of the contents of a closed neural tube defect if the skin overlying the defect is thin or no longer intact.

IV. Written Request for the Examination

The written or electronic request for an ultrasound examination should provide sufficient information to allow for the appropriate performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider or under the provider’s direction. The accompanying clinical information should be provided by a physician or other appropriate health care provider familiar with the patient’s clinical situation and should be consistent with relevant legal and local health care facility requirements.
V. Specifications of the Examination

The examination should be performed with the infant lying in the prone position, although the study can also be done with the patient lying on his or her side when necessary. A small bolster, such as a rolled blanket, may be placed under the lower abdomen/pelvis to help position the patient. The knees may be flexed to the abdomen to allow adequate spacing of the spinous processes and visualization of the spinal canal contents. An infant who has recently been fed will generally lie quietly during the examination. If feeding is not possible, a pacifier dipped in glucose solution will often be helpful in keeping an infant still for an optimal examination. It is important to note that infants, particularly if not full term, have difficulty maintaining normal body temperature. Therefore, the examination should be performed in a warm room, and the coupling agent should be warmed.

The cord should be assessed in the longitudinal and transverse planes, with right and left labeled on transverse images. The examination may be limited to the lumbosacral region in specific cases, such as in patients being evaluated for a sacrococcygeal dimple or in those patients being scanned to look for the presence of hematoma after an unsuccessful or traumatic spinal tap. The entire spinal canal, from the craniocervical junction to the coccyx, may be included in appropriately selected cases.

The normal cord morphologic characteristics and the level of termination of the conus should be assessed and documented. To do this, the vertebral body levels need to be accurately identified and numbered. Once the vertebral bodies are clearly numbered, the level of termination of the conus can be determined. In normal patients, the conus should lie at or above the L2 to L3 disk space. In fetuses and extremely preterm neonates, the normal conus medullaris may be caudal to the superior endplate of L3. In a preterm neonate with a conus that terminates at the L3 midvertebral body, a follow-up sonogram after age correction of 40 weeks’ gestation but before age correction of 6 months is warranted. The level of termination of the conus and its configuration should be documented, as well as any deviations from normal.

The vertebral level can be determined in a number of ways. These include:

1. After assessment of the normal lumbosacral curvature to locate the last lumbar vertebra or L5, the vertebral level of the conus is determined by counting the cephalad. This method tends to be more reproducible than the other methods described below, which rely on counting the number of rib-bearing vertebrae or the number of ossified sacral and coccygeal segments and can lead to less reliable results.
2. The first coccygeal segment has variable ossification at birth but, if ossified, can be distinguished by its more rounded shape compared with the square or rectangular shape of the sacral bodies. Counting cephalad from S1 again can help determine the vertebral level of the conus.
3. The last rib-bearing vertebra can be presumed to be T12, and the sequential lumbar level can be thus determined.

4. When the level of the conus cannot be definitively assessed as normal or abnormal, correlation with previous plain radiographs, if available, is helpful. A radiopaque marker can be placed on the skin at the level of the conus under sonographic guidance, followed by and correlated with a spine radiograph.

The level of termination of the cord is important in assessment of tethering. The cord position within the spinal canal and motion of cord and nerve roots are also helpful parameters in assessment for cord tethering. The normal position of the cord within the spinal canal, and deviation from normal, such as apposition to the dorsal aspect of the spinal canal as seen in tethering, should be documented. Cine evaluation can be helpful both in depicting anatomy and in showing movement of the distal cord and nerve roots in conjunction with cardiac-related pulsations of the spinal CSF. M-mode imaging can also be very helpful in documenting motion of the cord and nerve roots. The normal nerve roots pulsate freely with cardiac and respiratory motion, layer dependently with variable patient positioning, and are not adherent to each other. Cine evaluation can also document changes that occur with head flexion and extension. A standoff pad or a thick layer of coupling gel may be used, if needed, to follow a tract from the skin surface.

The integrity of the cord should be documented. Areas of abnormal fluid accumulation, such as hydromyelia or syringomyelia, anterior, lateral, or posterior meningoceles or pseudomeningoceles, or arachnoid cysts, should be documented and their level identified. Transverse images are essential to identify and document diastematomyelia, with off-center scanning to avoid the potential pitfall of a reverberation artifact creating a lateral duplication or ghost image.

The subarachnoid space should be evaluated for a normal anechoic appearance, interrupted by normal hyperechoic linear nerve roots and dentate ligaments. The subarachnoid space, dura, and epidural space should be evaluated, and abnormalities such as hematoma, lipoma, and other masses should be documented.

In addition to the termination of the conus, the termination of the thecal sac, typically located at S2, should be documented. The normal filum measures less than 2 mm in thickness. If the filum is abnormally hyperechoic or appears thickened, it should be measured and documented. The nerve roots of the cauda equina should be delineated within the thecal sac. In cases of failed lumbar puncture, additional imaging with the child supported in a seated position, bending forward, may be useful to allow gravity to distend the lower thecal sac with CSF.

Upright positioning can be used for image guidance of lumbar puncture or to depict meningoceles or pseudomeningoceles in some patients. Anterior meningoceles or presacral masses should also be scanned from an anterior position.

The vertebral bodies and posterior elements should be evaluated for deformities. Dysraphic defects with open posterior elements should be documented on transverse views.
VI. Documentation

Adequate documentation is essential for high-quality patient care. There should be a permanent record of the ultrasound examination and its interpretation. Images of all appropriate areas, both normal and abnormal, should be recorded. Variations from normal size should be accompanied by measurements. Images should be labeled with the patient identification, facility identification, examination date, and side (right or left) of the anatomic site imaged. An official interpretation (final report) of the ultrasound findings should be included in the patient’s medical record. Retention of the ultrasound examination should be consistent both with clinical needs and with relevant legal and local health care facility requirements.

Reporting should be in accordance with the AIUM Practice Guideline for Documentation of an Ultrasound Examination.

VII. Equipment Specifications

Sonography of the infant spine should be performed with real-time scanners using high-frequency linear array transducers, typically 7 to 10 MHz or higher in neonates. When possible, panoramic views of the entire spinal canal are very helpful in providing an overview of the anatomy and termination of the cord and thecal sac. Images of the craniocervical junction may need to be obtained with a small vector or tightly curved array transducer.

VIII. Quality Control and Improvement, Safety, Infection Control, and Patient Education

Policies and procedures related to quality control, patient education, infection control, and safety should be developed and implemented in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.

Equipment performance monitoring should be in accordance with the AIUM Standards and Guidelines for the Accreditation of Ultrasound Practices.

IX. ALARA Principle

The potential benefits and risks of each examination should be considered. The ALARA (as low as reasonably achievable) principle should be observed when adjusting controls that affect the acoustic output and by considering transducer dwell times. Further details on ALARA may be found in the AIUM publication Medical Ultrasound Safety, Second Edition.
Acknowledgments

This guideline was revised by the American Institute of Ultrasound in Medicine (AIUM) in collaboration with the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Radiologists in Ultrasound (SRU) according to the process described in the *AIUM Clinical Standards Committee Manual*.

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