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ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF VOIDING CYSTOURETHROGRAPHY IN CHILDREN

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care¹. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents 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 practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, 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 this document 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 this document. However, a practitioner who employs an approach substantially different from the guidance in this document 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 the guidance in this document 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 this document is to assist practitioners in achieving this objective.

¹ Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the ACR *Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

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

Voiding cystourethrography is a radiographic and fluoroscopic study of the lower urinary tract. It requires aseptic bladder catheterization, instillation of iodinated contrast media, fluoroscopic observation, and image documentation of the findings. The purpose of the examination is to assess the bladder, the urethra, other opacified structures, the presence or absence of vesicoureteral reflux, and micturition.

II. INDICATIONS AND CONTRAINDICATIONS [1-6]

Clinical indications for voiding cystourethrography include, but are not limited to, the following:

- Congenital anomalies of the urinary tract
- Febrile urinary tract infection, particularly if recurrent [7]
- Dysuria/difficulty voiding
- Dysfunctional voiding, such as neurogenic dysfunction of the bladder
- Incontinence
- Hydronephrosis and/or hydroureter
- Bladder outlet obstruction
- Hematuria
- Trauma
- Postoperative evaluation of the urinary tract

There are no absolute contraindications for voiding cystourethrography. Potential benefits must outweigh the minor risks of the procedure. Alerts for proceeding with caution may include prior significant reaction to iodinated contrast media, known or suspected latex allergy [8], acute urinary tract infection, recent urethral or bladder surgery, potential urethral trauma, and high spinal injury (risk of autonomic dysreflexia).

Nuclear voiding cystography may have a lower radiation dose and is an alternative study for reflux in children, especially in females with normal renal and bladder anatomy demonstrated by sonography, males with previously demonstrated reflux and normal urethral anatomy, children in whom allergy to iodinated contrast material might be a problem, and in situations in which male and female asymptomatic siblings of patients with reflux and normal renal and bladder anatomy are to be evaluated [9].

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

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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

IV. SPECIFICATIONS OF EXAMINATION

The written or electronic request for voiding cystourethrography 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. Patient Selection and Preparation

The study should be performed only for an appropriate clinical indication. Consultation with referring physicians helps to clarify which children may benefit from voiding cystourethrography.

B. Technique

Sedation

Voiding cystourethrography can typically be performed without sedation when parents and children receive adequate preparation and support [10]. When available, child-life specialists may be useful to facilitate catheterization and the remainder of the examination through use of education, distraction, and relaxation techniques [10,11]. The use of warmed contrast material may also decrease patient distress [11,12].

When clinically indicated in selected patients, sedation can help alleviate patient distress and can be performed safely, without negatively affecting the examination [11,13,14]. If sedation is used, the child must undergo pre-sedation evaluation and be monitored during and after the examination, as outlined in current practice parameter (See the [ACR-SIR Practice Parameter for Sedation/Analgesia](#)).

Preliminary Imaging

If a recent abdominal image is not available, a preliminary abdominal image may be obtained and reviewed before instilling contrast media in order to detect findings that would affect the performance of the study, such as contrast in the GI tract, opaque calculi, calcifications, and skeletal anomalies. Selective use of a lateral image may be helpful to evaluate the sacrum if there is a concern for sacral anomalies. In many cases, fluoroscopic image capture is sufficient, but a digitally acquired spot image or radiograph may be preferable in specific clinical situations needing superior spatial resolution [15,16].

Catheterization

Aseptic bladder catheterization of children should be performed by experienced personnel. Latex precautions should be observed, especially in those children with known latex allergy, multiple surgeries, or those with a diagnosis of myelomeningocele.

In males, to diminish sensation or pain, a topical anesthetic may be instilled retrograde into the urethra with aseptic technique; anesthetic gel may be applied externally in both males and females [17,18].

The catheter size should be appropriate for the child's age or urethral caliber. In premature or extremely small infants, a 5-French catheter is preferred. Above this age, an 8-French catheter is preferred, unless a smaller catheter is appropriate for the urethral anatomy, such as urethral stricture, or if there is inability to catheterize with the larger catheter. A catheter larger than 8-French may be used in adolescents. In order to avoid intravesical looping and knotting of the catheter, which may require invasive retrieval, excessive catheter length should not be inserted into the bladder. Importantly, in uncircumcised males, if the foreskin is retracted at catheterization, it should be repositioned over the glans immediately following catheterization, in order to avoid secondary paraphimosis.

Catheters may be secured by use of tape or by using catheters with balloons, filled to the appropriate volume. For balloon catheters the syringe used to inflate the balloon should be retained to deflate the balloon prior to voiding. For catheters without balloons, in girls, the catheter may be secured in place with tape to the perineum or to the thigh in older girls. In boys, once the catheter is inserted, a strip of tape may be placed on the catheter extending longitudinally along the dorsum of the penis to the symphysis. Circumferential placement of tape around the penis is discouraged.

After the catheter placement, the bladder should be drained prior to instillation of contrast media, and a sterile urine specimen may be retained for culture if clinically indicated.

Contrast Media

Iodinated contrast media (typically 12% to 18% weight/volume solution) should be administered by gravity drip. The height of the bottle controls the infusion pressure, but the diameter of the tubing somewhat limits this pressure, making the exact height somewhat less important. However, 3 feet above the table height is typically sufficient [19]. If recent bladder surgery has been performed, such as augmentation, gravity infusion should be performed with the container of contrast positioned as low as possible above the table height to assure low-pressure filling, and bladder volume should be limited, stopping infusion when patient has symptoms of pain, when contrast refluxes retrograde into the ureters beyond the ureteral stents (if present), or contrast extravasates.

Very few patients have allergic reactions to intravesical contrast. However, in the event that a patient has had anaphylaxis to intravenous contrast, one could consider allergy prophylaxis (See the [ACR–SPR Practice Parameter for the Use of Intravascular Contrast Media](#) and the [ACR Manual on Contrast Media](#)).

Fluoroscopy and Imaging

Pulsed fluoroscopy, last image hold, and fluoroscopic image capture reduce radiation dose and should be used when available [16,20]. Video recording of the examination may also be useful for later review. Estimators of radiation exposure, such as fluoroscopic parameters used and fluoroscopy time, should be documented. Fluoroscopy time should be monitored and minimized. The use of antiscatter grids should be limited to older patients, generally patients weighing more than 40–50 lbs, when the body part examined is greater than 12 cm in thickness. The examination should be collimated to the region of interest.

Standardization of an optimized imaging sequence should be employed as much as possible. Early-filling last-image capture of the bladder with a small amount of contrast may reveal an intravesical ureterocele or other mass, which might be obscured by larger contrast volume. While further bladder filling occurs, continuous imaging is not necessary [21,22].

Oblique radiographs of the bladder are obtained when the bladder is full. The approximate bladder capacity (mL) may be estimated by multiplying the patient's age in years, plus 2, by 30, ie, $(\text{age in years} + 2) \times 30$ [insert ref 23]. However, bladder capacity varies and depends on toilet habits, voiding frequency, and social attitude. Concluding a study when reaching the predicted bladder capacity may miss children with functional or neurological abnormalities (eg, infrequent voider syndrome that is characterized by a large capacity bladder). One should also be aware that in some patients overdistension of the bladder may result in inability to void [23].

Cyclical filling of the bladder (filling to capacity followed by voiding and refilling 2 to 3 times with the catheter in place) may be helpful in infants (1 year of age or younger) who void at low volumes and to increase detection of reflux in patients with a high pretest probability of reflux. The latter group includes patients with recent urinary tract infection, prior history of reflux, periureteral (Hutch) diverticulum, and evidence of pyelonephritis. Cyclical voiding is also helpful in patients who reflux into a very dilated ureter on the first fill; in these patients the refluxed contrast will be diluted by the large amount of unopacified urine, and additional voiding cycles will optimize visualization of the ureter and collecting system [24,25]. Cyclical voiding is also helpful in cases of suspected ectopic ureter inserting below the bladder base [26].

The full bladder oblique images that are obtained before voiding should profile each ureterovesical junction in relationship to the urethra (as outlined by the catheter). When vesicoureteral reflux occurs, the degree of reflux should be documented by imaging the renal fossae in the frontal projection.

For optimal imaging of the urethra, the field of view and patient positioning should be prepared before the child begins to void. Visual inspection of the perineum will reveal when the patient begins to void and avoids unnecessary and excessive fluoroscopy. Older males might be able to void more easily if the fluoroscopic table is tilted to 30 to 45 degrees or if they are able to stand.

Once voiding is detected, the male urethra may be imaged prior to removal of the catheter, since pertinent pathology may be demonstrated with the catheter in place [27]. However, it is preferable to also obtain images of the urethra after the catheter has been removed, especially in males. In neonates and young infants who may void sporadically, if the bladder has moderately emptied prior to catheter removal, it is wise to wait until it refills before removing the catheter, as the child may not void again without a full bladder.

The entire urethra should be demonstrated during the voiding phase. To image the urethra, boys should be positioned obliquely during voiding, with slight offset of the hips such that they are not superimposed. In most young boys, the entire urethra will be visible on a single voiding image. In adolescent boys, separate images of the posterior and anterior urethra may be necessary. The female urethra is generally imaged in the frontal projection, and catheter removal is not necessary for optimal views. Lateral imaging of the female urethra is performed in special circumstances, such as evaluation of urogenital sinus anomalies.

Spot images of the renal fossae immediately after voiding should be obtained to document the presence and grade of reflux or its absence. The maximal degree of vesicoureteral reflux should be accurately described and graded (see Appendix A). When an obstructive process, such as obstruction at the ureteropelvic or ureterovesical junction, coexists with reflux, refluxed contrast will be diluted by the indwelling unopacified urine, with decreased density of the refluxed contrast. In such situations, it is not possible to grade the reflux, since the degree of dilatation is not necessarily secondary to the reflux alone; this situation can lead to significant overestimation of reflux [28,29].

If there is concern for coexistent obstruction, the rate of contrast drainage from the pyelocalyceal system and ureter may be estimated by obtaining a delayed image, usually 10–20 minutes after voiding.

If a toilet-trained patient is unable to void during the fluoroscopic portion of the examination for psychological reasons, after adequate bladder distension and after a reasonable amount of time and coaxing, he or she may be allowed to void in the restroom if it is sufficiently adjacent to the fluoroscopy room to obtain quickly postvoid images. Postvoid images should be obtained immediately after voiding, with an estimate of the time interval between completion of voiding and imaging. As in postvoid imaging on the table, images should be obtained over the renal fossae and bladder to document the presence or absence of reflux and degree of bladder emptying. This limitation of the voiding portion of the examination must be documented.

Assessment of the study should include the following:

- Appearance of the spine and pelvic bones
- Documentation of opaque calculi, calcifications, or foreign bodies, when present
- Bladder contour, location, capacity, and residual volume
- Bladder lumen and filling defects, such as ureteroceles, clot, or other masses
- Presence or absence of reflux
- Site of insertion of ureter(s) when visualized by reflux
- Grade of greatest reflux and at what point in the examination it occurred
- Intrarenal reflux should be noted, if present
- Appearance of the entire urethra

- Presence or absence of extravasation or evidence of fistula

V. DOCUMENTATION

The findings of the voiding cystourethrogram should be reported in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings](#).

VI. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, registered radiologist assistants, 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 that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels) http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf

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

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available at the Image Gently[®] for children (www.imagegently.org) and Image Wisely[®] for adults (www.imagewisely.org) websites. 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 measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility’s dose information with national benchmarks, such as the ACR Dose Index Registry, the 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. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

VII. 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 (<http://www.acr.org/guidelines>).

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

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APPENDIX A

Grading System of the International Reflux Study of 1985 [30] (See Figure 7 from Pediatric Voiding Cystourethrography, a Pictorial Guide) [21]

1. Reflux only into the ureter.
2. Reflux into the entire ureter and pelvicalyceal system, no dilatation.
3. Mild pelvic or ureteral dilatation, with mild or no blunting of the fornices.
4. Moderate dilatation of the pelvis and ureter, with moderate dilation of the calyces.
5. Massive ureteral or pyelocalyceal dilatation.

*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.

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