Revised 2021 (Resolution 36)*

ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF PEDIATRIC FLUOROSCOPIC CONTRAST ENEMA EXAMINATIONS

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 care[1]. 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 considering 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 variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and 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 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 831 N.W.2d 826 (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).

Examination of the pediatric colon by fluoroscopically guided contrast enema is a proven and useful technique. This practice parameter was developed to guide physicians in the performance of contrast enema examinations for evaluating the colon in pediatric patients.

II. INDICATIONS AND CONTRAINDICATIONS

Specific indications for fluoroscopic enema in infants and children include, but are not limited to:

Investigation of potential causes of:

1. Abdominal pain
2. Constipation

Known or suspected congenital and acquired disease of the colon and distal intestine, including:

1. Lower intestinal obstruction in the neonate (such as Hirschsprung disease, meconium ileus, small left colon syndrome [meconium plug], ileal or colonic atresia, and postnecrotizing enterocolitis strictures), infant, child, or adolescent
2. Intussusception (reduction)
3. Preoperative evaluations (such as for ostomy takedown, evaluation of fistulae, or for colon abnormalities prior to small-bowel surgery)
4. Intraprocedural evaluation (such as percutaneous gastrostomy or cecostomy procedures)
5. Complications of inflammatory bowel disease or its treatment
6. Trauma
7. Postoperative or other iatrogenic conditions

Contraindications for contrast enema evaluations include evidence of colonic perforation (unless being performed to assess for perforation), ischemic colon, toxic megacolon, hypovolemic shock, peritonitis, or other potentially unstable clinical condition.

For the pregnant or potentially pregnant patient, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation [1] and the ACR Manual on Contrast Media [2].

III. QUALIFICATIONS OF PERSONNEL

See the ACR–AAPM–SIIM–SPR Practice Parameter for Digital Radiography [3] and the ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures [4].

A. Physician

In addition to the qualifications listed under the digital radiography practice parameter, the physician should have training in performing fluoroscopic examinations on infants and children. The physician should have documented training and understanding of the value of contrast enema examinations relative to other medical imaging procedures (radiography, computed tomography (CT), ultrasound, magnetic resonance imaging (MRI), and nuclear medicine) in order to choose the imaging procedure most appropriate for evaluating the clinical concerns or questions. The physician should also be familiar with the various types of contrast media that are available, including air, and their applicability to the specific clinical situation.

The physician should also have documented training in the principles of radiation protection, the hazards of radiation, and radiation monitoring requirements as they apply to both patients and personnel and in keeping radiation exposure as low as reasonably achievable (ALARA).

B. Other Ancillary Personnel

Other ancillary personnel who are qualified and duly licensed or certified under applicable state law may, under supervision by a radiologist or other qualified physician, perform fluoroscopic examinations or fluoroscopically guided imaging procedures. Supervision by a radiologist or other qualified physician must be direct or personal and must comply with local, state, and federal regulations.

Individuals should be credentialed for specific fluoroscopic and other imaging-guided interventional procedures and should have received formal training in radiation management and/or application of other imaging modalities, as appropriate. Personnel should also have training in performing fluoroscopic examinations on infants and children.

(For additional information, see the 2010 ACR Council of Digest Actions – Other Ancillary Personnel Performing Fluoroscopic Procedures, ACR Resolution 52.)

C. Radiologic Technologist

In addition to the qualifications listed under the digital radiography practice parameter, the radiologic technologist should have training in performing fluoroscopic examinations[2] on infants and children. The technologist should be skilled in performing contrast enema examinations, including patient positioning, contrast administration, and methods of applying safe and effective immobilization. Familiarity with appropriate equipment and technique is necessary to keep radiation exposure to patient and staff as low as reasonably achievable.

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for a pediatric contrast enema examination 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 – revised in 2016, Resolution 12-b)

The contrast enema examination should be performed only for an appropriate clinical indication. A qualified imaging physician, as described in Section III.A, who is familiar with the anatomy and disorders of the pediatric gastrointestinal tract should be available to help the clinician decide the most appropriate way to evaluate the child's problem(s).

Digital pulsed fluoroscopy, last image hold, and screen save features help to reduce radiation dose and should be used when available. If of adequate quality, screen saves are preferable to spot images or overhead radiographs to diminish radiation dose. Attention to collimation also aids in decreasing dose. Fluoroscopy times should be minimized and recorded. When possible, other parameters relative to radiation dose, such as dose area product (DAP), dose rate, or air kerma, should also be recorded.

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[2] The American College of Radiology approves of the practice of certified and/or licensed radiologic technologists performing fluoroscopy in a facility or department as a positioning or localizing procedure only, and then only if monitored by a supervising physician who is personally and immediately available*. There must be a written policy or process for the positioning or localizing procedure that is approved by the medical director of the facility or department/service and that includes written authority or policies and processes for designating radiologic technologists who may perform such procedures. (ACR Resolution 26, 1987 – revised in 2007, Resolution 12-m)

*For the purposes of this parameter, "personally and immediately available" is defined in manner of the "personal supervision" provision of CMS—a physician must be in attendance in the room during the performance of the procedure. Program Memorandum Carriers, DHHS, HCFA, Transmittal B-01-28, April 19, 2001.

A. Conventional Diagnostic Contrast Enema

The following examination protocols are general guidelines. The procedure should be tailored to the individual patient's needs based on clinical circumstances and the age and condition of the patient. The imaging physician exercises professional judgment in the choice of contrast media based on the clinical setting and their professional training and experience. Available normal measurement values of the diameter and length of different segments of the colon can be referred to for interpretation of results [5].

Pediatric contrast enemas are performed with single-contrast technique. With the improvement of pediatric endoscopic technique, indications for double-contrast technique in children no longer exist [6].

The child should be prepared for the procedure with an explanation appropriate to the developmental stage. The presence of child life specialist along with one or both parents may facilitate the conduct of the enema. Immobilization of the infant or young child may be helpful to facilitate performance of the procedure, minimize radiation exposure to the child and the personnel, and stabilize the child's position during the procedure. Appropriate beam filtration should be used when possible. A preliminary image may be obtained if indicated and should be primarily a fluoroscopic image. A direct exposure contributes to a significant radiation exposure [7]. A positional view (cross-table lateral or decubitus) should be obtained if there is a possibility of perforation.

Rectal catheterization should be performed or monitored by those with experience in pediatric rectal catheterization.

1. Examination preparation
   There is no specific preparation for contrast enema in most patients.

2. Examination technique
   a. Unless required by the study, the smallest possible catheter permitting adequate contrast flow is used. A balloon or cuff is not typically needed in the pediatric patient and should never be used in certain specific conditions, such as investigation for Hirschsprung disease. If a balloon catheter is used, the balloon may be inflated under fluoroscopic observation to confirm its position and the proper degree of inflation.
   b. In neonates being evaluated for distal bowel obstruction, water-soluble contrast media are preferred as there may be potential for bowel perforation; water-soluble media should be used cautiously, verifying that the concentration is iso-osmolar to slightly hyperosmolar (ie, 400 mOsm/kg) with serum. High-osmolality media are only indicated in specific cases, such as in treatment of meconium ileus, which should be undertaken only by an experienced radiologist with appropriate surgical input and backup.
   c. Rectal administration of a sufficient volume of contrast agent (barium and/or water-soluble contrast) is used to provide colonic distension. The patient is then positioned to visualize the flexures and entire colon. Filling of the entire colon in children with normal anatomy is confirmed by reflux into the small bowel, filling of the appendix, or conclusive identification of the ileocecal valve.
   d. Colonic distension positioning for optimal visualization of the flexures, as in adults, is not always necessary in pediatric patients, particularly in the neonate, and cannot be achieved in certain cases, such as in patients with microcolon or in evaluating for Hirschsprung disease (Section IV.D).
   e. High kilovoltage peak (kVp) technique is preferred (appropriate kVp will depend on contrast used and patient size).
   f. Images of the rectum in the lateral and frontal projections should be obtained. Lateral rectal images obtained for evaluation of possible Hirschsprung disease should be obtained at early filling to avoid false-negative examinations [8]. Images of the cecum should be obtained to document its position.
   g. Last image hold (or "fluoro store") functions can be used to document colonic findings. If necessary, limited images including a frontal view and lateral view that include the rectum may be obtained but are often not necessary.
   h. Postevacuation and/or postdrain images and, if needed, delayed postevacuation images and/or lateral rectal views, may also be obtained.

B. Intussusception
1. Examination preparation

No bowel preparation is indicated. A physician member of the surgical department should be notified prior to beginning the procedure and should be available in case of emergency [9]. Contraindications for examination include free intraperitoneal air, peritonitis, or shock. Other factors including atypical patient age, longer duration of symptoms, small-bowel obstruction, interloop fluid, and free intraperitoneal fluid; in addition, the lack of blood flow to the intussusceptum on Doppler evaluation may portend a more difficult reduction with greater risk of perforation [10,11]. Risks and benefits of the procedure should be explained to the patient's parent(s) or guardian. Informed consent should be obtained (see the ACR–SIR–SPR Practice Parameter on Informed Consent for Image-Guided Procedures [12]). Antibiotics may be administered preprocedure at the discretion of the clinical service [13]. The patient should have an intravenous line. The patient should receive intravenous fluids prior to the enema if there is evidence of significant dehydration. Preferably, the child is monitored throughout the procedure by a nurse or physician separate from the technologist and radiologist performing the procedure. There is no strong evidence for the adjunct use of glucagon or dexamethasone [14].

2. Examination preliminaries [15,16]
   Sonography is important in establishing the diagnosis of intussusception prior to beginning a reduction procedure. Sonography may also be useful in the prediction of reducibility [17] and the detection of a lead point [16]. Sonography may also be used in image-guided reduction with isotonic fluid, such as saline, and to confirm reduction or lack thereof postprocedure [18]. Ultrasound may also be used to guide air reductions [19]. Ultrasound-guided reduction has similar efficacy and safety as fluoroscopic reduction [20]. Preliminary supine and upright or cross-table lateral or left lateral decubitus images of the abdomen are recommended to identify free peritoneal air, which would be a contraindication to the examination.

   If an air enema for pneumatic reduction of an intussusception is performed, the equipment used should include a manometer to measure insufflation pressure and a filtration system to protect any reusable portions of the equipment [21]. An appropriate needle gauge (usually 18 gauge), large-capacity syringes, and sterile preparation material should be immediately available for paracentesis in case a tension pneumoperitoneum were to develop during a pneumatic reduction.

3. Examination technique
   Either pneumatic or hydrostatic reduction techniques are acceptable for intussusception reduction.

   a. Pneumatic reduction [14-16,22-26]
      i. Investigations indicate that pneumatic technique can lead to faster reduction (resulting in lower radiation exposure) and can have fewer complications in the rare case of perforation compared with hydrostatic techniques [14]. Air, CO_2, or O_2 may be used for a fluoroscopically guided enema for intussusception.
      ii. The rectum should be catheterized with a soft catheter, and the catheter tubing should be securely taped to the patient's buttocks. The buttocks should be firmly taped to provide as tight a seal as possible. An external plug made by winding soft tape around the catheter approximately 1 to 2 inches from the tip, in conjunction with a thin anal occluder, is helpful. An assistant who can hold the child's buttocks together during the procedure is also helpful. Alternatively, a balloon may be inflated in the rectum as needed to maintain a closed system during reduction of an intussusception [27]. The balloon should be inflated under fluoroscopic observation to confirm its position and the proper degree of inflation.
      iii. The pressure must be monitored as the gaseous contrast is insufflated into the colon. The pressure chosen depends on patient size and clinical circumstances. The recommended range is 80 to 120 mm Hg. The pressure may fluctuate during insufflation or when the patient is crying or straining, and it can also drop between insufflations. Rapid, constant insufflations tend to maintain even colonic pressure. Fluoroscopic images (or screen saves) should be obtained judiciously to document findings while limiting the radiation dose; with fluoroscopy store, more detailed documentation of the progress of reduction can be obtained. Intermittent but frequent fluoroscopy should be performed to identify the intussusception, possible mass as a lead point, free reflux of air into the small bowel, and resolution of soft-tissue mass identifying successful reduction, or development of free intraperitoneal air, signifying perforation.

iv. The length of time spent on a continuous reduction attempt or intermittent filling is at the discretion of the individual physician. A rough guideline is that if there is no progress after three separate 5-minute attempts, the procedure is likely to be unsuccessful, but other clinical factors, such as patient age and presence or absence of high-grade small-bowel obstruction also need to be considered. Signs during pneumatic reduction that suggest a lower likelihood of successful reduction include a more distal location of the intussusception mass (at or distal to the hepatic flexure) and the presence of a dissecting sign (air dissecting between the walls of the intussusceptum and the intussuscipiens)[28]. If the intussusception is reduced, the intussusceptum should disappear and air should reflux, often rapidly, into the distal small bowel. The physician should search for a residual filling defect to suggest a lead point or incomplete reduction of the intussusception. There is literature supporting a second delayed intussusception reduction attempt after waiting an hour or more in the appropriate clinical setting after unsuccessful reduction [29].

v. If a tension pneumoperitoneum occurs, paracentesis should be performed immediately in the midline infraumbilical location. Additional resuscitative measures may be needed to stabilize the child.

vi. Radiographic or fluoroscopic imaging or sonography of the abdomen may be performed at the completion of air insufflation. This may identify spontaneous reduction of a previously irreducible intussusception or immediate recurrence of a reduced intussusception. Documentation of the absence of pneumoperitoneum as a complication of the procedure is accomplished by radiography.

b. Hydrostatic reduction [14,22,30]

i. Water-soluble near-isotonic or iso-osmolar contrast media are preferred for hydrostatic reduction (see the section on Contrast Media in Children in the ACR Manual on Contrast Media [2]).

ii. The rectum should be catheterized with a soft catheter in a manner similar to the procedure outlined in the preceding section on air reduction. A balloon may be inflated in the rectum as needed to maintain a closed system during reduction of an intussusception [27]. The balloon should be inflated under fluoroscopic observation to confirm its position and the proper degree of inflation.

iii. The colon should be filled by gravity infusion. There are no absolute criteria for the height of the infusion bag, but it is typically kept approximately 3 feet above the table. The duration of each attempt at reduction and the number of attempts are at the discretion of the physician; typically, if there is no movement of the intussusception after 5 minutes, consideration may be given to stopping the reduction attempts. Fluoroscopic images (or screen saves) should be obtained judiciously, balancing the need for documentation with maintaining radiation dose at a minimum. A continuous hydrostatic reduction is maintained during each attempt at reduction. If the intussusception is reduced, contrast should fill the distal small bowel. The physician should search for a residual filling defect in the contrast column to detect a possible lead point or an ileoileal component of the intussusception. The contrast should then be drained or evacuation allowed.

iv. Large-format or fluoroscopic imaging or sonography of the abdomen may be performed at the completion of filling and after evacuation or gravity drainage of the colon; this may identify spontaneous reduction of a previously irreducible intussusception or reintussusception of a previously reduced intussusception.

C. Distal Bowel Obstruction in Neonates [31]

1. Examination

Neonates with a distal bowel obstruction may present with failure to pass meconium, abdominal distention, and/or vomiting. As the point of obstruction is distal to the ampulla of Vater, the vomiting may be bilious. Clinical examination and plain radiographs guide further imaging evaluation. Imperforate anus is diagnosed clinically. The presence of multiple distended bowel loops suggests a distal obstructive process. Differential considerations for a distal bowel obstruction in a neonate include small-bowel atresia, meconium ileus (associated with cystic fibrosis), small left colon syndrome (ie, meconium plug syndrome or functional immaturity of the colon), and Hirschsprung disease. In an infant with a history of medical necrotizing enterocolitis, an ischemic stricture should be considered.

2. Examination preparation

There should be no bowel preparation prior to the enema and preferably no digital rectal examination.

3. Examination preliminaries
   Preceding radiographs or scout images should include a positional view of the abdomen (usually cross-table lateral) to assess for free intraperitoneal air. Scout images will also show the degree of bowel dilatation and obstruction, associated abnormalities of the spine, and intra-abdominal calcifications. Intraperitoneal calcifications may be present due to meconium peritonitis as a consequence of in utero perforation from complicated small-bowel atresia or complicated meconium ileus.

4. Examination technique
   a. Contrast enema for distal bowel obstruction in a neonate is performed with water-soluble contrast material. Barium should not be used because of the possibility of an occult perforation. Water-soluble contrast also aids in relieving obstructing meconium. Near-iso-osmolar water-soluble contrast is preferred to avoid fluid shift (dehydration and electrolyte abnormalities).
   b. A soft small-gauge catheter is utilized. If a balloon catheter is used, the balloon should not be inflated until the rectum is evaluated and Hirschsprung disease excluded. During initial filling, consideration is given to the possible diagnosis of Hirschsprung disease, as discussed below in Section IV.D. Initial filling in the lateral projection allows for early filling evaluation of rectal caliber. Once evaluated in the lateral projection, the infant is turned supine (or prone at the operator's preference) to evaluate the rectum and sigmoid colon in the anteroposterior projection.
   c. Contrast is introduced via gravity to opacify the entire colon retrograde. The cecum is identified by opacification of the terminal ileum and/or appendix. If necessary, after evaluation of the rectum, the catheter balloon can be carefully inflated under fluoroscopic evaluation to achieve a better seal. Contrast is introduced until a point of obstruction is identified, an occult perforation causes intraperitoneal spill of contrast, or after opacification of the entire colon and distal small bowel with exclusion of or definition of an obstructing process.
   d. With small left colon syndrome (ie, meconium plug syndrome or functional immaturity of the colon), a relatively smaller caliber of the descending and sigmoid colon is encountered, with a plug-like filling defect of the meconium. Ideally, contrast is refluxed into the dilated colon proximal to the meconium. The contrast will facilitate passage of the meconium plug after removal of the catheter. However, Hirschsprung disease may appear identical at enema. If the baby does not clinically improve, the baby should undergo rectal biopsy. Approximately 55% of those with meconium plug syndrome are found to have Hirschsprung disease upon rectal biopsy [32].
   e. With colonic or small-bowel atresia, contrast inflow may cease once the blunt point of obstruction is encountered.
   f. With meconium ileus, contrast may opacify the distal ileum, demonstrating obstructing meconium. Water-soluble contrast enema may be therapeutic in resolving the obstruction. This is discussed below in Section IV.E.
   g. Either an atresia or meconium ileus may uncover a pre-existing perforation or be complicated by a procedural perforation. Surgical consultation prior to the enema is recommended. When performing the enema, fluoroscopic collimators are kept reasonably wide so as to monitor for intraperitoneal spillage of contrast. When perforation is detected, no further contrast is administered.
   h. A very small-caliber colon (so-called "microcolon") may be the consequence of atresia, meconium ileus, total colonic aganglionosis (Hirschsprung disease), or the rare entity megacystis microcolon intestinal hypoperistalsis syndrome [33]. The anatomy of the colon and findings at the distal ileum may aid in differentiating these processes.

D. Hirschsprung Disease [8,31,34-36]

1. Examination preparation
   Patients do not need to fast prior to this examination. There should be no bowel preparation prior to the enema, including oral or rectal cleansing medications, and preferably no recent digital examination. If the patient has had a recent rectal biopsy, the type and the time interval since the biopsy should be considered prior to scheduling the enema. There are suggestions to perform the contrast enema routinely after a rectal biopsy for further diagnostic and surgical planning [37].

2. Examination preliminaries
   Preliminary images or fluoroscopic assessment of the abdomen can be helpful in evaluating the amount of stool in the colon, the presence of obstruction, abnormalities of the spine, and in planning the extent of the contrast enema. A supine view of the abdomen may suffice; however, a positional view (upright, cross-table lateral, or decubitus) may be helpful and should be performed if the enema is performed following a recent biopsy.

3. Examination technique
   a. Water-soluble contrast should be used for evaluating childhood Hirschsprung disease. In the neonate or infant, water-soluble media diluted to near-isotonic or iso-osmolar concentrations are preferred.
   b. The rectum should be catheterized with a soft catheter, with the tip just inside the rectum. The caliber of the catheter should be small for the patient's size in order to avoid effacing a transition zone. No balloon or retention device should be inflated in the rectum during the course of the examination.
   c. The examination should be performed under fluoroscopic guidance with positioning to adequately demonstrate the transition zone if present. The child is imaged initially in the lateral position when the rectum and sigmoid colon first fill with contrast. Images are obtained immediately upon early filling and during distension (to avoid under- or overdistension); this will maximize the detection of Hirschsprung disease.
   d. The colon should be gravity-filled with contrast. The extent of filling depends on the fluoroscopic findings. Once a transition zone is demonstrated, it is desirable to avoid complete colonic filling, particularly if the colon is dilated, to prevent complications such as fluid and electrolyte disturbances. If the rectum and distal sigmoid appear normal or dilated and the proximal colon is not disproportionately distended, it is also not necessary to opacify the entire colon.
   e. Fluoroscopic images (or screen saves) of the abdomen should be obtained following colonic filling. Large-format radiographs are occasionally helpful. Following catheter removal, postevacuation views in the frontal and lateral projections may assist in evaluation but are not required in most cases.
   f. In children with a high clinical suspicion, rectal biopsy is still required regardless of enema findings [37-39].

E. Meconium Ileus of the Neonate [31,40,41]

1. Examination preparation
   Surgical evaluation should precede attempted nonoperative management of uncomplicated meconium ileus. Contraindications to the performance of a therapeutic enema include clinical or radiologic evidence of complicated meconium ileus, including perforation and pseudocyst formation. These may be manifested clinically by a palpable abdominal mass, discoloration of the abdominal wall, and signs of peritonitis and radiographically by intraperitoneal calcifications (with or without mass effect) or free intraperitoneal air.

2. Examination preliminaries
   Supine and left lateral decubitus or cross-table lateral views are evaluated for evidence of complicated meconium ileus or other etiologies of neonatal bowel obstruction requiring operative intervention. If the images remain compatible with a diagnosis of uncomplicated meconium ileus, a diagnostic contrast enema usually employing a near-isotonic or iso-osmolar water-soluble agent is performed to diagnose simple meconium ileus and exclude other causes of distal intestinal obstruction, such as ileal atresia, Hirschsprung disease, small left colon syndrome (meconium plug), or colonic atresia. If the diagnosis of meconium ileus is made by the contrast enema, the examination may proceed to a therapeutic contrast enema.

3. Therapeutic enema technique [31,42-45]
   a. A wide variety and concentration of water-soluble contrast media have been recommended for therapeutic enema for meconium ileus, including ionic and nonionic water-soluble contrast media, typically in a moderately hyperosmolar concentration. The successful use of ultrasound-guided contrast enema has been shown [41].
   b. An appropriately sized catheter is placed in the rectum, and the catheter and buttocks are secured in the usual manner (see Section IV.B.3.a.ii). A balloon may be inflated in the rectum as needed to achieve better distention. The balloon should not be distended prior to evaluating the rectum and excluding

Hirschsprung disease and should only be inflated if deemed necessary. The balloon should be inflated under fluoroscopic observation to confirm its position and the proper degree of inflation.

c. Under fluoroscopic control, contrast material is preferably infused via gravity until it reaches the dilated small bowel or until significant resistance is met.
d. The duration and number of attempts and the intervals between attempts to reflux contrast material into the meconium-filled ileum are left to the discretion of the physician. In general, repeated attempts at therapeutic enema for meconium elimination and bowel decompression are useful as long as the infant remains stable and under continued surgical and radiologic evaluation. The neonate should be kept warm and dry during the procedure and should be carefully monitored for dehydration during and in the postprocedure period due to fluid shifts as described below. Immediate postprocedural large-format or fluoroscopic images should be obtained. Follow-up abdominal radiographs should be obtained as needed to assess for relief of obstruction and for potential perforation.
e. Fluid shifts created by intraluminal hyperosmolar contrast and systemic absorption of hyperosmolar contrast may lead to dehydration and hypovolemic shock. Continued clinical surveillance and communication with the health care team are essential.

F. The following steps are suggested for a quality control program:

1. Correlation of radiologic, endoscopic, and pathologic findings where available
2. Correlation of radiologic and pathologic diagnosis of Hirschsprung disease
3. Monitoring the reduction rate and complication rate of enema for intussusception

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [46].

VI. EQUIPMENT SPECIFICATIONS

Examinations should be performed with fluoroscopic image intensification and radiographic equipment that meets all applicable federal and state radiation standards**,** optimally with pulsed fluoroscopy. Equipment should provide diagnostic fluoroscopic image quality and recording (film, video, or digital) capability. Equipment capable of producing kilovoltage >100 kVp should be available. Equipment necessary to compress and isolate regions of the colon for spot filming should be readily available.

Facilities should have the ability to deliver supplemental oxygen, to suction the oral cavity and upper respiratory tract, and to respond to life-threatening emergencies.

Equipment performance monitoring should be in accordance with the ACR-AAPM Technical Standard for Management of the use of Radiation in Fluoroscopic Procedures [4] and the ACR-AAPM Technical Standard for Diagnostic Medial Physics Performance Monitoring of Radiographic Equipment [47].

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers**,** 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 who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Nationally developed guidelines, such as the ACR's Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Facilities should have and adhere to policies and procedures that require ionizing radiation examination protocols (radiography, fluoroscopy, interventional radiology, CT) to vary according to diagnostic requirements and patient body habitus to optimize the relationship between appropriate radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used, except when inappropriate for a specific exam. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). 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 periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, 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; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

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 under the heading *ACR Position Statement on Quality Control & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement).

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REFERENCES

1. American College of Radiology. ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf. Accessed January 14, 2020.
2. American College of Radiology. ACR manual on contrast media. Available at: https://www.acr.org/Clinical-Resources/Contrast-Manual. Accessed January 14, 2020.
3. American College of Radiology. ACR–AAPM–SIIM–SPR practice parameter for digital radiography. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Rad-Digital.pdf. Accessed August 15, 2022.
4. American College of Radiology. ACR–AAPM technical standard for management of the use of radiation in fluoroscopic procedures. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/MgmtFluoroProc.pdf. Accessed January 14, 2020.
5. Koppen IJ, Yacob D, Di Lorenzo C, et al. Assessing colonic anatomy normal values based on air contrast enemas in children younger than 6 years. Pediatr Radiol 2017;47:306-12.
6. Lee HJ, Lee JH, Lee JS, Choe YH. Is colonoscopy necessary in children suspected of having colonic polyps? Gut and liver 2010;4:326-31.
7. Rao AG, Simmons CE, Sr., Thacker PG, Collins H, Ritenour ER, Hill JG. Radiation exposure contribution of the scout abdomen radiograph in common pediatric fluoroscopic procedures. Pediatr Radiol 2016;46:1241-8.
8. Berdon WE, Baker DH. The Roentgenographic Diagnosis of Hirschsprung's Disease in Infancy. Am J Roentgenol Radium Ther Nucl Med 1965;93:432-46.
9. Nguyen HN, Kan JH, Guillerman RP, Cassady CI. Intussusception revisited: is immediate on-site surgeon availability at the time of reduction necessary? AJR Am J Roentgenol 2014;202:432-6.
10. Johnson B, Gargiullo P, Murphy TV, Parashar UD, Patel MM. Factors associated with bowel resection among infants with intussusception in the United States. Pediatric emergency care 2012;28:529-32.
11. Fallon SC, Lopez ME, Zhang W, et al. Risk factors for surgery in pediatric intussusception in the era of pneumatic reduction. J Pediatr Surg 2013;48:1032-6.
12. American College of Radiology. ACR–SIR-SPR practice parameter on informed consent for image-guided procedures. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/InformedConsent-ImagGuided.pdf. Accessed January 14, 2020.
13. Al-Tokhais T, Hsieh H, Pemberton J, Elnahas A, Puligandla P, Flageole H. Antibiotics administration before enema reduction of intussusception: is it necessary? J Pediatr Surg 2012;47:928-30.
14. Gluckman S, Karpelowsky J, Webster AC, McGee RG. Management for intussusception in children. Cochrane Database Syst Rev 2017;6:CD006476.
15. Daneman A, Navarro O. Intussusception. Part 2: An update on the evolution of management. Pediatr Radiol 2004;34:97-108; quiz 87.

16. Navarro O, Daneman A. Intussusception. Part 3: Diagnosis and management of those with an identifiable or predisposing cause and those that reduce spontaneously. Pediatr Radiol 2004;34:305-12; quiz 69.

17. del-Pozo G, Albillos JC, Tejedor D, et al. Intussusception in children: current concepts in diagnosis and enema reduction. Radiographics : a review publication of the Radiological Society of North America, Inc 1999;19:299-319.

18. Britton I, Wilkinson AG. Ultrasound features of intussusception predicting outcome of air enema. Pediatr Radiol 1999;29:705-10.

19. Lee JH, Choi SH, Jeong YK, et al. Intermittent sonographic guidance in air enemas for reduction of childhood intussusception. J Ultrasound Med 2006;25:1125-30.

20. Chew R, Ditchfield M, Paul E, Goergen SK. Comparison of safety and efficacy of image-guided enema reduction techniques for paediatric intussusception: A review of the literature. J Med Imaging Radiat Oncol 2017;61:711-17.

21. Shiels WE, 2nd, Bisset GS, 3rd, Kirks DR. Simple device for air reduction of intussusception. Pediatr Radiol 1990;20:472-4.

22. Applegate KE. Intussusception in children: imaging choices. Semin Roentgenol 2008;43:15-21.

23. Gu L, Alton DJ, Daneman A, et al. John Caffey Award. Intussusception reduction in children by rectal insufflation of air. AJR Am J Roentgenol 1988;150:1345-8.

24. Shiels WE, 2nd, Kirks DR, Keller GL, et al. John Caffey Award. Colonic perforation by air and liquid enemas: comparison study in young pigs. AJR Am J Roentgenol 1993;160:931-5.

25. Shiels WE, 2nd, Maves CK, Hedlund GL, Kirks DR. Air enema for diagnosis and reduction of intussusception: clinical experience and pressure correlates. Radiology 1991;181:169-72.

26. Beres AL, Baird R. An institutional analysis and systematic review with meta-analysis of pneumatic versus hydrostatic reduction for pediatric intussusception. Surgery 2013;154:328-34.

27. Betz BW, Hagedorn JE, Guikema JS, Barnes CL. Therapeutic enema for pediatric ileocolic intussusception: using a balloon catheter improves efficacy. Emergency radiology 2013;20:385-91.

28. Ntoulia A, Tharakan SJ, Reid JR, Mahboubi S. Failed Intussusception Reduction in Children: Correlation Between Radiologic, Surgical, and Pathologic Findings. AJR Am J Roentgenol 2016;207:424-33.

29. Navarro OM, Daneman A, Chae A. Intussusception: the use of delayed, repeated reduction attempts and the management of intussusceptions due to pathologic lead points in pediatric patients. AJR Am J Roentgenol 2004;182:1169-76.

30. Hernanz-Schulman M, Foster C, Maxa R, et al. Experimental study of mortality and morbidity of contrast media and standardized fecal dose in the peritoneal cavity. Pediatr Radiol 2000;30:369-78.

31. Carroll AG, Kavanagh RG, Ni Leidhin C, Cullinan NM, Lavelle LP, Malone DE. Comparative Effectiveness of Imaging Modalities for the Diagnosis of Intestinal Obstruction in Neonates and Infants:: A Critically Appraised Topic. Acad Radiol 2016;23:559-68.

32. Buonpane C, Lautz TB, Hu YY. Should we look for Hirschsprung disease in all children with meconium plug syndrome? J Pediatr Surg 2019;54:1164-67.

33. Ballisty MM, Braithwaite KA, Shehata BM, Dickson PN. Imaging findings in megacystis-microcolon-intestinal hypoperistalsis syndrome. Pediatr Radiol 2013;43:454-9.

34. Proctor ML, Traubici J, Langer JC, et al. Correlation between radiographic transition zone and level of aganglionosis in Hirschsprung's disease: Implications for surgical approach. J Pediatr Surg 2003;38:775-8.

35. Reid JR, Buonomo C, Moreira C, Kozakevich H, Nurko SJ. The barium enema in constipation: comparison with rectal manometry and biopsy to exclude Hirschsprung's disease after the neonatal period. Pediatr Radiol 2000;30:681-4.

36. Stranzinger E, DiPietro MA, Teitelbaum DH, Strouse PJ. Imaging of total colonic Hirschsprung disease. Pediatr Radiol 2008;38:1162-70.

37. Frongia G, Gunther P, Schenk JP, et al. Contrast Enema for Hirschsprung Disease Investigation: Diagnostic Accuracy and Validity for Subsequent Diagnostic and Surgical Planning. Eur J Pediatr Surg 2016;26:207-14.

38. Muller CO, Mignot C, Belarbi N, Berrebi D, Bonnard A. Does the radiographic transition zone correlate with the level of aganglionosis on the specimen in Hirschsprung's disease? Pediatr Surg Int 2012;28:597-601.

39. Putnam LR, John SD, Greenfield SA, et al. The utility of the contrast enema in neonates with suspected Hirschsprung disease. J Pediatr Surg 2015.

40. Carlyle BE, Borowitz DS, Glick PL. A review of pathophysiology and management of fetuses and neonates with meconium ileus for the pediatric surgeon. J Pediatr Surg 2012;47:772-81.

41. Cho HH, Cheon JE, Choi YH, et al. Ultrasound-guided contrast enema for meconium obstruction in very low birth weight infants: Factors that affect treatment success. Eur J Radiol 2015;84:2024-31.

42. Jameison D, Stringer DA. Small Bowel. In: Stringer DA, Babyn PS, ed. *Pediatric Gastrointestinal Imaging and Intervention*. 2nd ed. Philadelphia, Pa: BC Decker; 2000:311-474.

43. Kao SC, Franken EA, Jr. Nonoperative treatment of simple meconium ileus: a survey of the Society for Pediatric Radiology. Pediatr Radiol 1995;25:97-100.

44. Rescorla FJ, Grosfeld JL. Contemporary management of meconium ileus. World J Surg 1993;17:318-25.

45. Ziegler MM. Meconium ileus. Curr Probl Surg 1994;31:731-77.

46. American College of Radiology. ACR practice parameter for communication of diagnostic imaging findings. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf. Accessed January 14, 2020.

47. American College of Radiology. ACR-AAPM technical standard for diagnostic medical physics performance monitoring of radiographic equipment. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/RadEquip.pdf. Accessed January 14, 2020.

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