



## Preparing Children for Imaging Studies

- Imaging studies such as CT and MRI require patients to remain still while images are acquired; in order to obtain diagnostic-quality images, some children require deep sedation or general anesthesia
- Fast scanning methods, combined with behavior distraction techniques, can often help children undergo imaging studies without sedation or general anesthesia
- Neither sedation nor general anesthesia is necessary for most children >6 years for MRI and children < 12 months or > 4 years for CT; exceptions include those with certain neurological conditions or significant developmental delay that impair their ability to lie still
- Sedation and anesthesia are a continuum; in this context "sedation" is provided by experienced sedation nurses for children who meet specific criteria
- Children with certain co-morbidities (cardiac conditions, airway abnormalities, sleep apnea, significant reflux, increased intracranial pressure) require the care of an anesthesiologist

Radiology imaging studies are becoming an increasingly important part of patient care. However, patients must remain still during these examinations for optimal image quality and, in some cases (for example, cardiac imaging), breath-holding is necessary to minimize respiratory motion. This can be very difficult for children, especially for examinations that take 45-60 minutes, as is common for MRI. Children are generally better able to tolerate nuclear medicine and fluoroscopic exams because, although comparable in duration to MRI, they are performed in less confined spaces and involve fewer loud noises.

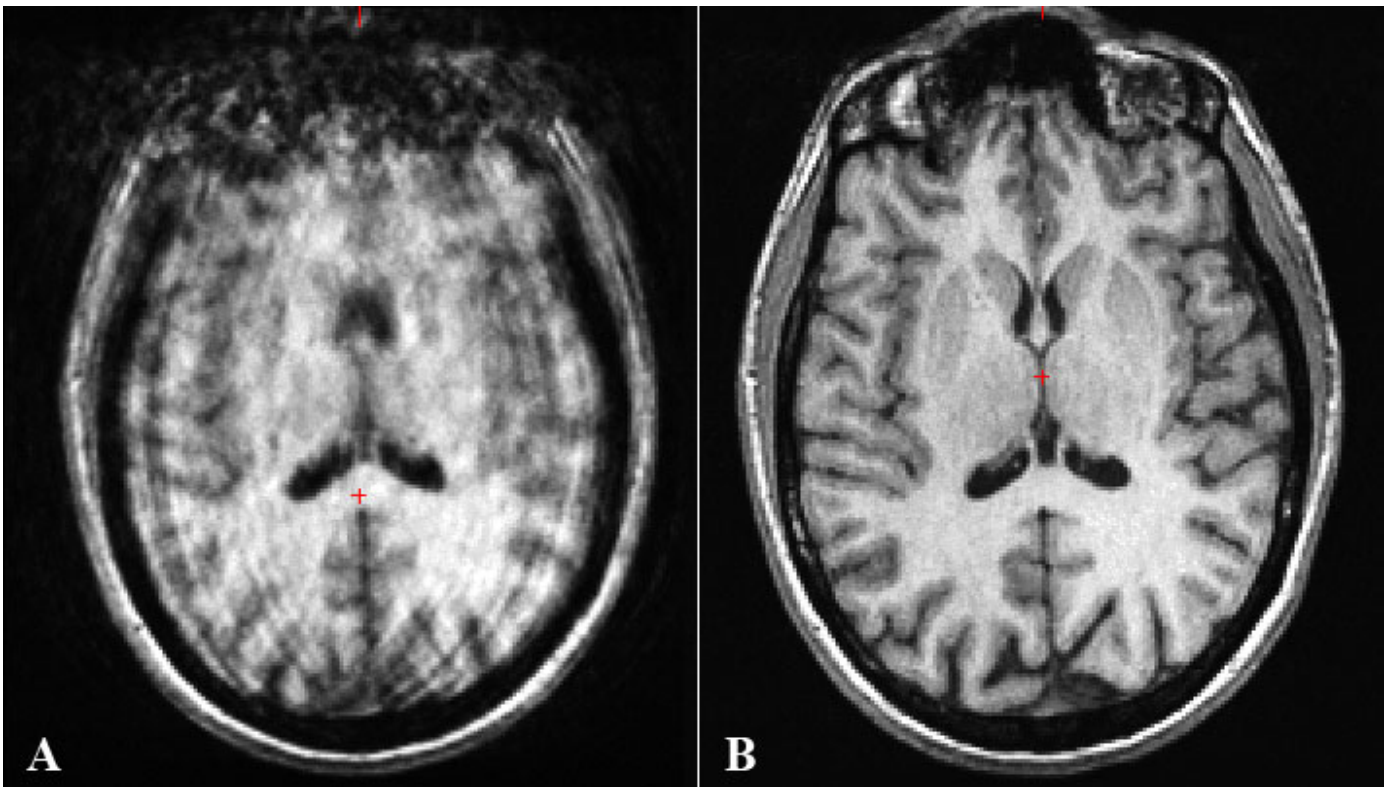
Whenever possible, children are encouraged to undergo imaging studies while awake, without sedation or general anesthesia (Figure 1). A number of behavior distraction techniques can increase a child's ability to tolerate the examination, such as watching a movie, listening to a story, watching bubble-blowing, or listening to music. Fewer options are available for distracting children during MRI due to metal incompatibility with the magnets; however, MRI-compatible audio systems and movie goggles are becoming more readily available. A child life specialist employing such distraction techniques can often help a child successfully complete an imaging examination, particularly for nuclear medicine, fluoroscopy or CT. Also, a parent accompanying a child into the scanner room can provide a soothing presence.

For children undergoing MRI, a number of scanner hardware and software strategies can minimize scan time and reduce motion artifacts. Hardware-based strategies include high field-strength magnets with



**Figure 1.** A child life specialist giving encouragement and support to a young child in an MRI scanner. Such measures often enable a child to remain still during the examination.

multi-channel phased-array coils. Software-based strategies include fast imaging sequences, parallel image processing, and respiratory triggering methods that allow chest and abdomen imaging while the child breathes normally. Additionally, real-time motion-correction sequences can be applied in certain cases to preserve image quality (Figure 2).



**Figure 2.** Axial FLAIR images of the brain obtained before (A) and after (B) application of a real-time motion-correction algorithm. Images courtesy of Ellen Grant, MD.

Despite these strategies, children are typically 6 years old before they are able to remain still long enough for MRI scanning without sedation or anesthesia, although a few children are able to do so at a younger age. Neonates and infants under 3 months, can occasionally undergo MRI examinations without sedation immediately after they have been fed, a time when they naturally fall asleep. This protocol is most commonly used for infants in neonatal intensive care.

Because modern volumetric CT scanners can image an entire patient in a few seconds, the majority of children < 12 months or > 4 years are able to remain still for CT examinations without the need for sedation or anesthesia. The exceptions are children with cognitive developmental delays who are unable to understand the process and procedure, and children who have fears that cannot be addressed with comfort measures.

### Preparing Children for Radiology Examinations

Whether a child is able to tolerate a radiology exam without sedation or anesthesia depends on personality and cognitive ability as well as the type of examination. Parents often know whether their child will be able to lie still for 30 minutes or more, if helped with some distraction. Children are less likely to be able to cooperate during an MRI examination if they do not cope well with doctors visits in general, react badly to immunization injections, or get upset by loud noises. Children with moderate or severe cognitive developmental delays are unlikely to be able to cooperate.

If it seems possible that a child will cooperate, caregivers can increase the likelihood that he or she will be able to do so through careful preparation, which

is especially important for MRI because of the loud noises from the machine, the confined space within the bore of the magnet, and the duration of the scan. Children are better able to cooperate if they know what to expect and have been coached in ways to stay still, such as pretending to be a statue. The website of the Lucille Packard Children's Hospital in Palo Alto, California, offers an excellent interactive animation on [experiencing an MRI examination](#).

If the child is likely to be able to cooperate, the child life specialist will show the child what to expect by looking at a picture book that describes what will happen during the examination and playing a recording of the [sounds of an MRI scanner](#). Parents can usually stay in the MRI room with their child, although neither pregnant mothers nor parents with MRI-incompatible metal in their bodies are permitted.

### The Choice Between Sedation or Anesthesia

Children who are not able to cooperate and remain still during imaging will need either general anesthesia or deep sedation so that they remain motionless during image acquisition. Sedation and anesthesia are a continuum; in this context "sedation" is provided by experienced sedation nurses for children who meet specific criteria.

At the MGH, the determination between sedation and anesthesia is made by the pediatric radiology nurse who reviews the child's history and physical and speaks with a parent when the test is ordered. After the decision is made, the nurse or anesthesiologist will explain it to the parent.

Pediatric nurses provide sedation to children who meet the criteria. Anesthesiologists care for children with certain co-morbidities, including those with conditions that may compromise their airways, such as sleep apnea or tracheomalacia, as well as cardiac conditions or severe gastric reflux disease. Children over 6-7 years or more than 60 lb in weight exceed dosage guidelines for nurse-administered sedation and are referred to the anesthesia team. If anesthesia is deemed appropriate, the anesthesiologist should know whether there is a family history of problems associated with anesthesia, such as malignant hyperthermia or cholinesterase deficiency.

## Procedure

Within a week of the scheduled examination, a confirmation call is made to remind the parent of the patient instructions and make sure that the child does not have a cold, a cough or flu symptoms. If sedation or anesthesia is anticipated, children may have formula 6 hours prior to the examination if they are less than 12 months old; breast milk may be given up to 4 hours prior to the examination. Children greater than 1 year old may not have any food or drink after midnight except for clear liquids up to 2 hours prior to arrival. Children scheduled for an MRI examination should wear clothes that have no metal, including zips, buckles or snaps. Full [patient instructions](#) for children undergoing sedation or anesthesia can be found on the Pediatric Radiology web site. The total time for an examination, including premedication and recovery, varies from 2-5 hours.

All children who will be receiving an IV are asked to arrive one hour before their appointment. If the child is receiving IV contrast or sedation, lidocaine/prilocaine cream (EMLA cream) is placed on the skin and covered with a waterproof adhesive dressing at the site; the IV is placed after the skin is numb.

A pediatric nurse with specialized training in the care of children undergoing sedation is responsible for administration of sedatives and patient care throughout the procedure. Chloral hydrate is commonly used as a sedative for children less than 1 year old. Older children usually receive pentobarbital, possibly in conjunction with fentanyl and midazolam.

If the child is to receive anesthesia, a pediatric anesthesiologist administers the anesthesia. Short acting anesthetic agents such as inhalation sevoflurane and or IV Propofol are often administered and children are usually calm when they emerge from anesthesia. Intubation is not usually necessary; however this is at the discretion of the anesthesiologist.

## Further Information

For further questions on pediatric imaging, please contact [Michael S. Gee, M.D., Ph.D.](#), Pediatric Radiologist at **617-724-4207** or [Anita Trombley, MS, MEd., CCLS](#), Child Life Specialist, at **617-724-1153**.

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## Scheduling

Based on the guidelines in this article, if the referring physician assesses that the child may be able to tolerate CT/MRI without sedation/anesthesia, he/she can schedule the exam through [ROE](#) or by calling **617-724-4972 (XRAY)**. A child life specialist is available to speak with families to provide some information about what the child will experience by calling **617-724-1153**. If the child will be having an MRI examination, parents will be instructed how to find a recording of the [sounds of an MRI scanner](#), which is available on the Pediatric Imaging section of the MassGeneral Hospital for Children website.

If it is anticipated that sedation or anesthesia will be necessary for successful completion of the examination or procedure, the Pediatric Radiology division must receive a completed [Procedural Sedation / Anesthesia Requisition form](#) prior to scheduling, together with the child's recent clinical history and physical examination. The form also requests information on other tests that will be done immediately before or after the requested examination(s) while still under anesthesia or sedation. This information, together with the physical and clinical history, will determine whether the patient will receive sedation or anesthesia.

Once it has been determined whether sedation, anesthesia, or no medication is needed, the non-sedated imaging examinations can be scheduled via [ROE](#) or by calling **617-724-4972 (XRAY)**. Sedation and anesthesia cases are scheduled with the sedation/anesthesia scheduler at **617-726-7915**.

Pediatric examinations that do not require anesthesia or sedation, including CT, ultrasound, GI/GU fluoroscopy, MRI, nuclear medicine, and plain film radiography are performed on the main campus and at Mass General West Imaging, Waltham. All examinations that require sedation or anesthesia are performed on the main campus.

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