

# Successful MRI Scanning of Unsedated Infants and Children: How to Scan an Infant or Child without Using Sedation

Kelly N. Botteron M.D.

[botteronk@mir.wustl.edu](mailto:botteronk@mir.wustl.edu)

## Highlights

- Research characterizing early brain development associated with developmental, psychiatric, neurologic disorders and typical healthy development has been limited due to legitimate concerns about MRI scanning of infants, toddlers and young children under sedation for research purposes
- Increasing research experience is demonstrating the feasibility of obtaining high resolution, research protocol imaging in unsedated naturally sleeping infants and awake but pre-prepped preschoolers.
- Specific techniques have been demonstrated to enhance successful research compatible data acquisition, details of these procedures will be described, including technical acquisition concerns and behavioral preparation and modifications

**Target Audience:** Pediatric Research Neuroradiologists, Infant Neuroimagers

## Objectives

1. To provide background rationale for need for unsedated pediatric neuroimaging for research and clinical purposes.
2. To describe the rate of successful scanning results from research protocols which have employed techniques to acquire unsedated naturally sleeping infant and preschool images.
3. Consideration of image acquisition protocols and factors which may influence choice of sequence parameters
4. To describe component steps of parental and child preparation prior to day of visit scanning.
5. To detail procedures utilized to facilitate successful scan acquisition on the day of visit.

## Background

Infant imaging without sedation has generally appeared to be a very daunting task and thus it has not been attempted much in the clinical or research community. Recent increased concern about possible neurodevelopmental anesthetic side effects in developing infants & children has highlighted the need for increased acquisition of unsedated scans in young infants and children(1). Although a relatively recent development, there have been several reported successful experiences across a few sites in acquiring research quality, high resolution, multi-

modal brain MRI in infants and toddlers during natural sleep (2,3,5). This was originally demonstrated and established as a fairly common clinical routine in premature infants and infants up to 1-2 months of age (4). However it was generally thought to not be not feasible to complete unседated scans in infants and toddlers. The Normal Brain Development project, a multi-site investigation sponsored by 4 NIH agencies then developed and demonstrated that in fact, scans with naturally sleeping unседated infants could be successfully completed to acquire infant neuroimaging MRI research exams (2). Subsequently a few groups have built upon this initial experience to apply these techniques and to add enhanced techniques to study similar aged cohorts across several sites (3,5).

### **Methods**

Protocols of several published and unpublished experiences will be detailed to examine protocol features which increase successful scan acquisition in naturally sleeping unседated infants. In general these methods include parent and infant preparation and environmental desensitization prior to scanning appointments. Preparation of families for what to expect and to help them feel more familiar with the process and more relaxed in the environment has enhanced success. Details of the scanning environment can also influence success and often include protocols to keep the scanning area dark and quiet and to include MRI compatible furniture such as rocking chairs and a crib for parent and child to use during preparation. A very important feature also includes protocols to markedly attenuate scanner sound with earplugs, foam inserts and headphones etc.. Conditioning to the sound of scanner prior to the day of visit is often also helpful. Order of scan acquisition, and scanning parameters based on sound & vibration effects can also improve success. All reported protocols have had staff in the room to monitor the infant and possible movement during the scan acquisition. For some infants actually continual playing of scan sounds even when sequences end can help to avoid jarring changes in volume & stimuli and promotes sleep continuation

### **Results**

Results from initially reported studies and currently ongoing studies will be detailed, with discussion of success rates by age and diagnoses. In general all published studies have reported success rates of >80% in unседated naturally sleeping infants less than 24 months of age. Discussion of estimates of impact of different protocol features will be reviewed.

### **Discussion**

The ongoing development and application of procedures to obtain unседated MRI images for research purposes in infants and very young children is definitely needed. There may also be some relevance of this work to clinical settings. It is becoming progressively clearer that quantitative characterization of early brain development is crucial to our understanding of a number of developmental disorders. Because understanding developmental disorders will require the use of longitudinal scanning – it is increasingly important that we continue to develop and apply non-sedation imaging protocols to further our knowledge about the underlying

neuroanatomy and neurophysiology associated with these disorders. Once interventions or specifically targeted pharmacotherapies or genetic modifications are possible, it will be imperative to monitor the impact on the underlying brain development in order to assess their efficacy. Recent studies are demonstrating that although it can be labor intensive, unседated imaging can be accomplished in these populations.

## References

1. Rappaport RA, Sursh S, Hertz S, Evers AS, Orser BA. Anesthetic neurotoxicity - clinical implications of animal models. *NEJM* (2015): 372(9): 796-797.
2. Almlı CR, Rivkin MJ, McKinstry RC, Brain Development Cooperative Group. The NIH MRI study of normal brain development (Objective-2): Newborns, infants, toddlers and preschoolers. *Neuroimage* (2007) 35:308-325.
3. Mathur, AM, Neil JJ, McKinstry RC, Inder TE. Transport, monitoring, and successful brain MR imaging in unседated neonates. *Pediatric Radiol* (2008) 38:260-264.
4. Dean D.C., Dirks H., O'Muircheartaigh J., Walker L., Jerskey B.A., Lehman K., Han M., Waskiewicz N. and Deoni S.C. Pediatric neuroimaging using magnetic resonance imaging during non-sedated sleep. *Pediatric Radiol* (2014) 44:64-72.
5. Wolff JJ, Gu H, Gerig G, Ellison J, Styner M, Botteron KN et.al. Piven J for the IBIS Network. Differences in white matter fiber tract development present from 6 to 24 months in infants with Autism. *Am J Psychiatry* (2102) 169:589-600.