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Case Report

Gradient Echo imaging in the evaluation of pachygyria in the pediatric patient

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Abstract: MRI is an invaluable component of the pediatric seizure evaluation. Of the differential diagnosis, the migration abnormality can be among the most challenging to establish. This novel paper demonstrates the benefit of the gradient echo sequence in detecting cortical thickening and establishing the diagnosis of pachygyria.

The submission is approved by the Institutional Review Board of the Mount Sinai School of Medicine, in accordance with Mount Sinai's Federal Wide Assurances.

Keywords:

pediatric, seizures, neuroimaging, pachygyria, gradient echo sequence

Points:

1. Pachygyria is a rare but well documented migration abnormality.
2. Gradient Echo is a common sequence used in MR imaging.
3. Migration abnormalities, such as pachygyria are diagnosed with MRI evaluation of the brain, primarily with T2 and FLAIR sequences.
4. Gradient Echo is relegated for assessing hemorrhage and calcification but can be more adept at demonstrating pachygyria than the standard sequences.

INTRODUCTION: When a child has clinical symptoms of seizures and developmental delay a migration abnormality is suspected. Migration abnormalities detection on MR imaging is challenging (1). This is especially difficult in the developing or unmyelinated brain, in which Fluid Attenuated Inversion Recovery (FLAIR) is of limited utility. While higher strength magnets and detailed higher level imaging have been invaluable to elucidating subtle abnormalities, axial T2 weighted and FLAIR imaging remain the initial primary sequences utilized. Disparity in cortical thickness may be difficult in the newborn, as the cortex is thin. The diagnosis of pachygyria in the baby may be suspected by assessing an adjacent dysmorphic sulcus, but thickening of the cortex is the diagnosis key. Pachygyria consists of four layers which are thicker than the normal six cortical layers (2).

Gradient echo imaging is generally reserved for determining susceptibility as seen in hemorrhage and calcification. (3). It is rapidly acquired and therefore a component of all standard protocols at our institution. We present 9 patients with pachygyria in which the diagnosis is aided by gradient echo imaging.

The study retrospectively reviewed our MR database to reveal 9 cases of pachygyria over a 4 year period in which axial t2, FLAIR and gradient images were obtained.

MATERIALS AND METHODS:

This study was compliant with the Health Insurance Portability and Accountability Act and was approved by the local institutional review board. Patients were identified retrospectively from a search of existing patient data. Inclusion in this study was based on the following criteria based on Picture Archival System database search:

1) age group
2) confirmed diagnosis of seizures and developmental delay
3) an MR imaging examination of the brain.
4) total of 9 patients (age range, 0 months–18 years; 5 male, 4 female with a diagnosis of pachygyria comprised the final study group.

Imaging Acquisition:

Sequences:

MRI was performed under sedation when necessary. All sequences were performed on a 1.5 tesla MRI GE signal HDxt using an 8 channel head coil. The following is our institutional protocol for evaluating a possible seizure disorder in the pediatric brain and was used for all patients. Initially, a three-plane localizer scan was performed, followed by an axial diffusion weighted sequence TR 10,000 TE minimum, FOV 20, slice thickness/gap 6/0, bandwidth 250, matrix frequency/phase 128/128, coronal and axial turbo spin-echo T2-weighted scan (TR/TE 2467/120 ms, flip angle 90°, FOV 16 cm, matrix frequency/phase 320/192, slice thickness/gap 4/1 mm), coronal and axial FLAIR sequence (TR/TE 8000/2000 ms, flip angle 90°, FOV 16 cm, matrix frequency/phase 320/192 slice thickness/gap 4/1 mm), NEX 4,sagittal and axial T1 weighted flip angle 75, TR 634 TE 12 FOV 16 slice thickness/gap 4/1 mm bandwidth 31.2 matrix frequency/phase 288/192 NE 2, axial gradient MERGE Flip 20 FOV 22 , slice thickness/gap 5/0 mm, matrix frequency/phase 256/192 TR/TE 960/2.4, 3D MPRAGE volumetric acquisition of the whole brain was acquired (TR/TE 8.3/3.8 ms, sense factor 1.5, flip angle 8°, FOV 256, ACQ voxel size 1/1/1 mm).

Imaging Data Analysis:

Evaluation of the patients was done via consensus review by 2 radiologists (G.D.H) [with 25 years of imaging experience], M.K. [with 4 years of imaging experience])

RESULTS:

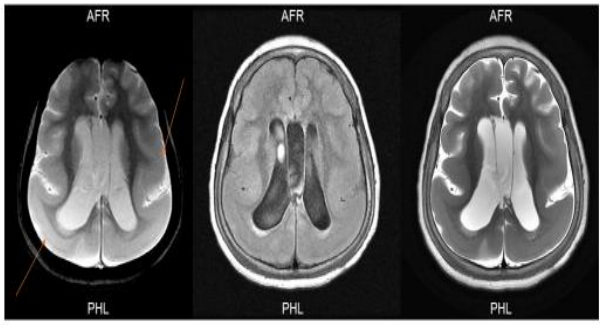
Table: 1

Patient number	Age(years)	Sex (M/F)	location
1	11	M	bilateral parietal lobes
2	9	F	diffuse, bilateral
3	3	F	diffuse, bilateral
4	17	M	left parietal lobe
5	0	M	right parietal lobe
6	7	F	right frontal lobe
7	12	M	right frontal, temporal lobes (perisylvian)
8	7	M	right parietal lobe
9	4	F	bilateral frontal and parietal lobes

Patient 2 is nine year female:

Axial gradient echo, flair and T2 weighted images (from left to right) demonstrate bilateral diffuse pachygyria, best appreciated on the gradient echo images (orange arrows).

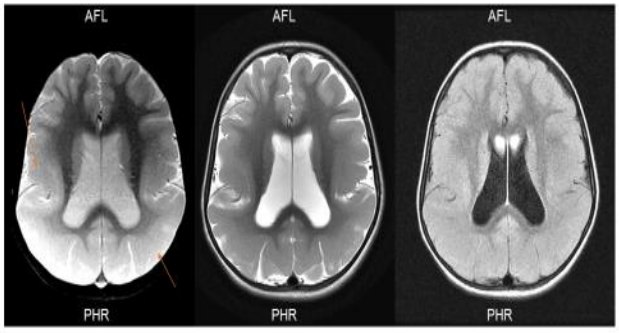
Patient 2



Patient 3 is a three year female:

Axial gradient echo, T2 and flair images (from left to right) demonstrating diffuse, bilateral pachygyria best appreciated on the axial gradient echo images (orange arrows).

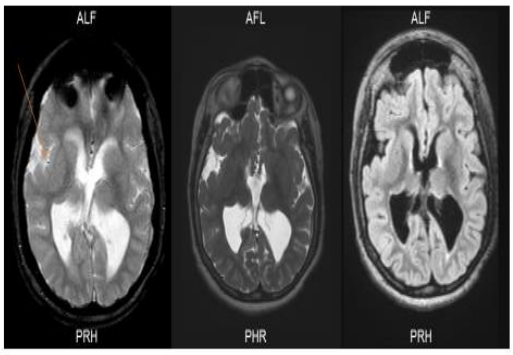
Patient 3



Patient 7 is a twelve year male.

Right perisylvian pachygyria is noted, best appreciated on the gradient echo image on the left (orange arrows). T2 image and FLAIR image (center and right) are less adept at demonstrating the migration abnormality but do demonstrate a dysplastic sylvian fissure.

Patient 7



The gradient echo imaging was the best sequence in detecting pachygyria in all patients and particularly helpful in the unmyelinated patients.

DISCUSSION:

MRI evaluation with a dedicated seizure protocol plays a significant role in the evaluation of pediatric patients presenting with epilepsy and developmental delay. The imaging can identify a seizure evoking structural abnormality which in some cases is a migration abnormality in a patient with developmental delay. Developmental malformations are noted to be the etiology of 13.5% of all causes of seizures (4).

Pachygyria is a rare but well documented migration abnormality. It is abnormal thickening of the cortex (5). The cortex is dysplastic consists of four layers which are thicker than the normal six cortical layers (2)

This is the result of arrested migration of the neurons along the radial glial unit (6).

Conventional diagnosis of pachygyria is primarily based on evaluation of T2 weighted and FLAIR images (1). The FLAIR sequence is of limited utility in the unmyelinated brain (1, 7).

Various methods have attempted to increase detectability in the diagnosis, such as three dimensional surface display (2) and diffusion tensor imaging (8).

Gradient echo, although a mainstay of imaging for neurologic disease, has been relegated for the evaluation of hemorrhage and calcification (3). However, it has proven invaluable in the detection of pachygyria at our institution, especially in the unmyelinated brain in which FLAIR is of limited utility.

CONCLUSION:

This paper offers novel evidence to suggest that gradient echo imaging, conventionally used as a means of identifying calcification and hemorrhage, is of significant utility in the identification of pachygyria, especially in the unmyelinated brain.

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