Original Investigation

Incidental Findings on Pediatric Abdominal Magnetic Resonance Angiography

Nattinee Leelakanok, MD, Matthew A. Zapala, MD, PhD, Emily A. Edwards, MD, Andrew S. Phelps, MD, John D. Mackenzie, MD, Jesse Courtier, MD

Rationale and Objectives: Abdominal magnetic resonance angiography (MRA) has gained favor in pediatric patients owing to its lack of ionizing radiation and noninvasive nature. Reports exist regarding incidental findings on body MRA in adult patients. However, the incidental findings in pediatric abdominal MRA have not been previously reported. Our study aims to determine the frequencies, characteristics, and categories of incidental findings in pediatric patients undergoing abdominal MRA.

Materials and Methods: Retrospective study was performed in 78 consecutive contrast-enhanced abdominal MRA of patients between ages 0 and 20 years over a 7-year time period. The presence of incidental vascular and extravascular findings was noted. Reports were categorized in consensus by two radiologists as no incidental finding (group A), normal or normal variants or nonsignificant incidental common findings (group B), or abnormal incidental findings (group C). Group C was reviewed to determine whether additional management was performed.

Results: A total of 40 boys and 38 girls (51%:49%) were reported, with a mean age of 12.3 years (standard deviation ±5.6 years, range 7 days to 20 years). Three most common indications for MRA were renal artery stenosis (24.4%), vasculitis (21.8%), and suspected intra-abdominal venous thrombosis (14.1%). We identified a total of 92 incidental findings in 50 of 78 patients; 60 findings in 29 patients in group B, and 32 findings in 21 patients in group C. Atelectasis at the lung bases was the most common incidental finding in group B (14 of 78 patients). The most common findings in group C were ascites, scoliosis, and splenomegaly. There were three abnormal incidental findings that led to causative workup and/or further management (moderate ascites, pericardial and pleural effusion, and venous malformation). The remaining cases with abnormal findings received treatment of their primary conditions only.

Conclusions: Pediatric abdominal MRA revealed a large number of incidental findings. The large majority were findings without clinical significance. Basal lung atelectasis was the most common overall incidental and nonsignificant finding, whereas ascites was the most common abnormal incidental finding. Although not all abnormal incidental findings affected management, appropriate identification and communication of relevant findings would improve patient care.

Key Words: MRI; MRA; Pediatric; Incidental.

INTRODUCTION

Magnetic resonance angiography (MRA) is a noninvasive method for evaluation of arterial blood vessels (1). It has many advantages such as excellent tissue contrast, multi-planar imaging capability, and noncontrast angiographic imaging. Recently, MRA has become the favored mode of angiographic imaging over computed tomography angiography or digital subtraction angiography in pediatric patients owing to its lack of ionizing radiation and noninvasive nature (2).

The preference for MRA in pediatric patients also holds true with respect to imaging of abdominal vasculature. Common indications for abdominal MRA of children are renal artery stenosis, vasculitis, tumor vascularity, portal hypertension, and transplant evaluation (1). There is no single widely accepted standard protocol of abdominal MRA in children. Additionally, there is variability in the amount of nonangiographic sequences performed to assess extravascular structures.

Few reports exist in the current literature regarding incidental findings on body MRA. Studies in adult patients undergoing renal (3) and thoracic MRA examinations (4) investigated incidental vascular and extravascular findings; however, the types of incidental findings common in adult patients (degenerative disease, malignancies, etc.) differ greatly from those in the general pediatric population. The incidence and importance of incidental findings on abdominal MRA in children, to the best of our knowledge, has not been previously reported. Our study aims to determine the frequencies, characteristics, and categories of incidental vascular

Acad Radiol 2017; ■:■■–■■

From the Department of Radiology and Biomedical Imaging, UCSF Benioff Children's Hospital, 1975 4th St C1768L, San Francisco, California, 94158, United States (N.L., M.A.Z., E.A.E., A.S.P., J.D.M., J.C.); Faculty of Medicine, Chulalongkorn University and King Chulalongkorn Memorial Hospital, Thai Red Cross Society, 1873 Rama 4 Rd. Pathumwan, Bangkok, 10330, Thailand (N.L.). Received November 18, 2016; accepted January 25, 2017. **Address correspondence to:** N.L. e-mail: Nattinee.l@chula.ac.th

http://dx.doi.org/10.1016/j.acra.2017.01.019

and nonvascular findings in pediatric patients undergoing abdominal MRA.

MATERIALS AND METHODS

A total of 78 consecutive contrast-enhanced abdominal MR angiograms of patients between ages 0 and 20 years from January 2009 to September 2016 were retrospectively reviewed. Search of the radiology report database was performed using dedicated report archive search software (Montage Healthcare, Philadelphia, PA). All repeated studies from the same patient were separately reviewed. In patients with multiple studies, if an incidental finding was seen in all examinations, then only the initial study was used. If former studies were negative and an incidental finding was described in the later studies, then the latter report was used. Studies with very limited sequences, defined as only angiographic images without the sequences that show details of extravascular structures in any plane, or non–contrast-enhanced MRA studies, were also excluded. All studies were performed on either 1.5 T or 3 T MRI systems with different vendors. Outside-hospital studies with digital images on Picture Archiving And Communication System (PACS) system meeting selection criteria were also used. The sequences and imaging parameters varied, as the institutional MRA protocol evolved during the study period, specifically with the incorporation of radial and DIXON fat-saturation techniques as well as non-contrast angiographic sequences. The current institutional protocol is provided in Table 1. All patient data were obtained using the electronic medical record and the radiological information system.

All images and finalized reports from the abdominal MRA were rereviewed by a pediatric radiologist with 4 years of experience in cross-sectional imaging (NL). The presence of incidental vascular and extravascular findings was noted. The reported incidental findings as well as the reviewed findings that were discrepant from the finalized reports were reanalyzed in consensus between the initial reviewer (NL) and a pediatric radiologist with 12 years of experience in cross-sectional imaging (JC). Reports were classified in consensus by the same set of two radiologists as no incidental finding (group A), normal or normal variants or common findings without clinical significance (group B), or abnormal incidental findings that were unexpected but whose presence might alter clinical management (group C, Fig 1). Abnormal findings that were known based on the chief problem or condition or follow-up images of previously diagnosed nonvascular lesions were not counted as incidental findings. The cases in group C were reviewed by electronic medical record to determine whether additional intervention or management was performed. Data were analyzed and statistics (percentage, mean, standard deviation, and median) were generated using Microsoft Excel 2010 (Microsoft, Inc., Redmond, WA). This retrospective cohort study is compliant with Health Insurance Portability and Accountability Act guidelines. For this type of study, formal consent is not required, but institutional review board approval was obtained.

RESULTS

Demographic Data

MRA examinations of 78 patients met the inclusion criteria (78 studies). Forty cases are boys and 38 cases are girls (51%:49%). Mean age was 12.3 years (standard deviation ±5.6) with a median of 14 years, minimum of 7 days, and maximum of 20 years. Of the 78 studies, three were performed at outside institutions. The most common indication for MRA was renal artery stenosis (24.4%). The full list of indications is summarized in Table 2.

Incidental Findings on MRA

No incidental findings were identified in 28 out of 78 patients (36%, defined as "group A"). However, incidental

TABLE 1. Current Institutional Protocol for Pediatric MRA

Sequences	Plane	TR/TE (ms)	Flip Angle	NSA	Slice Thickness/ Spacing (mm)	Rationale
T2-weighted single-shot fast spin echo	Coronal	1065/865	142	2	4/–2	Overview anatomic assessment
T2-weighted motion correction radial fat-saturated sequence	Axial	6375/93.6	142	2	4/0	General anatomic assessment, motion-resistant sequence useful in pediatric patients
T1-weighted SPGR DIXON fat saturated (including in/opposed phase)	Axial	7.4/1.9	10	0.7	3.2/–1.6	Anatomic assessment, characterization of the lesion before contrast-enhanced phase
Time resolved MRA sequence	Coronal	3.4/1.4	16	0.75	3/–1.5	High temporal and spatial volumetric MRA imaging
T1-weighted SPGR DIXON fat saturated (including in/opposed phase)	Axial and coronal	7.4/1.9	10	0.7	3.2/–1.6	Delayed imaging

MRA, magnetic resonance angiography; NSA, number of signal averages; SPGR, spoiled gradient recalled echo; TR/TE, repetition time/echo time.