Case Report: MRI of the Lung in a Young Child with Abscess Pneumonia Caused by H1N1 Infection

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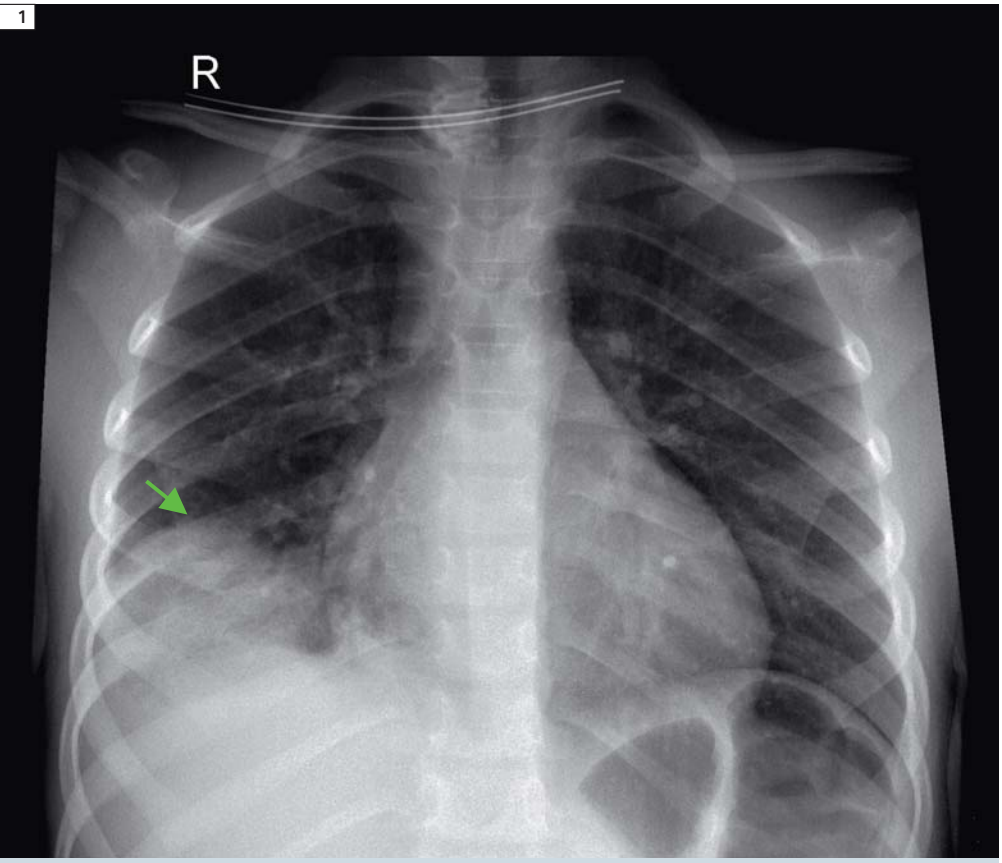


1 Chest-X-ray at admission: homogenous opacification of the right lower lung field and obscured costo-diaphragmatic angle (arrow).

Introduction

Influenza is an infectious disease caused by RNA viruses of the family Orthomyxoviridae [1]. The most common symptoms of the infection are: fever, rhinorrhoea, sore throat, cough, muscle pain, frontal/retro-orbital headache, weakness/fatigue [1–3]. Pneumonia is a common complication of influenza in young children. [1]. We present a case of abscess pneumonia caused by H1N1 infection in a young child and discuss the MRI findings of the lungs during the course of the disease.

Patient history

A 5-year-old girl with a history of rhinitis, cough and fever over a period of 2–3 weeks, with proven H1N1 infection but unsuccessfully treated with antibiotics was admitted to our hospital because of progressive dyspnoea and fever of 39.7°C. A chest radiograph showed a consolidation of the right lower lung field (Fig. 1).
Laboratory tests demonstrated nonspecific findings of systemic inflammatory illness:
CRP of 203.9 mg/l (normal < 5 mg/l),
erythrocyte count 4.0 /pl (normal 3.9–5.3/pl),
haemoglobin 10.8 g/dl (normal 11–14.5 g/dl),

leukocyte 12.34/nl (normal 4.5–13.0/nl). Therapy with Cefuroxim and Oseltamivir was started. Under treatment the girl's clinical situation worsened and lung abscess was suspected following ultrasound examination of the chest. Cross sectional imaging was therefore requested and MRI examination of the thorax was performed.

Imaging findings

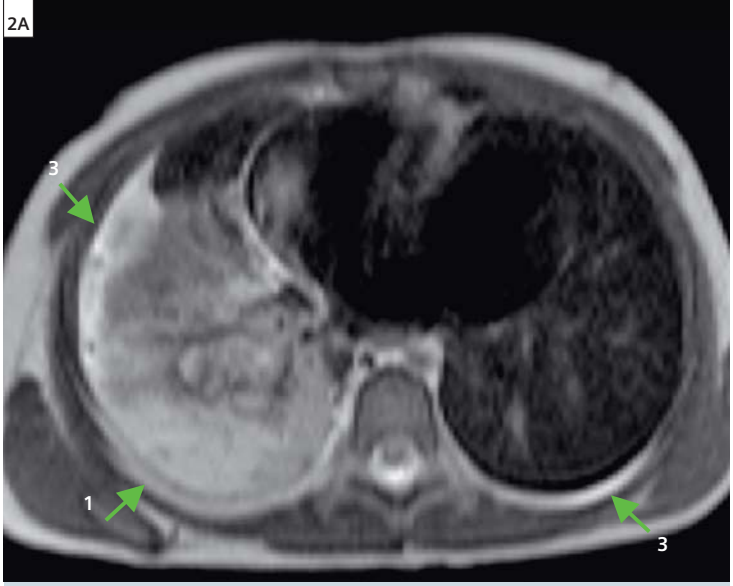
MRI evaluation of the thorax demonstrated right lower and middle lobe consolidation with multiple abscesses (Figs. 2A–C), enlarged mediastinal lymph nodes and small bilateral pleural effusion (Figs. 2A, B).
Treatment with Meropenem and Clindamycin was started immediately, the latter being replaced by Vancmycin four days later. A follow-up MRI examination was performed after two weeks. MRI showed progression of the pleural effusion on the right side, unchanged right lower and middle lobe consolidation as well as left lower lobe bronchial wall thickening (Fig. 3).
During the following few days the pleural effusion was drained and the antibiotic treatment was changed to Tazobactam and Clindamycin.
A second follow-up MRI after further two weeks demonstrated a decrease of pleural effusion and of infiltrates in the right lower lobe with residual dystelectasis. However, a progress of the infiltration in the left lower lobe (Figs. 4A–C) and basal perfusion defects on the right side, as well as dorso-basal defects on the left side (Fig. 4D), were seen.
After clinical restitution a final follow-up MRI was performed 4 months later showing a small dystelectasis in the right lower lobe and pleural thickening as sequelae of the consolidation and abscess pneumonia (Figs. 5A, B) and normal homogenous perfusion of the whole lung (Fig. 5C).

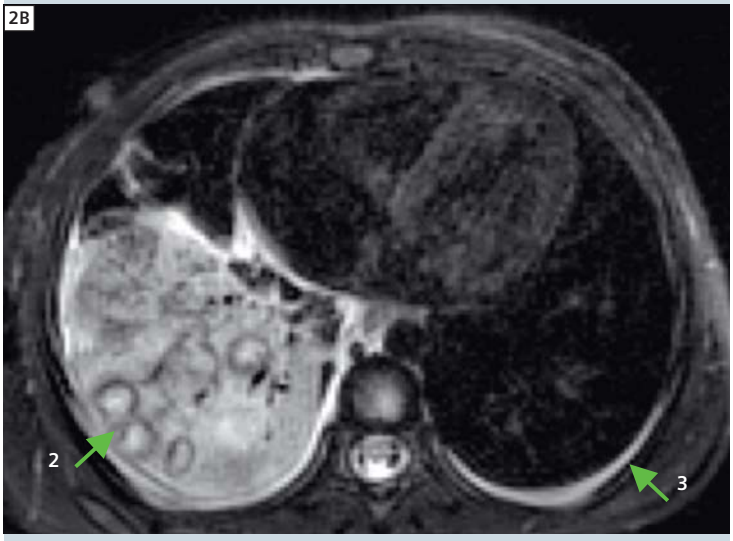
Sequence details

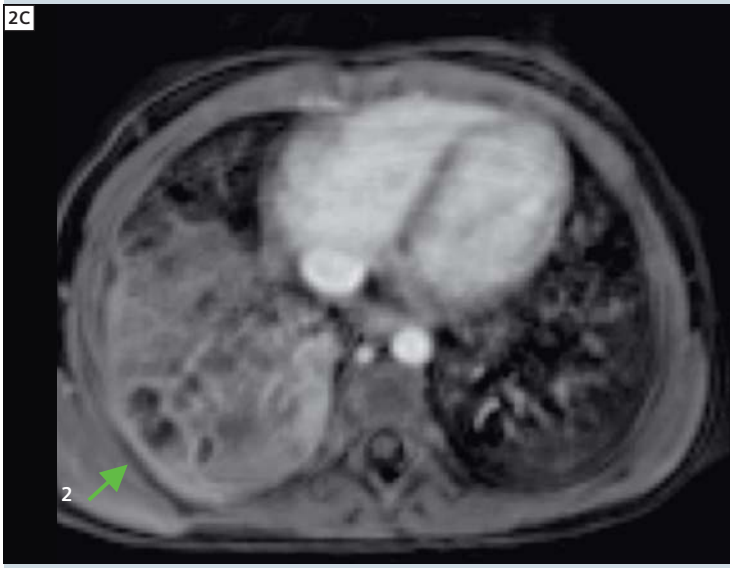
The T2-weighted *syngo* BLADE sequence parameters were:
TR 3994 ms, TE 116 ms, FA 146°, slice thickness 4 mm, with navigation triggering.
The T2-weighted HASTE sequence parameters were:
TR 571 ms, TE 42 ms, FA 160°, slice thickness 6 mm, patient adapted field-of-view, with respiratory gating (approximately 90 s).
The T1-weighted VIBE sequence parameters were:
TR 5.46 ms, TE 2.38 ms, FA 18°, slice thickness 4 mm, with inspiratory breathhold.
In non-compliant patients or smaller* children, a T1-TSE-sequence can be performed within 3 acquisitions in free breathing with TR 775 ms, TE 17 ms, FA 160°.

Table 1: Sequence parameters

Sequence	Technique	Respiratory phase	TR (ms)	TE (ms)	Flip angle (°)
BLADE	T2-weighted	navigation triggering	3994	116	146
HASTE	T2-weighted single-shot sequence	respiratory gating	571	42	160
VIBE	T1-weighted 3D gradient echo	inspiratory breath hold	5.46	2.38	18







2 First MRI: axial T2-weighted HASTE **(2A)**, *syngo* BLADE **(2B)** and T1-weighted VIBE image post contrast **(2C)** showing abscess pneumonia of the right lower lobe. Areas of a homogenous increase in T2w signal (consolidation) in the right lower lobe (1) and multiple inclusions of in T2w hyper and in T1w hypo intense areas with circular peripheral contrast media enhancement (abscesses, 2) are demonstrated. Additionally a small bilateral pleural effusion is visualized (3).

Discussion

In clinical practice, as a widely available imaging modality, chest x-ray is essential for primary diagnoses of lung diseases. Actually CT is considered to be the "gold standard" for the assessment of lung parenchyma and the majority of lung pathology. However, repeated examinations to evaluate the progress of the disease are frequently necessary in severe illness. This leads especially in small children to cumulative radiation doses, which can be avoided if radiation-free imaging modalities are used.

Magnetic resonance imaging (MRI) as a radiation-free technique was already proposed as a potential alternative for lung imaging in the late 80s [4]. At that time, MRI technology was not able to produce results comparable to CT [5]. New technologies and strategies were able to overcome the inherent difficulties of MRI of the lung [6]. With the introduction of parallel imaging in clinical practice, faster image acquisition became possible and thus substantial improvement in temporal and/or spatial resolution [7–9]. MRI has a lower spatial resolution than CT, but its major advantage is the possibility to characterize different aspects of tissue based on different contrasts in T1w and T2w, as well as enhancement after contrast media administration. Additionally, MRI is able to visualize different regional functional aspects of the lung parenchyma (pulmonary hemodynamics, perfusion, ventilation).

Today, lung MRI is considered a sensitive detector of infiltrative and solid lung pathology. It is therefore the ideal follow-up assessment of pneumonia, pleural disease or chronic lung patients with pulmonary exacerbations. In children with cystic fibrosis it is more and more used as a monitoring strategy for lung disease progression [10].

In this report we present a child with a severe abscess pneumonia caused by H1N1 virus infection. In addition to the areas of consolidation, abscesses were found in the right lower lobe accompanied by bilateral pleural effusion.

For assessment of lung parenchyma, T2-weighted images as well as

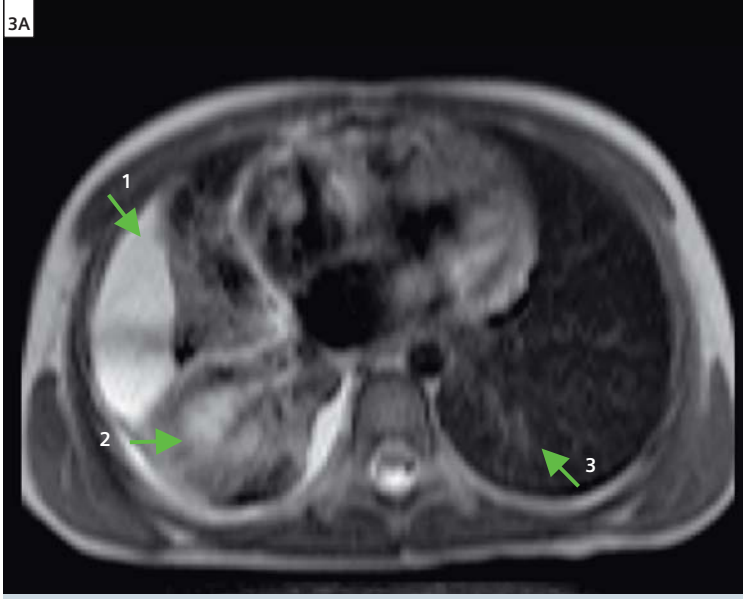
T1-weighted images before and after contrast media injection are performed. T1-weighted sequences pre- and post-contrast are used for the detection of lymph nodes especially in the mediastinum and tumor infiltration into the thorax wall. T2-weighted sequences are nowadays the method of choice for the assessment of lung parenchyma, and additionally enable visualization of the pathology of mediastinum and thoracic wall.

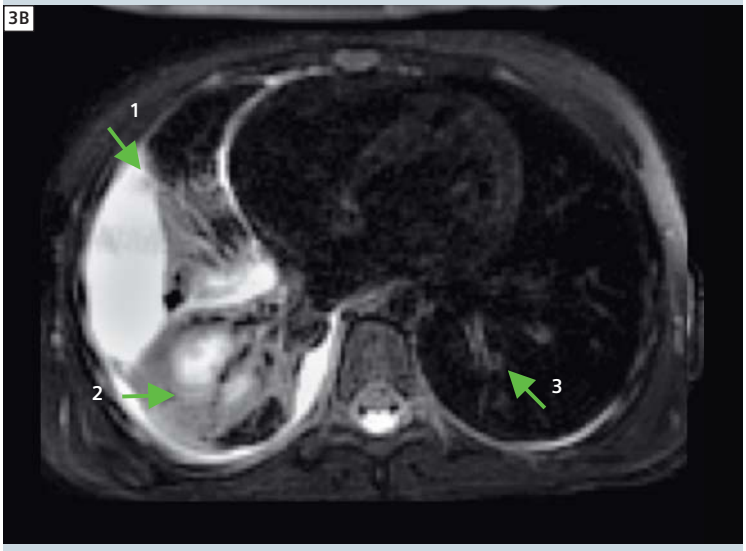
Ex vivo experiments and in vivo experience have shown that solid lung pathology can be successfully detected with fast T1-weighted gradient echo sequences (T1-GRE). For lung nodules larger than 4–5 mm, 3D gradient echo sequences reach the detection rates of conventional helical CT with a single row detector technique [11].

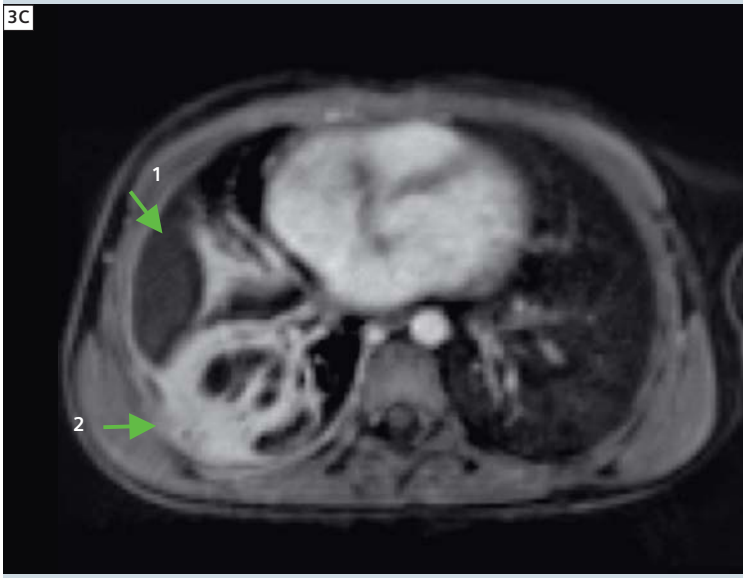
The T2-weighted 'Half-Fourier single-shot turbo spin-echo' (HASTE) sequence has a sensitivity of 85%–90% for lung nodules larger than 4 mm and a sensitivity of 100% for lung lesions larger than 8 mm [12, 13]. Post-contrast imaging is necessary for differentiation of pleural processes, such as empyema, abscesses or metastatic spread of malign tumors, as well as for the evaluation of solid intraparenchymal benign/malign tumor masses [12].

In airways disease the reflex of hypoxic vasoconstriction leads to impaired perfusion in less ventilated lung areas. To detect lung perfusion defects, an injection of contrast media at the same time that a repeated 3D GRE sequence with high temporal resolution is acquiring MRI data is necessary.

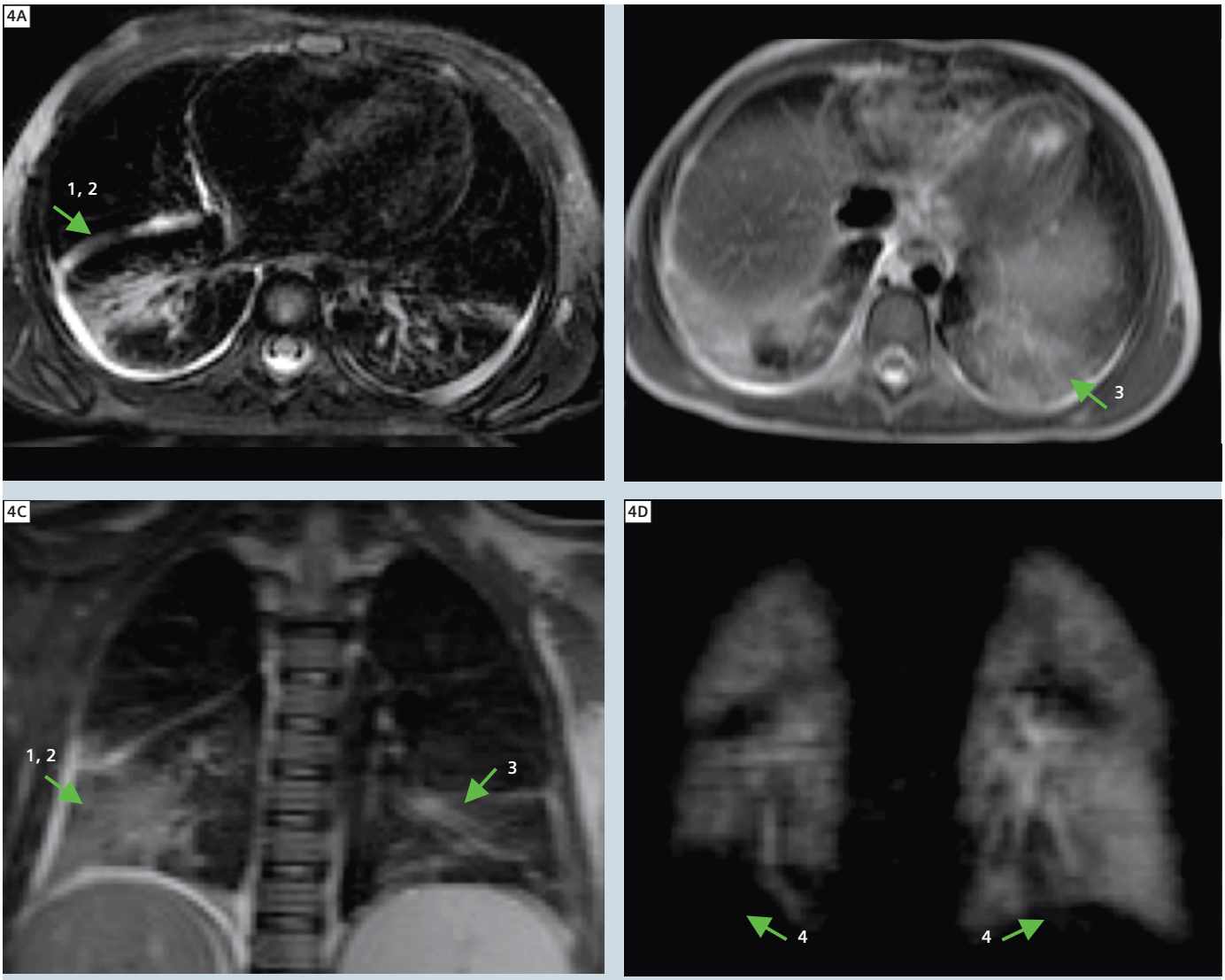
In the presented case, MRI examinations were performed on a 1.5 Tesla MR scanner (MAGNETOM Avanto, Siemens Erlangen, Germany). Orientated on a previously published standard protocol for lung image examination [11], a navigator triggered T2w BLADE and T2w HASTE sequence as well as a T1w VIBE sequence pre- and post-contrast media in inspiratory breath hold were used. For functional assessment a 3D GRE sequence with high temporal resolution with parallel contrast media injection was performed.







3 First follow-up MRI: axial T2-weighted HASTE **(3A)**, *syngo* BLADE **(3B)** and T1-weighted VIBE image post contrast **(3C)**: progressive pleural effusion on the right side (1) and unchanged right lower lobe consolidation with abscesses (2). Bronchial wall thickening is visible in the left lower lobe (3).



4 Second follow-up MRI: axial T2-weighted *syngo* BLADE **(4A)** as well as axial and coronal HASTE **(4B, 4C)** show a partial resolution of infiltration and pleural effusion in the right lower lobe (1, 2) but a new infiltrate in the left lower lobe (3). Subtraction image of MR perfusion from a dorsal slice **(4D)** show basal right sided and dorso-basal left-sided perfusion defects (4) corresponding to the areas of consolidation.

Perfusion imaging was performed using a time-resolved 3D GRE pulse sequence with TR 1.8 ms, TE 0.68 ms, FA 18°. With this sequence an image data set of the whole lung was acquired within 1.2 seconds. A total of 25 data sets were acquired continuously from the start of an intravenous injection of 0.1 mmol/kg body weight of Gadopentetat (Magnevist, Bayer Vital, Leverkusen, Germany) at a rate of 3 ml/s. Image data were post-processed for image assessment by subtraction of the baseline images without contrast from those with maximal contrast. Parallel imaging modalities with PAT 2 were used for all images.

The presented case shows that the detection of lung pathology and its development during the course of a severe illness can be achieved with MRI. A combination of T1w and T2w sequences together with functional imaging provides relevant inormation and is able to gide therapeutic decisions. In-room time for a patient receiving this protocol takes about 20–30 minutes. Considering the highly-relevant information acquired without ionizing radiation, this seems acceptable for clinicians. Moreover, repeated examination can be performed without compromising the patient, which is important particularly in children for follow-up examination.

In conclusion, MRI of the lung should be considered for the assessment of parenchymal lung changes and especially if radiation safety aspects are of major interest.

References
1 Delaney JW, Fowler RA. 2009 influenza A (H1N1): a clinical review. Hosp Pract (Minneap). 2010:38(2):74–81.
2 Smith SM, Gums JG. Antivirals for influenza: strategies for use in pediatrics. Paediatr Drugs. 2010 Oct 1;12(5):285–99.
3 Nelson Textbook of Pediatrics Elsevier 18th edition 2011, editors: Robert M. Kliegman, MD, Richard E. Behrman, MD, Hal B. Jenson, MD and Bonita M.D. Stanton, MD.
4 Fiel SB, Friedman AC, Caroline DF et al. Magnetic resonance imaging in young adults with cystic fibrosis. Chest. 1987:91:181–184.
5 Carr DH, Oades P, Trotman-Dickenson B et al. Magnetic resonance scanning in cystic fibrosis: comparison with computed tomography. Clin Radiol. 1995:50:84–89.
6 Kauczor HU, Heussel CP, Schreiber WG et al. [New developments in MRI of the thorax]. Radiologe. 2001:41:279–287.
7 Swift AJ, Woodhouse N, Fichele S et al. Rapid lung volumetry using ultrafast dynamic magnetic resonance imaging during forced vital capacity maneuver: correlation with spirometry. Invest Radiol. 2007:42:37–41.
8 Heidemann RM, Griswold MA, Kiefer B et al. Resolution enhancement in lung 1H imaging using parallel imaging methods. Magn Reson Med. 2003:49:391–394.
9 Fink C, Bock M, Puderbach M et al. Partially parallel three-dimensional magnetic resonance imaging for the assessment of lung perfusion-initial results. Invest Radiol. 2003:38:482-488.
10 M. Puderbach, M. Eichinger, J. Haeselbarth, A. Niemann, M.Mall, H.-U. Kauczor Magnetic Resonance Imaging (MRI) for early diagnosis of lung changes in Children with Cystic Fibroisis AJRCCM, 2008:177:773, Abstract issue.
11 Puderbach M, Hintze C, Ley S, Eichinger M, Kauczor H-U, Biederer J. MR imaging of the chest: A practical approach at 1,5 T. Eur J of Radiology, 2007: 64: 345–355.
12 MRI of the lung, Springer-Verlag Berlin Heidelberg, 1st edition 2009, editor: Kauczor H.-U.
13 Biederer J, Hintze C, Fabel M MRI of pulmonary nodules: technique and diagnostic value. Cancer Imaging, 2008: 8(1): 125–130.

*MR scanning has not been established as safe for imaging fetuses and infants under two years of age. The responsible physician must evaluate the benefit of the MRI examination in comparison to other imaging procedures.

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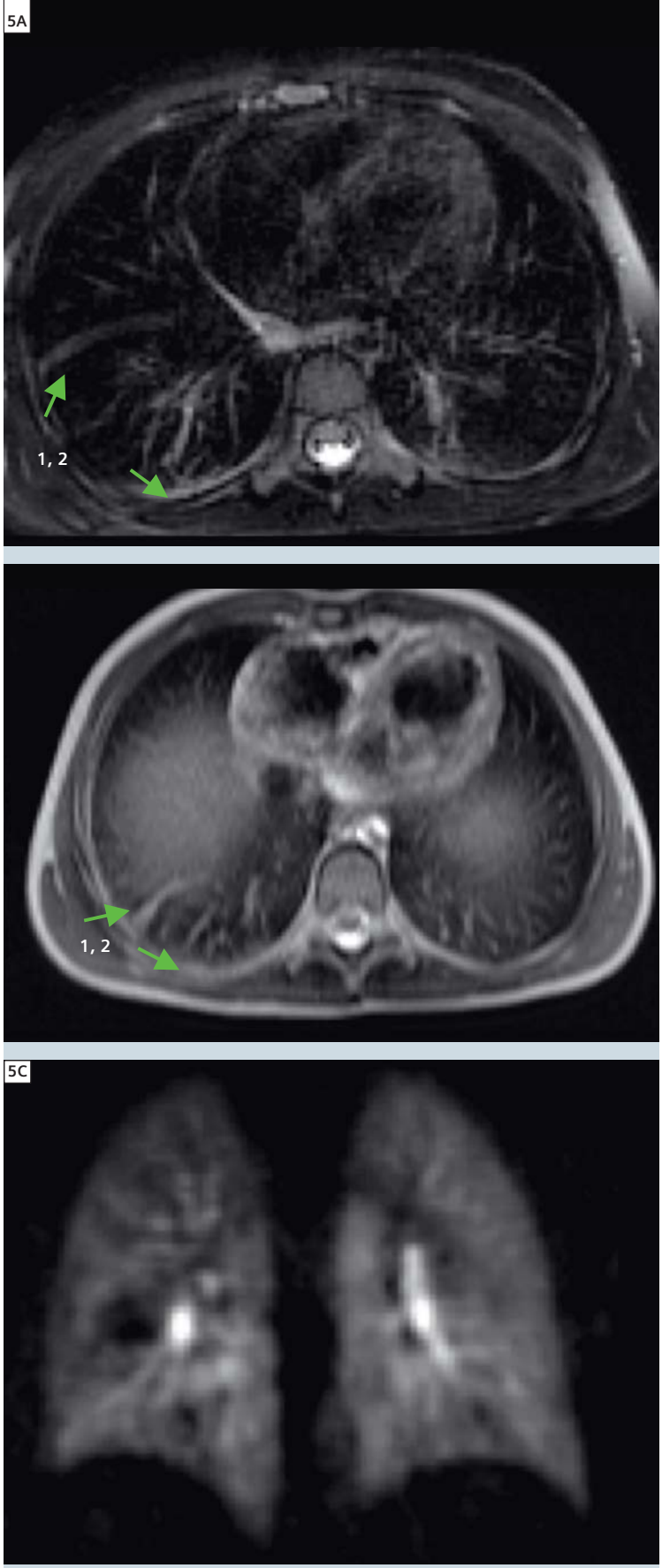

5 MRI after clinical restitution: T2-weighted axial *syngo* BLADE image **(5A)** and T2-weighted axial HASTE image **(5B)** demonstrate the residual infiltrates in the right lower lobe with dysatelectasis (1) and pleural thickening (2). Subtraction image of MR perfusion from a dorsal slice shows homogenous perfusion **(5C)**.