European Journal of Radiology 82 (2013) e860–e866

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Comparison of foetal US and MRI in the characterisation of congenital lung anomalies

Leonor Alamo[a,*], Olivier Reinberg[b], Yvan Vial[c], François Gudinchet[a], Reto Meuli[a]

[a] Unit of Pediatric Radiology, Department of Diagnostic and Interventional Radiology, Centre Hospitalière Universitaire Vaudois (CHUV), Rue du Bugnon 46, 1011 Lausanne, Switzerland
[b] Department of Pediatric Surgery, Centre Hospitalière Universitaire Vaudois (CHUV), Rue du Bugnon 46, 1011 Lausanne, Switzerland
[c] Unit of Prenatal Obstetric Diagnosis, Department of Gynecology and Obstetrics, Centre Hospitalière Universitaire Vaudois (CHUV), Rue du Bugnon 46, 1011 Lausanne, Switzerland

ARTICLE INFO

Article history:
Received 4 July 2013
Received in revised form
11 September 2013
Accepted 15 September 2013

Keywords:
Prenatal diagnosis
Foetal MRI
Foetal US
Congenital lung malformation
Complex lung lesions

ABSTRACT

Objectives: To compare the accuracy of prenatal ultrasonography (US) to magnetic resonance imaging (MRI) in the characterisation of congenital lung anomalies, and to assess their agreement with final diagnosis. To evaluate the influence of additional MRI information on therapeutic management.
Methods: 26 prenatal congenital lung anomalies detected consecutively between 2006 and 2012 were retrospectively evaluated. Lesions were initially observed at prenatal US and further investigated with MRI. Prenatal US and MRI imaging findings, and suggested diagnosis were compared with the final diagnosis, obtained from autopsies (4), pathological evaluation following surgical resection (15) and postnatal imaging studies (7).
Results: Postnatal diagnoses included 7 congenital pulmonary airway malformations, 8 complex lesions, 7 overinflations, 1 sequestration, 1 bronchogenic cyst, 1 blastoma and 1 bilateral lymphangioma. Suggested prenatal US and MRI diagnosis was correct in 34.6% and 46.2% of patients, respectively, mainly isolated lung lesions with typical imaging findings. Nonspecific imaging findings at US and MRI studies were observed in 38.4% of cases. In 42% of the operated anomalies, pathological dissection revealed the presence of complex anomalies. MRI changed the US diagnosis, but not the further management in 9.7% of the lesions.
Conclusions: Prenatal US and MRI showed a high accuracy in the diagnosis of isolated congenital lung lesions with typical imaging findings. However, overall characterisation rates were low, because of both a high percentage of complex lesions and of lesions with nonspecific imaging findings. MRI was better than US in characterising complex lesions, but its additional information did not influence therapy decisions.

1. Introduction

The most frequent pulmonary lesions detected *in utero* are congenital lung malformations (CLMs) [1–3], a heterogeneous group of pathologies which originate in developmental abnormalities of the airways, the pulmonary vasculature or both. CLMs include congenital pulmonary airway malformations (CPAM), bronchopulmonary sequestrations (BPS), bronchogenic cysts, bronchial atresia, congenital lobar emphysema and hybrid or complex lesions, with components of at least two of these pathologies. Rarely, other lung pathologies may also be detected in foetal life, including pleuro-pulmonary tumours [4] such as blastoma or fibrosarcoma or pulmonary extension of thoracic lymphangiomas [5].

The prenatal diagnosis of lung pathologies has considerably increased in recent years due to the generalisation and technical improvements of US screening during pregnancy, but their complete characterisation *in utero* remains difficult. Complementary MRI has been increasingly performed over the last few years [3,6–8]. The method allows for multiplanar imaging and a better tissue characterisation than US, but until now, only a few studies have compared the accuracy of both techniques for final diagnosis or evaluated the real influence of additional MRI on further management of the lesions [1,9–11].

Abbreviations: BPS, bronchopulmonary sequestration; CDH, congenital diaphragmatic hernia; CE-CT, contrast-enhanced computed tomography; CLM, congenital lung malformation; CPAM, congenital pulmonary airway malformation; GLV, global lung volume; MRI, magnetic resonance imaging; PLV, pathologic lung volume; US, ultrasound.

* Corresponding author. Tel.: +41 21 3143054; fax: +41 21 3144645.
E-mail addresses: leonor.alamo@chuv.ch (L. Alamo), Olivier.reinberg@chuv.ch (O. Reinberg), Yvan.vial@chuv.ch (Y. Vial), Francois.Gudinchet@chuv.ch (F. Gudinchet), Reto.Meuli@chuv.ch (R. Meuli).

0720-048X/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ejrad.2013.09.012

Table 1
Protocol (sequences parameters) for foetal lung imaging in our centre.

	Slice thickness (mm)	TR (ms)	TE (ms)	Angle	FOV	Matrix
T2-HASTE	5	999	88	135	350 × 350	307 × 512
T2-TRUE FISP	5	6.44	3.22	70	350 × 262.5	230 × 512
T1-VIBE	4	3.69	1.6	12	255 × 340	192 × 256

The purpose of these study was to compare the accuracy of prenatal US and MRI for the characterisation of congenital lung anomalies. To do that, we conducted a retrospective analysis of all cases detected and followed-up in our Institution over the last 6 years. Moreover, we evaluated whether the additional information provided by MRI had any real influence on the management of the lesions.

2. Material and methods

All consecutive lung anomalies detected *in utero* in our institution and followed up in pre- and postnatal life between 01.2006 and 12.2012 were retrospectively identified. Patients with prenatal US, prenatal MRI and an available final diagnosis, obtained by pathological dissection and/or postnatal imaging studies, were included in the study. The ethical committee was informed about the study but being a retrospective comparison between two imaging methods, no further evaluation was required.

Patients included in the study came from two different sources. The first group involved patients having a lung pathology initially detected at our institution through US pregnancy screening exams, usually performed at 20–24th weeks of pregnancy. In the second group of patients, the lung pathology was initially detected in other centres and the patients were than referred to our hospital, which is a reference centre for prenatal diagnosis. Some of these group 2 cases arrived later in pregnancy. A second-line US was performed at our institution for all patients. Studies were performed by gynaecologists with proven experience in prenatal diagnosis by using a GE 730 Expert (General Electric, Zipf, Austria) US scanner.

Additional MRI exams were performed at an interval of 7 days after second-line US, by using a 1.5 T scanner (Magnetom Symphony or Aera, Siemens Medical Solutions, Erlangen, Germany) with a phased-array body coil. Our protocol included coronal, sagittal and transverse sections of the foetus with T2-half-Fourier single-shot turbo spin-echo (HASTE), steady-state free precession imaging (SSFP, true-FISP) and a 3D-spoiled gradient-echo sequence (VIBE) [Table 1]. The exam did not exceed 30 min and neither sedation nor i.v. contrast were used. MRI studies were evaluated by radiologists with proven experience in prenatal diagnosis, who were informed about the US imaging findings and the suggested diagnosis of the lesions at the time of the exam.

The morphological description of the lesion by US and MRI included location, extension, homo/heterogenicity, echogenicity and signal intensity compared to normal lung, presence of solid or cystic components and presence or absence of an abnormal systemic artery to the lung lesion. With this information the most likely diagnosis at US and MRI was suggested [6]. Volumetric MRI measurements of the normal and the pathologic lung were obtained [14] and patients were divided in three groups: A: pathologic lung volume (PLV) <25% of global lung volume (GLV); B: PLV 25–50% of GLV and C: PLV > 50% of GLV. All these data were retrospectively reviewed for the study.

The presence of poor outcome criteria was also evaluated. Adverse criteria included development of hydrops fetalis, as the most important one. Other adverse criteria included bilateral pulmonary pathology, group C lesions, volume mass-head circumference ratio >1.6 and/or significant mass-effect signs – compression of the remaining ipsi- and contralateral lung, intercostal lung herniation, mediastinal shift and/or inversion of the ipsilateral diaphragm.

Therapeutic management during pregnancy and in the immediate postnatal period were revised. Standard postnatal follow-up included plain chest X-rays for all patients at birth and neonatal contrast-enhanced chest CT scan (CE-CT) only in case of respiratory distress [6]. Asymptomatic children were usually investigated with two CE-CT chest scans: the first one at 4–6 weeks of life, to confirm diagnosis and reevaluate the extension and morphology of the lesion and the second one at 5–7 months, to discuss surgical indication, which if decided upon, was performed at 6–12 months of age.

The prenatal diagnosis suggested by US and MRI studies were retrospectively compared with the final diagnosis obtained from pathological records and/or postnatal imaging studies.

3. Results

Between 01.2006 and 12.2012, 30 cases of congenital pulmonary pathology were detected *in utero* and then followed-up at our institution. Four of these patients were excluded from the study because US was the only prenatal imaging method performed. The suggested US diagnoses – 3 BPS and 1 CPAM – were confirmed at pathology for all of them.

The 26 remaining foetuses constitute our study group. The medians (ranges) for maternal and gestational ages at the time of MRI were 30.3 years (25–42) and 26 weeks (20–33), respectively. Pulmonary pathology was first detected at US in 24 cases whereas for the last two patients, it was first observed at MRI following US diagnosis of congenital diaphragmatic hernia (CDH). The time of prenatal imaging, the most relevant US and MRI findings, the suggested prenatal diagnosis and the final diagnosis are shown in Table 2. The most relevant adverse prognostic factors, evolution of lesions and management during pregnancy, symptoms at birth and pre- and postnatal management are shown in Table 3.

Final diagnosis included 7 CPAMs, 8 complex lesions, 7 segmental/subsegmental overinflations, 1 BPS, 1 bronchogenic cyst, 1 blastoma (Fig. 1) and 1 bilateral pleuro-pulmonary lymphangioma (Table 2).

Concerning the most relevant adverse prognostic factors, 5 patients presented large, group C lesions – 2 macrocystic CPAMs; 1 blastoma and 2 complex lesions – from which 4 foetuses developed hydrops during pregnancy – and 3 foetuses presented bilateral pulmonary pathology – 2 CDH/CLM and 1 lymphangioma. Pregnancy was terminated in 3 foetuses – 1 blastoma, 1 lymphangioma and 1 complex lesion – and therapeutical procedures during pregnancy were required in 2 foetuses with macrocystic type CPAM, with drainage of the largest cyst *in utero*. Neonatal respiratory distress was observed in 4 children: the 2 CPAMs treated *in utero* and the 2 foetuses with CDH/CLM. One of the babies with CDH died shortly after birth because of respiratory insufficiency (Table 3).

Pathological records were obtained in 19 cases – 4 autopsies and 15 resections, and identified 11 isolated lung lesions (57.8% of all proven cases) – 7 CPAMs, 1 BPS, 1 bronchogenic cyst, 1 lymphangioma and 1 blastoma – and 8 complex lesions (42.1%) (Table 2). Segmental/subsegmental overinflation was diagnosed from postnatal CE-CT chest scans imaging findings in 7 conservatively treated patients.