Pedunculated focal nodular hyperplasia in a healthy toddler

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ABSTRACT

Focal nodular hyperplasia (FNH) is a benign hepatic tumor rarely seen in pediatric patients, with most cases reported in school-aged children with a history of malignancy, liver disease, chemotherapy, or hematopoietic stem cell therapy. Despite having advanced radiographic imaging, diagnosing FNH before surgical resection can be difficult. We report a rare case of pedunculated FNH presenting as a large abdominal mass palpated on physical exam in a healthy 3-year-old girl with no history of malignancy or underlying liver disease. Ultrasound, computed tomography, and magnetic resonance imaging (MRI) did not demonstrate the typical imaging characteristics of FNH, because the mass was pedunculated with a poorly visualized central scar. Because approximately 75% of all primary hepatic tumors in this age group are malignant, this report also discusses the importance of adding hepatobiliary phase imaging with MRI to avoid, if possible, the need for biopsy or surgical resection of a benign hepatic tumor.

KEYWORDS Focal nodular hyperplasia; hepatic tumor; hepatobiliary phase imaging

Focal nodular hyperplasia (FNH) is a benign subcapsular hepatic neoplasm that most commonly occurs in adult women and is only rarely found in the pediatric population. When seen in children, the median age is 8.7 years with a female predominance and it is associated with chemotherapy, radiation, hematopoietic stem cell transplantation, and underlying liver disease.^{1,2} The etiology of FNH is unclear; however, it is thought to arise from local disruption of blood flow in the liver resulting in a hyperplastic response of the surrounding hepatic parenchyma.¹ The diagnosis of FNH can be made with confidence when the lesion demonstrates classic magnetic resonance imaging (MRI) features, particularly when using hepatocyte-specific contrast agents. We report a case of a pedunculated FNH arising in a healthy toddler. Because 75% of pediatric liver tumors are malignant, confirmation by tissue diagnosis is important in cases with unusual presentation or imaging features.² Thus, optimizing imaging to identify FNH in children with an atypical presentation can help avoid unnecessary invasive procedures.¹

CASE STUDY

A 3-year-old girl was admitted due to parental concerns of abdominal distention and ultrasound findings at an outside hospital of a right-sided abdominal mass. The patient was born premature at 34 weeks secondary to preeclampsia but was healthy

with no other medical history. Physical exam revealed abdominal distention along with a firm, nontender, golf ball-sized mass in the right upper quadrant. Routine blood tests including liver function tests were normal and tumor markers (alpha-fetoprotein and beta-human chorionic gonadotropin) were negative.

Computed tomography (CT) of the chest, abdomen, and pelvis revealed a large, well-circumscribed, pedunculated, heterogeneously enhancing mass along the inferomedial aspect of the right hepatic lobe measuring up to 5.9 cm. The exophytic mass extended from the hepatic parenchyma and received vascular supply from the right hepatic artery and drained into the right hepatic vein. At the time of the CT, the differential diagnosis for a solid liver mass in a 3-year-old included hepatoblastoma and FNH because it did not have the enhancement pattern of a hemangioma.

An MRI was obtained for further characterization (*Figure 1*). The mass was heterogeneous and predominantly T1 hypointense and T2 iso- to hyperintense. There was an ill-defined T1 hypointense and T2 hyperintense spoke-wheel appearance that in retrospect represented the central scar. There was avid arterial enhancement of the mass relative to liver with partial washout on the portal venous phase, though it was still hyperintense relative to liver. At 5 minutes, the mass was isointense. The ill-defined central scar was not well seen on the arterial phase and avidly enhanced in the portal

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Figure 1. MRI findings of a hepatic mass in a 3-year-old female. **(a)** Coronal T1-weighted precontrast image demonstrates a heterogeneous mass (arrows) hypointense relative to the liver with a hypointense central scar. **(b)** Coronal T2-weighted fat-saturated precontrast image demonstrates a heterogeneous mass (arrows) that is iso- to hyperintense to the liver with areas of ill-defined hyperintense central scar. **(c)** Axial 20-second postcontrast arterial phase image demonstrates avid arterial enhancement of the mass (arrows) relative to the liver (L). **(d)** 70-second postcontrast imaging demonstrates partial washout with the mass (arrows), remaining minimally hyperintense relative to the liver (L). **(e)** Coronal 5-minute postcontrast image demonstrates further tumor washout with the mass isointense to slightly hyperintense relative to the liver and persistent scar enhancement.

venous phase and the enhancement persisted. Delayed hepatobiliary imaging was not performed because the available hepatobiliary contrast agent would have required prolonged sedation.

In a 3-year-old patient with a heterogeneous enhancing liver tumor, there was concern for malignancy despite normal alpha-fetoprotein. Due to concerns of malignancy, the patient underwent surgical excision. Intraoperatively, the mass was pedunculated, arising from the lower right lobe of the liver. Intraoperative ultrasound was performed and no intrahepatic component of the mass could be identified.

Histologic analysis supported a diagnosis of FNH (*Figure 2*) showing a multinodular mass with a central 1.2×1.1 cm tan, fibrous scar with smaller septations radiating from the central scar. Hematoxylin and eosin sections demonstrated well-differentiated hepatocytes that were separated into nodules by fibrous septa containing blood vessels. There were multiple, broad, radiating scars that included many bile ducts and collections of abnormally dilated veins in a random distribution. Glutamine synthetase was expressed in a geographic map-like pattern in the mass.

DISCUSSION

Most children who develop FNH have had chemotherapy, radiation therapy, underlying liver disease, or hematopoietic stem cell transplantation.¹ In this case, the patient was 3 years of age and did not have any risk factors for FNH. Ma et al found that of 6 cases of pediatric FNH in children 5 years and younger, 5 of them had no history of underlying liver disease or malignancy, whereas their literature review indicated that the majority of children under 5 years had risk factors.¹

Another particularly unique feature of this case was the exophytic nature of the mass. The mass was pedunculated, arising

from the inferomedial right lobe of the liver with a 1-cm stalk. Pediatric liver tumors, with the exception of mesenchymal hamartomas, are typically not pedunculated.³ There is a single case report of exophytic FNH documented in a 12-year-old female with tetralogy of Fallot, and review of the pathology literature mentions 2 pedunculated lesions without imaging correlates.^{4,5}

The typical features of FNH seen on MRI include a mass that is iso- to hypointense on T1-weighted images, is iso- to hyperintense on T2-weighted images, and has avid enhancement on arterial phase imaging and isointensity on portal venous phase imaging. The central scar, when present, classically appears hypointense on T1-weighted imaging, hyperintense on T2-weighted imaging, and hyperintense on equilibrium-phase imaging. Unfortunately, over 50% of cases of FNH do not present in a classic manner, making differentiation from other liver lesions challenging.² In this particular case, the central scar was ill defined and was not recognized as a scar prospectively.

The use of hepatocyte-specific contrast agents such as gadobenate dimeglumine and gadoxetate disodium (Eovist) can be beneficial in characterizing liver lesions. Hepatocyte-specific agents are partially excreted through the biliary system, which is particularly useful in identifying FNH. Functioning hepatocytes in FNH take up contrast, and malformed blind ending biliary ductules result in delayed biliary excretion. This causes the lesion to appear hyperintense relative to the surrounding hepatic parenchyma on delayed hepatobiliary phase imaging. This feature is rare in other liver lesions and is sufficient evidence to diagnose FNH. Hepatobiliary phase enhancement has been reported in highly differentiated hepatocellular carcinoma, atypical hepatoblastoma with teratoid features, some congenital and infantile hemangiomas, and regenerating nodules but with an appearance congruent with those diagnoses on the other imaging sequences.

Figure 2. Three-year-old female with a liver mass. **(a)** Gross examination revealed an encapsulated, exophytic red-brown vaguely nodular liver lesion with a central fibrous scar (arrow). **(b)** Microscopically, the well-circumscribed nodules (arrow) are composed of well-differentiated hepatocytes (hematoxylin and eosin, 20 $\times$). **(c)** The intervening fibrous septa contain a proliferation of small- to medium-sized blood vessels (arrow) (hematoxylin and eosin 100 $\times$). **(d)** The hepatocytes express glutamine synthetase in a geographic map-like pattern (arrow) (20 $\times$).

If all of the MRI features suggest FNH, a more conservative approach with imaging follow-up may be implemented, whereas if there are atypical features on other sequences in a mass with hepatobiliary phase enhancement, biopsy is warranted.^{1,6-8}

In the case presented, gadobenate dimeglumine was the formulary hepatobiliary contrast agent available for use, and at the time it was not routinely used in sedated pediatric patients at our institution. Gadobenate dimeglumine has approximately 3% to 5% biliary excretion and requires delayed imaging at 45 to 60 minutes, whereas gadoxetate disodium has approximately 50% biliary excretion and the hepatobiliary phase images are obtained at 20 minutes, making routine delayed imaging with gadoxetate disodium more feasible for sedated pediatric imaging.²

If delayed hepatocyte phase imaging had been performed, the surgeon would have followed the mass with imaging rather than resecting it. This unique case of a pedunculated FNH with a poorly defined central scar in an otherwise healthy toddler has prompted our department to routinely use hepatobiliary phase imaging with gadoxetate disodium for all pediatric liver mass MRI scans.

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