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MR imaging of intrahepatic cholangiocarcinoma

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Abstract

Background: The purpose of this study was to determine the magnetic resonance (MR) features of intrahepatic cholangiocarcinoma.

Methods: MR imaging studies of seven cases of pathologically proven intrahepatic cholangiocarcinoma were retrospectively reviewed.

Results: On MR images the tumors presented as a single mass (N = 5) or multiple nodules (N = 2), as well-delineated (N = 5) or ill-defined (N = 2), and as nonencapsulated (N = 7). Mean tumor diameter ranged from 6–14 cm (mean, 10 cm). On T1-weighted (TR/TE = 400–600/10–17 msec) images, the tumors were hypointense compared to the liver. The five tumors studied with dynamic MR imaging showed progressive centripetal filling-in after intravenous administration of a gadolinium chelate. On T2-weighted (TR/TE = 2000–2500/80–100 msec) images, all tumors were hyperintense compared to the liver; five were markedly hyperintense and two moderately hyperintense. Vascular encasement, bile duct dilatation within the tumor, and central scar were depicted on MR images in four, three, and two tumors respectively.

Conclusion: The typical MR appearance of intrahepatic cholangiocarcinoma is a large well-delineated nonencapsulated tumor associated with intrahepatic venous encasement.

Key words: Cholangiocarcinoma, MR imaging—Liver, neoplasms—Bile ducts, carcinoma.

Cholangiocarcinoma is the second most common hepatic malignant tumor after hepatocellular carcinoma [1]. Intrahepatic cholangiocarcinoma is a relatively uncommon tumor that arises from the intrahepatic bile ducts, and represents less than 10% of primary hepatic tumors. Although the computed tomographic (CT) features of intrahepatic cholangiocarcinomas have been well described [2–4], their appearances on magnetic resonance (MR) images have received little attention [5–7]. In this retrospective analysis, we studied the MR imaging features of seven cases of pathologically proven intrahepatic cholangiocarcinoma.

Materials and Methods

During a 2-year period MR imaging was performed in two men and five women, aged 44–72 years (mean, 56 years), with histologically confirmed intrahepatic cholangiocarcinoma. All patients were evaluated at initial presentation and did not receive any treatment for their tumors at the time of the MR studies. No patient had evidence for Thorotrast exposure. Histologic confirmation was obtained in all cases by percutaneous biopsy (N = 3), surgical biopsy (N = 2) or after surgical resection of the tumor (N = 2).

MR examinations were performed at 1.0T (Magnetom SP 42, Siemens, Iselin, NJ, USA) in two patients, or at 1.5T (Signa, General Electric-Medical System, Milwaukee, WI, USA, or Magnetom SP 63, Siemens) in five patients.

All patients had axial T1-weighted spin-echo (SE) MR images with a repetition time (TR) of 400–600 ms and an echo-time (TE) of 12–17 ms. T2-weighted SE MR images were obtained in all patients, with a TR of 2000–2500 ms and a TE of 30–50/60–100 ms. Multiple sections were simultaneously obtained in all patients. Section thickness was 10 mm, with a gap of 1–5 mm. The number of signals averaged was four for the T1-weighted SE images and two for the T2-weighted SE images. Image matrix size was 128–256 × 256. The field of view (FOV) was 30–40 cm. No flow compensation technique was used.

Five patients were studied with dynamic MR images obtained with a gradient recalled technique. Dynamic MR images were obtained in two patients with the fast low-angle shot (FLASH) technique with imaging parameters as follow: slice thickness, 10 mm; intersection gap, 1 mm; FOV, 40 cm; matrix size, 171 × 256; one signal average. We used a TE of 4.6 ms, a TR of 77 ms, and a 65° flip angle. In three patients, dynamic MR images were obtained with the fast spoiled gradient-recalled (FSPGR) imaging, with imaging parameters as follow:

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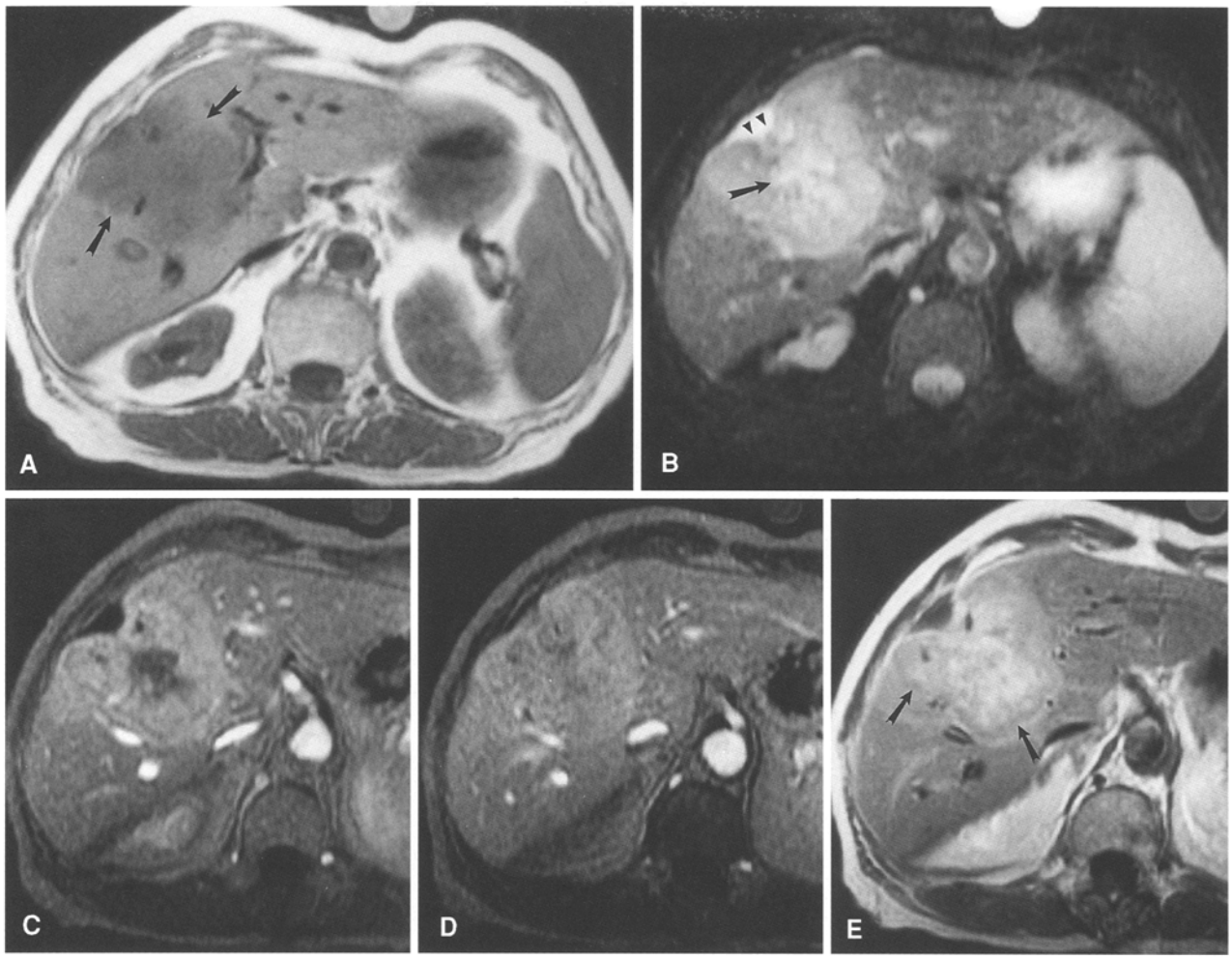

Fig. 1. A 72-year-old woman with intrahepatic cholangiocarcinoma. **A** T1-weighted (TR/TE = 450/15 ms) spin-echo (SE) MR image shows hypointense well-defined intrahepatic tumor (*arrows*). **B** T2-weighted (TR/TE = 2500/80 ms) SE MR image shows hyperintense well-defined tumor. A hyperintense central scar is seen (*arrow*). Retraction of the liver capsule adjacent to the tumor is present (*arrowheads*). **C** Gradient-recalled echo (FSPGR, TR/TE = 11/4 ms, flip angle = 30°) MR image obtained 40 s after intravenous (IV) administration of a gadolinium chelate shows enhancement at the periphery of the tumor sparing the central scar. **D** Two minutes after IV, the tumor displays complete and slightly heterogeneous enhancement. **E** On delayed T1-weighted SE MR image obtained 10 min after IV, the tumor shows pooling of contrast. A peripheral slightly hypointense rim is noted (*arrows*).

slice thickness, 8 mm; intersection gap; 2 mm, FOV, 34 cm; matrix size, 192 × 256; one signal average. We used a TE of 4.2 ms, a TR of 11.5 ms, and a 30° flip angle. After a precontrast set of gradient recalled MR images was obtained, a bolus of 0.1 mmol/kg gadolinium chelate was injected through an antecubital vein. The gadolinium chelate was rapidly administered by hand in every patient. Postcontrast serial gradient-recalled MR images were obtained at every 20 s after the intravenous injection, up to 5 min. T1-weighted SE MR images were obtained 10 min after injection in these patients.

Morphologic features, such as tumor location, size (when a lesion was not round, the largest diameter was measured), shape and contours, presence or absence of capsule, invasion of neighboring structures, intrahepatic bile duct dilatation, presence or absence of central scar, retraction of the liver capsule adjacent to the tumor, and hepatic parenchymal atrophy or hypertrophy were searched for. Special attention was given to the presence or absence of venous stenosis or occlusion. Because of the retrospective nature of the study, the signal intensity of the tumors was qualitatively assessed in relation to normal liver and was classified as hypointense, isointense, or hyperintense. In the five patients studied with a dynamic MR technique, patterns of enhancement were analyzed.

Results

On MR images the tumors presented as single mass (N = 5) or multiple nodules (N = 2), were well-delineated (N = 5) or ill-defined (N = 2) and nonencapsulated (N = 7). Mean tumor diameter ranged from 6–14 cm (mean, 10 cm). On T1-weighted (TR/TE = 400–600/10–17 ms) images, all tumors were hypointense compared to the liver (Fig. 1A). On T2-weighted (TR/TE = 2000–2500/80–100 ms) images, all tumors were hyperintense compared to the liver; five were markedly hyperintense (Fig. 1B) and two moderately hyperintense

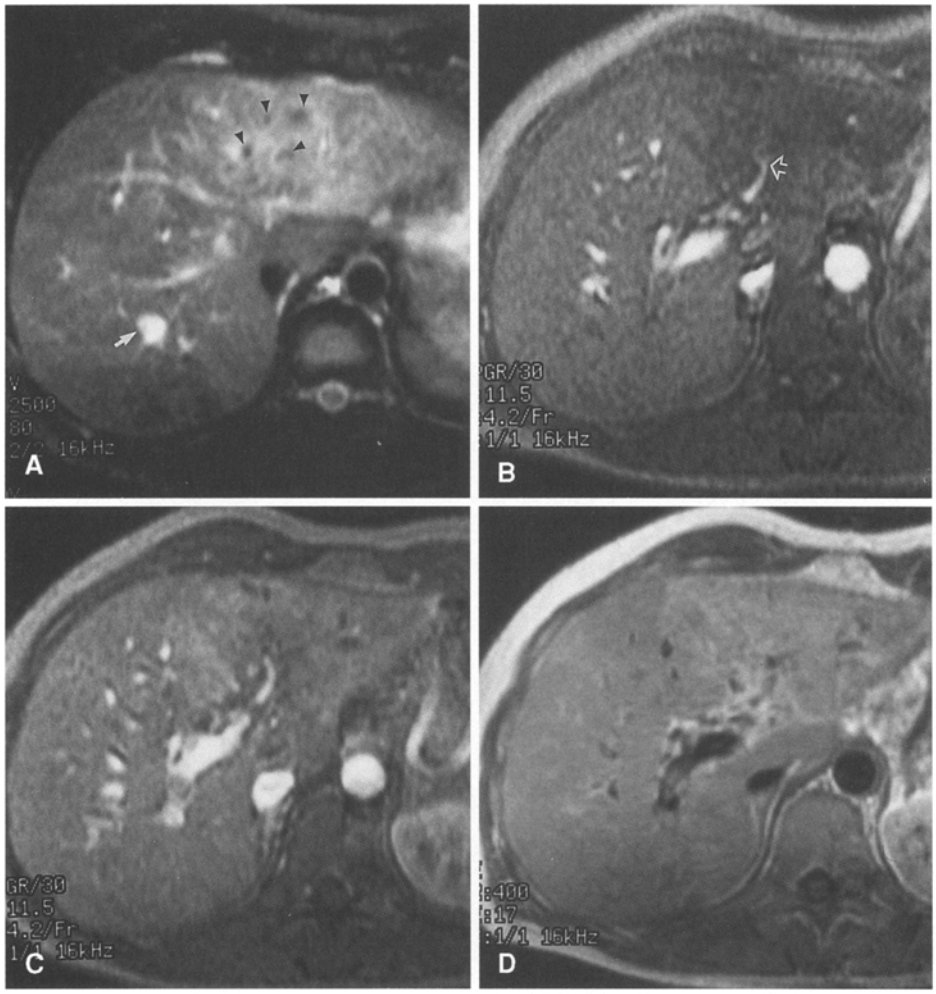

Fig. 2. A 44-year-old man with intrahepatic cholangiocarcinoma. **A** T2-weighted (TR/TE = 2500/80 ms) spin-echo (SE) MR image shows moderately hyperintense ill-defined tumor. Dilated biliary ducts are present in the tumor (*arrowheads*). A small hemangioma is seen (*arrow*). **B** Gradient-recalled echo (FSPGR, TR/TE = 11/4 ms, flip angle = 30°) MR image obtained before IV shows portal encasement (*arrow*) by hypointense tumor. **C** Forty seconds after IV, the tumor displays mild peripheral enhancement. **D** On delayed T1-weighted SE MR image obtained 10 min after IV, the tumor shows complete but moderate enhancement compared to that of the liver.

(Fig. 2A). In one tumor made of several nodules, a hypointense rim surrounding a hyperintense center was seen within the nodules on T2-weighted images. A central scar was seen in two tumors. On T1-weighted SE MR images, the central scar was hypointense to the tumor in one case, and isointense to the tumor in the other case (Fig. 1A). On T2-weighted SE MR images, the central scar was hyperintense to the tumor in the two cases (Fig. 1B). Capsular retraction was seen on both T1- and T2-weighted SE MR images in two cases (Fig. 1B). The five tumors studied with dynamic MR imaging showed a progressive centripetal fill-in after intravenous administration of a gadolinium-chelate. In three tumors, incomplete filling of the tumor was observed, with a more pronounced enhancement at the periphery of the tumors, and no enhancement in the center of the tumor. In two cases, the filling of the tumor with the gadolinium chelate was complete at 3 min after the start of the injection, but the tumors remained slightly heterogeneous (Figs. 1C and D). On delayed T1-weighted SE MR images obtained after injection, five tumors showed complete enhancement (Figs. 1E and 2D), a peripheral slightly hypointense halo was seen in one tumor (Fig. 1E). The two central scars showed complete enhancement and became isointense to the tumor (Fig. 1D and E). Vascular encasement was accurately depicted on MR images in four tumors and confirmed by angiography (Fig. 2B and C). Intratumoral bile duct dilatation was clearly depicted in three cases (Figs. 2A and 3), and confirmed by direct cholangiography. Hepatic parenchymal atrophy of the tumor-bearing area was seen in one case. No compensatory hypertrophy was found.

Discussion

Three previous reports have described the MR features of 17 cases of intrahepatic cholangiocarcinoma [5–7]. Before intravenous administration of a gadolinium chelate, this tumor was heterogeneous (53% of the cases) or homogeneous (47% of the cases), hypointense (88% of the cases) to normal liver on T1-weighted SE images and hyperintense (100% of the cases) on T2-weighted SE MR images. In our study, all tumors were hypoin-

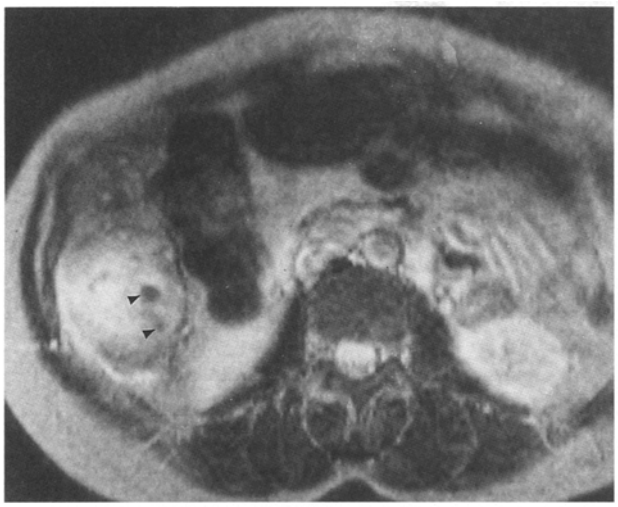

Fig. 3. A 47-year-old woman with intrahepatic cholangiocarcinoma. T2-weighted (TR/TE = 2500/80 ms) SE MR image shows hyperintense well-defined tumor. Dilated biliary ducts are present in the tumor (*arrowheads*).

tense to normal liver on T1-weighted SE images and hyperintense on T2-weighted SE MR images in accordance with previous studies. The tumors were better seen on T2-weighted SE images, and none displayed encapsulation.

Dynamic MR findings of intrahepatic cholangiocarcinoma after intravenous administration of a gadolinium chelate have been reported previously [6, 7]. This tumor shows a characteristic early moderate peripheral enhancement followed by progressive concentric enhancement. As stressed by Fan et al. [6] and Hamrick-Turner et al. [7], in their nine cases, the enhancement spared the central area of the tumor on late images. Furthermore, these researchers considered that pooling of contrast within the tumor on late MR images was a finding highly suggestive for the diagnosis of cholangiocarcinoma [6, 7].

The presence of a central scar in intrahepatic cholangiocarcinoma seen on MR images has been addressed in only two reports [6–7], and found in six of the nine described cases. In our study, central scar was found in two of seven cases. Although central scar is not specific for malignancy, this finding is mostly found in primary tumors of the liver [8]. In our study, central scar, when present, was better seen on T2-weighted SE MR images than on T1-weighted SE MR images. Of interest was the enhancement of the central scar on late MR images obtained after intravenous administration of a gadolinium chelate. It has been previously shown that the fill-in of contrast spared the central part of the tumor and the central scar [6, 7]. Such a finding was of importance because it was able to differentiate between intrahepatic cholangiocarcinoma and hemangioma and focal nodular hyperplasia [6, 7]. Our results show that the central scar can enhance, making important the analysis of enhancement patterns. In our study, the central scars of intrahepatic cholangiocarcinoma showed enhancement making them undifferentiable from the rest of the tumor, whereas in focal nodular hyperplasia, the central scar is usually hyperintense to the rest of the tumor on delayed MR images [9]. Furthermore, the tumors and the central scars were heterogeneous on late MR images, whereas hemangioma displays commonly homogeneous enhancement on late dynamic MR images [10].

Albeit rare, retraction of the liver capsule can be found in different types of hepatic tumors [11]. However this imaging feature has received little attention in radiologic literature. To date, the presence of this imaging finding in association with an hepatic tumor has been emphasized only in papers describing epithelioid hemangioendotheliomas of the liver. Furui et al. [12], reported capsular retraction in one of five cases of epithelioid hemangioendothelioma of the liver. Van Beers et al. [13] found retraction of the liver capsule in two of five cases of this tumor. In the series by Miller et al. [14], this finding was found in nine of 13 cases. Therefore, capsular retraction in association with a peripheral hepatic mass should be considered as highly suggestive for epithelioid hemangioendothelioma of the liver. In accordance with a recent study [15], our two cases reaffirm that retraction of the liver capsule adjacent to an hepatic tumor is not a specific finding for epithelioid hemangioendothelioma of the liver but can be associated with other malignant hepatic tumors, particularly, intrahepatic cholangiocarcinoma.

During the past decade, intrahepatic cholangiocarcinoma has been described as rarely invading the portal or hepatic veins [2, 16]. This feature was felt to be helpful in differentiating intrahepatic cholangiocarcinoma from hepatocellular carcinoma. This latter tumor, as reported by Freeny et al. [17], involves the intrahepatic venous structures in up to 48% of the cases. However, pathologic studies with histologic evaluation have shown that intrahepatic cholangiocarcinoma invades the intrahepatic vascular structures in up to 90% of the cases [1]. In our study, venous involvement was accurately depicted by MR in four of seven cases, and confirmed by angiography.

Currently, complete preoperative assessment of resectability of cholangiocarcinoma requires hepatic arteriography and portal venography [18]. Intraoperatively, the amount of dissection necessary to determine resectability is often extensive and associated with elevated morbidity and mortality [19]. Surgical exploration should be undertaken for patients in whom extensive preoperative evaluation has shown a potential for curative resection. In particular, preoperative detection of venous involvement is crucial. MR provides good delineation of the portal and hepatic veins. Because vascular involvement by intrahepatic cholangiocarcinoma is frequent, the results of our study support the use of MR in selected patients in the preoperative evaluation

of intrahepatic cholangiocarcinoma. Further studies are needed to determine the potential value of MR angiography in such patients.

Morphological changes in hepatic parenchyma are found in 47% of intrahepatic cholangiocarcinoma of the hilar type and in only 10% of intrahepatic cholangiocarcinoma of the peripheral type [20]. Atrophy of the tumor-bearing parenchyma is the most frequent morphological change. Compensatory hypertrophy of the uninvolved liver is rare. Morphological changes arise through a gradual process of involvement of the intrahepatic biliary ducts and portal veins. In our study, parenchymal atrophy was found in one case, however, no contralateral parenchymal hypertrophy was found.

In conclusion, the typical appearance of intrahepatic cholangiocarcinoma on MR images is a well-delineated nonencapsulated tumor with vascular encasement, displaying hyperintensity on T2-weighted MR images. A central scar and bile duct dilatation within the tumor, as well as an associated retraction of the liver capsule adjacent to the tumor, are suggestive features which should raise the possibility of an intrahepatic cholangiocarcinoma in the presence of an intrahepatic mass. In contrast with previous reports, this study points out that an enhancing central scar within an intrahepatic tumor on dynamic MR images obtained after intravenous administration of a gadolinium chelate cannot rule out the diagnosis of intrahepatic cholangiocarcinoma.

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