Pictorial Essay

J Korean Soc Radiol 2022;83(4):808-829
https://doi.org/10.3348/jksr.2021.0178
eISSN 2951-0805

Atypical Manifestation of Primary Hepatocellular Carcinoma and Hepatic Malignancy Mimicking Lesions

원발성 간세포암의 비특이적 영상 소견 및 간암으로 오인될 수 있는 병변에 대한 영상의학적 고찰

Jiyoung Yoon, MD, So Hyun Park, MD*, Su Joa Ahn, MD, Young Sup Shim, MD

Department of Radiology, Gil Medical Center, Gachon University College of Medicine, Incheon, Korea

Hepatocellular carcinoma (HCC) can be diagnosed noninvasively on multiphasic CT and MRI based on its distinctive imaging findings. These features include arterial phase hyperenhancement and washout on portal or delayed phase images. However, radiologists face significant diagnostic challenges because some HCCs exhibit atypical imaging characteristics. In addition to many HCC-mimicking lesions, such as arterioportal shunts, combined HCC-cholangiocarcinoma, intrahepatic cholangiocarcinoma, and hemangioma present a challenge for radiologists in actual clinical practice. The ability to distinguish HCCs from mimickers on initial imaging examinations is crucial for appropriate management and treatment decisions. Therefore, this pictorial review presents the imaging findings of atypical HCCs and HCCs mimicking malignant and benign lesions and discusses important clues that may help narrow down the differential diagnosis.

Index terms Liver Neoplasms; Carcinoma, Hepatocellular; Computed Tomography, X-Ray; Magnetic Resonance Imaging

Received November 15, 2021
Revised December 27, 2021
Accepted January 27, 2022

***Corresponding author**
So Hyun Park, MD
Department of Radiology,
Gil Medical Center,
Gachon University
College of Medicine,
21 Namdong-daero 774beon-gil,
Namdong-gu, Incheon 21565,
Korea.

Tel 82-32-460-3060
Fax 82-32-460-3065
E-mail nnoleeter@gilhospital.com

ORCID iDs
Jiyoung Yoon
https://orcid.org/0000-0001-7456-9951
So Hyun Park
https://orcid.org/0000-0001-9935-2863
Su Joa Ahn
https://orcid.org/0000-0001-9026-0399
Young Sup Shim
https://orcid.org/0000-0002-8214-2904

Invited to Pictorial Essay at 2021 KCR Annual Meeting.

INTRODUCTION

Hepatocellular carcinoma (HCC) is the most common primary liver malignancy and the second leading cause of worldwide cancer-related deaths (1). The typical imaging features of HCC are arterial phase hyperenhancement (APHE) and portal/delayed washout on dynamic CT or MRI, and its unique features allow for a non-invasive diagnosis solely based on imaging studies in patients with chronic liver disease (2, 3). However, some HCCs may present with atypical image features that mimic benign or other malignant masses. On the other hand, intrahepatic cholangiocarcinoma and sclerosing

hemangioma are often confused with HCC by radiologists on CT and MRI (4). Awareness of these atypical hepatic malignant or benign nodule presentations on images is crucial for accurate differentiation from other focal liver lesions, which allows adequate treatment. Therefore, we reviewed various atypical manifestations of primary hepatic malignancy and benign lesions with radiologic findings.

HCC WITH ATYPICAL IMAGING FEATURES

HCCS WITH THE TARGETOID APPEARANCE

The targetoid appearance, categorized as liver imaging reporting and data system-M (LR-M), refers to the target-like morphology, including rim APHE, peripheral washout appearance, delayed central enhancement, targetoid diffusion restriction, and targetoid transitional phase or hepatobiliary phase (HBP) signal intensity (SI) (5). The targetoid appearance is considered to reflect the distribution of histologic tumor components. Although it is a common imaging feature of non-HCC malignancies such as combined HCC-cholangiocarcinoma (CC), intrahepatic cholangiocarcinoma (IHCC), or other non-HCC malignancies (6, 7), it can also be seen in HCCs with atypical appearance. Poorly differentiated HCCs and large HCCs (> 5 cm) often show a targetoid appearance owing to central ischemia and necrosis (8, 9) which frequently show thick-rim APHE (Fig. 1). HCC with a targetoid appearance may have enhanced capsule and blood products on CT or MRI examination, which can be useful for differentiating HCC from non-HCC malignancy (10). Scirrhous HCC (sHCC), a rare subtype of HCC with more central fibrotic components than classical HCCs, can also show a targetoid appearance (11). Although the image features of sHCC are similar to those of IHCC, the $\geq$ 20% hyperenhancement in the arterial phase (i.e., thick rim APHE) is a helpful feature in distinguishing sHCC from IHCC (11).

ARTERIAL ONLY HYPER-ENHANCING LESION: AP SHUNT VS. EARLY HCC

Arterial-hyper-enhancing nodules without washout are often seen on multiphasic CT in cirrhotic livers to impose diagnostic challenges. Arterioportal (AP) shunts are frequently encountered in hypervascular pseudo-lesions on dynamic CT and MRI (12). Because AP shunts may undergo spontaneous disappearance (13), interval growth of the arterial-hyper-enhancing nodule is a key feature for differentiating early HCC from AP shunts (Fig. 2). AP shunts can be seen in various hepatic diseases as a consequence of compromised portal or hepatic venous flow and communication of trans-sinusoidal, trans-tumoral, peribiliary, and transvasal routes (14). The imaging findings of AP shunts are typically wedge-shaped transient parenchymal enhancement in subcapsular or peripheral location on the late arterial phase and early enhancement of peripheral portal veins without washout on portal and delayed phases (14). When imaging findings of AP shunts on CT are atypical, for example, round or oval-shaped lesions, gadoxetic acid–enhanced MR imaging and diffusion-weighted imaging (DWI) could help to differentiate AP shunts from HCCs. AP shunts usually show no diffusion restriction on DWI and iso SI on the HBP, whereas HCCs usually show diffusion restriction and low SI on the HBP (15, 16).

Fig. 1. Targetoid appeance of a 5 cm biopsy-proven hepatocellular carcinoma in a 70-year old male patient with liver cirrhosis and chronic hepatitis B.
A-C. On examination of pre (A), arterial (B), and portal (C) phase CT images, a mass (arrows) with thick rim arterial phase hyperenhancement appears in segment IV/VIII of the liver and shows a peripheral washout appearance on the portal venous phase.
D-F. On gadoxetic acid-enhanced MR images of pre (D), arterial (E), and-portal (F) phase CT images, the mass (arrows) also shows arterial thick rim enhancement and portal peripheral washout.
G-I. The mass (arrows) shows hypointensity in the transitional phase (G) and hepatobiliary phase (H) and central hyperintensity on T2-weighted image (I), which suggest a central cystic lesion or necrosis.
J, K. Diffusion-weighted image (J) and apparent diffusion coefficient (K) show restricted diffusion in the periphery (arrow) and less restricted diffusion in the center (arrowhead).

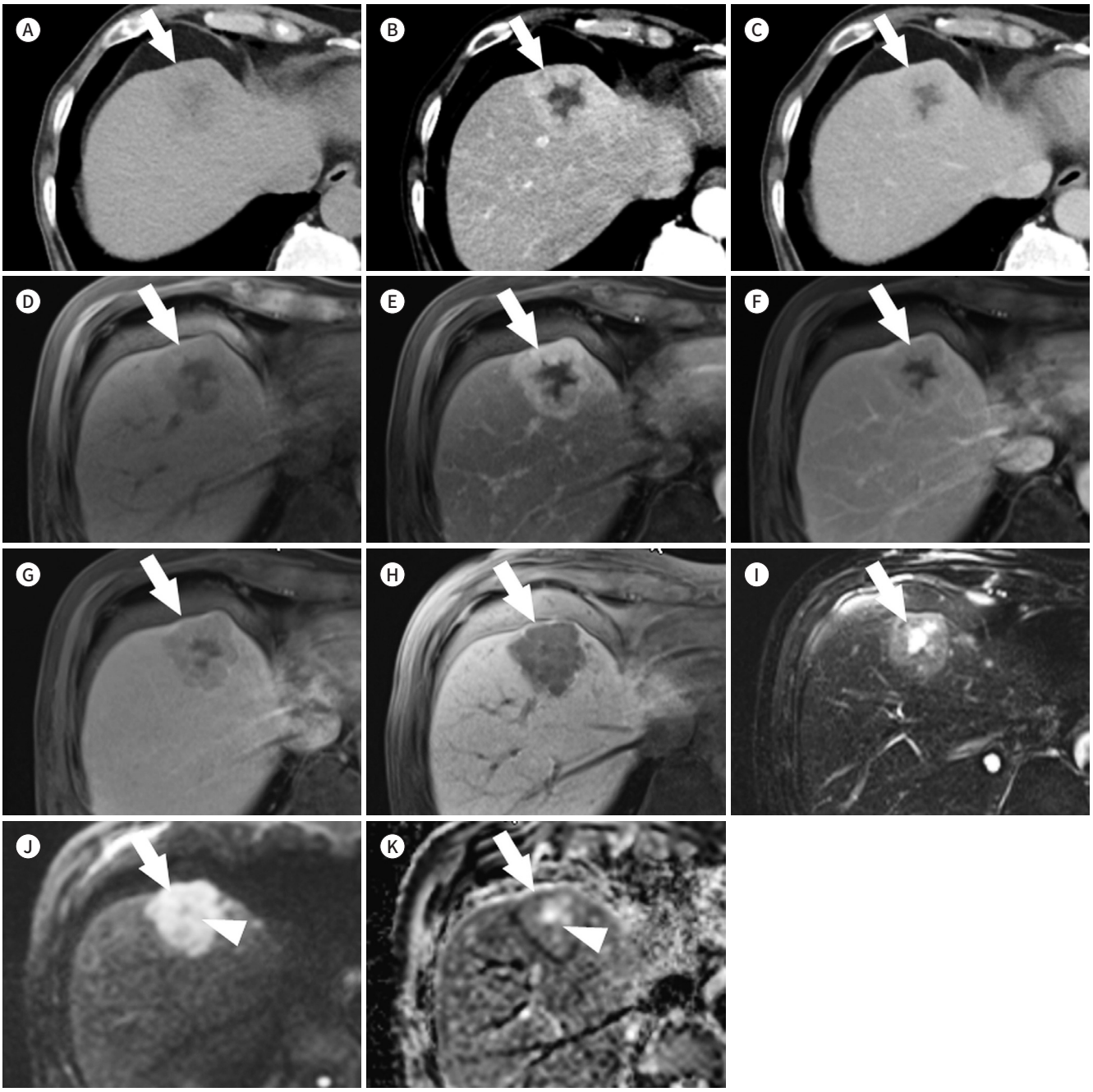
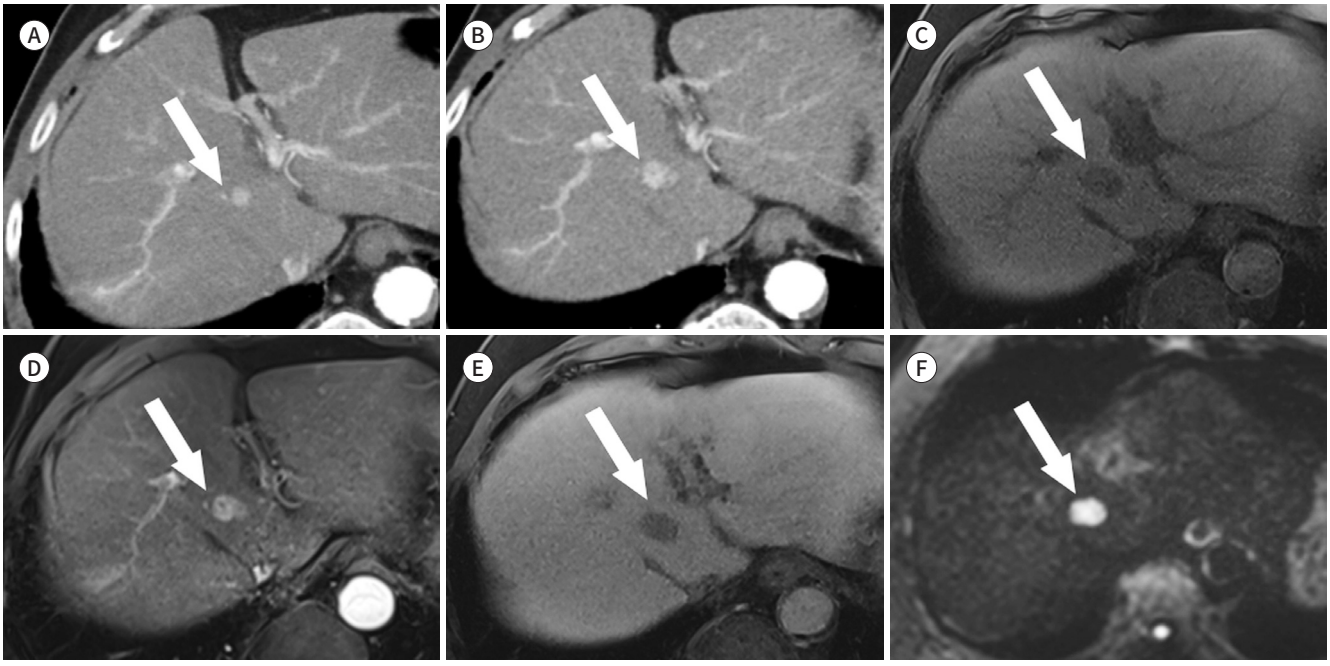


Fig. 2. Arterial only hyperenhancing nodule with interval growth on CT images of a 1.5-cm surgically-proven hepatocellular carcinoma in an 80-year old male patient with alcoholic liver cirrhosis and sigmoid colon cancer.
A, B. On contrast CT images, a subcentimeter arterial hyper-enhancing nodule (arrow, A) in segment VIII of the liver shows an interval increase in size after six months (arrow, B), suggesting early hepatocellular carcinoma or hepatic metastasis of the known sigmoid colon cancer, rather than an AP shunt.
C-F. Gadoxetic acid-enhanced MR images of pre (C), arterial (D), and transitional (E) phases reveal a 1.5-cm arterial hyper-enhancing lesion (arrows) with defect on the transitional phase (C-E) with diffusion restriction (F) in segment VIII of the liver.



PROGRESSIVE ENHANCING LESION: NO WASHOUT HCC OR HEMANGIOMA MIMICKING LESION

The imaging findings of hemangiomas are typically nodular or peripheral enhancement similar to the enhancement of the artery, followed by progressive or centripetal fill-in enhancement on the portal phase. On the other hand, differentiating small rapid-filling hemangiomas from small HCCs is often challenging because small HCCs can show arterial hyperenhancement without washout on the portal phase (17).

Several previous studies have described that over 80% of hemangiomas show no interval change in size (18, 19). A small portion of hepatic hemangiomas grow gradually, and the overall rate of growth is slow at approximately 2 mm/year in the linear dimension (20). Thus, interval growth of arterial-hyper-enhancing nodules and newly developed washout appearance on follow-up imaging highly suggests the possibility of HCC rather than hepatic hemangioma (Fig. 3), especially in patients at risk for HCC.

On MRI, hemangioma shows bright high SI on T2-weighted image, while HCC shows iso- or mildly high SI on T2-weighted image. Moreover, hemangiomas show hyperintense signals on DWI with increased apparent diffusion coefficient (ADC) values (Fig. 4), while atypical HCCs with progressive enhancement patterns tend to show restricted diffusion with lower ADC values (Figs. 5, 6) (21). Therefore, sequential imaging follow-up with contrast-enhanced MRI is essential when an indeterminate arterial enhancing lesion is identified on dynamic

Fig. 3. A newly diagnosed hepatocellular carcinoma in a 77-year old male patient during follow up for a known hepatic nodule mimicking hemangioma.
A-C. On initial pre (A), arterial (B), and portal venous (C) phase CT images, a small well-defined arterial enhancing nodule (arrows) shows progressive enhancement that suggested hemangioma.
D-F. After six months, follow-up CT images show an increase in the size of the arterial enhancing mass, with developed washout (arrows) in the left lateral segment of the liver. The nodule was finally diagnosed as hepatocellular carcinoma.

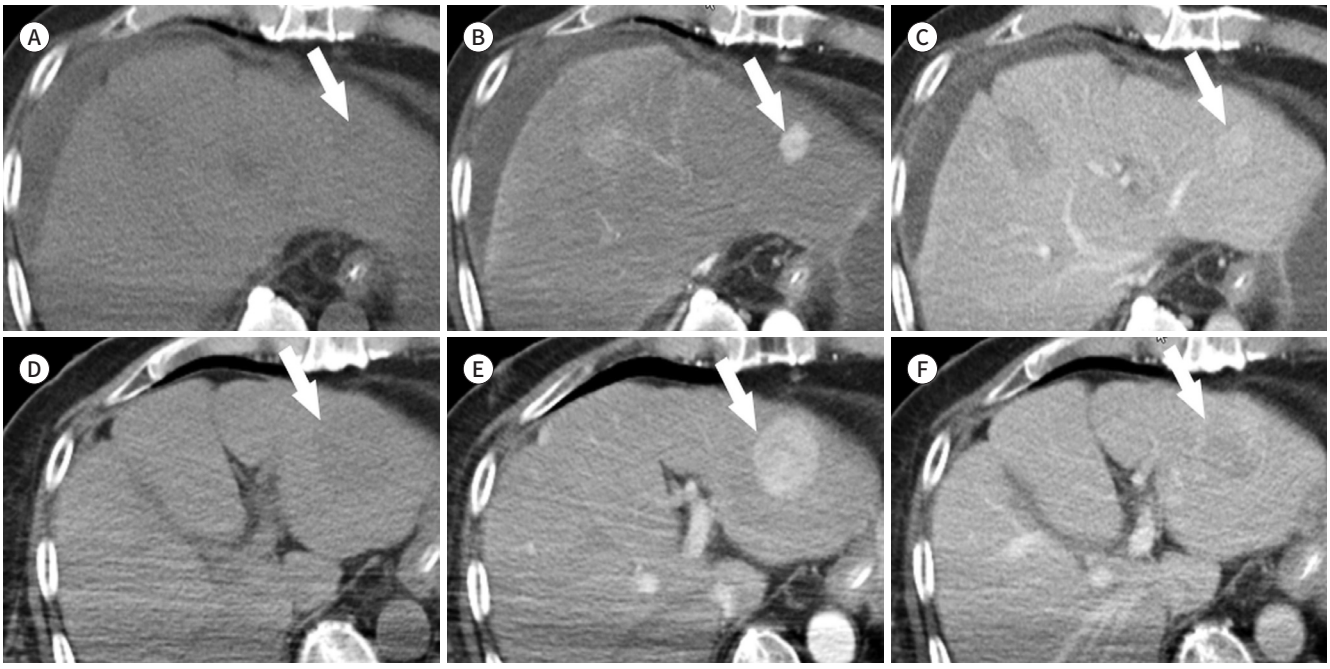


Fig. 4. A 6-mm hemangioma mimicking hepatic metastasis in a 40-year old female with a history of breast cancer.
A-C. Axial pre (A), arterial (B), and portal (C) phase images of multiphasic CT show a newly developed small subtle low attenuating lesion (arrows) in segment VII of the liver.
D-F. T2-weighted image (D) reveals a 6-mm bright high signal intensity lesion (arrow), and the diffusion-weighted (E) and apparent diffusion coefficient map (F) images show no diffusion restriction (arrows).

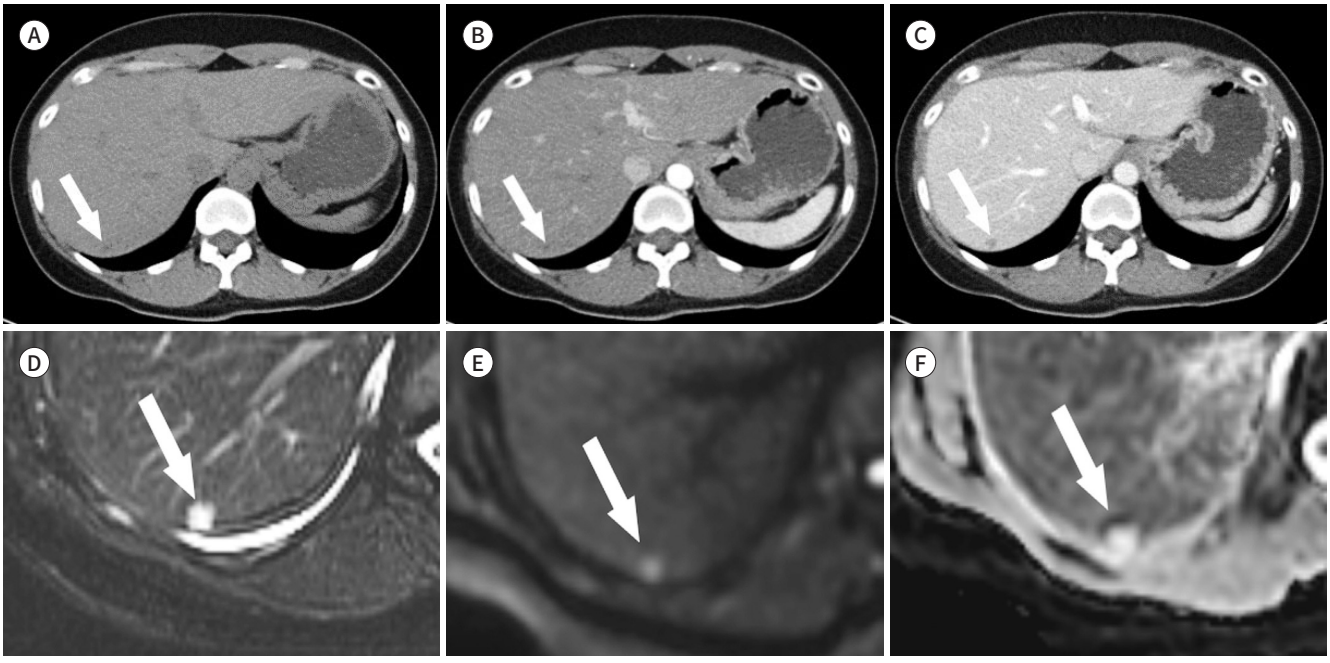


Fig. 5. A 13.5-cm surgically-confirmed hepatocellular carcinoma arising in the hepatocellular adenoma in a 19-year old male patient presenting with fever for 2 weeks and no underlying disease.
A-C. On pre (A), portal venous (B, C) phase CT images, a 13.5-cm mass shows heterogeneous enhancement on portal venous phase (arrowheads) with internal cystic or necrotic portion in the right posterior segment of the liver. These findings suggest a benign tumor, such as focal nodular hyperplasia, atypical hepatocellular carcinoma, or other sarcomas.
D, E. The diffusion-weighted image (D) and apparent diffusion coefficient map (E) image show diffusion restriction (arrowheads).
F-J. Gadoxetic acid-enhanced MR images of pre (F), arterial subtraction (G), portal venous (H), and transitional (I) phase CT reveal a mass with heterogeneous enhancement on arterial phase, progressive enhancement, and high signal intensity on hepatobiliary (J) phase.

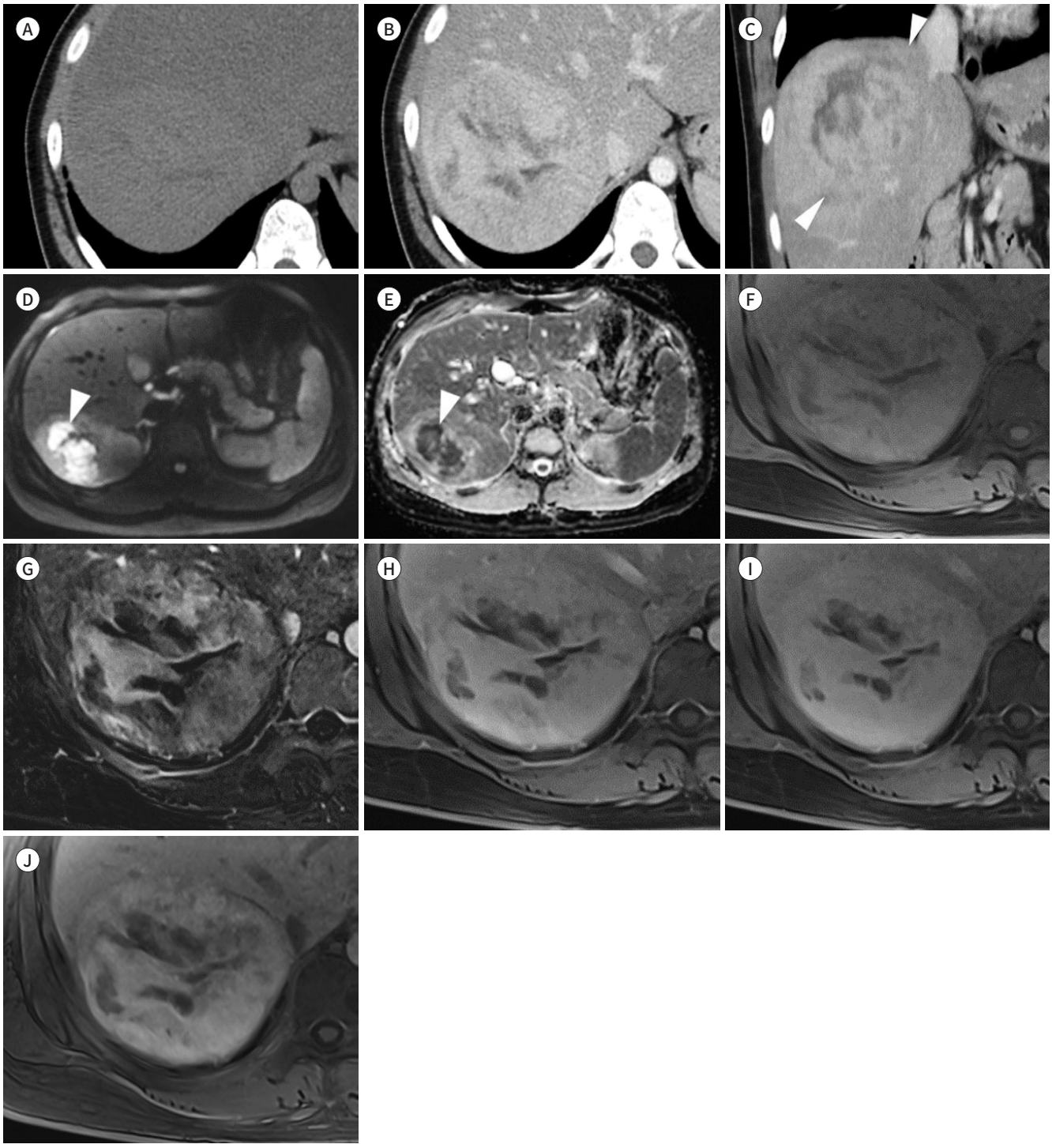
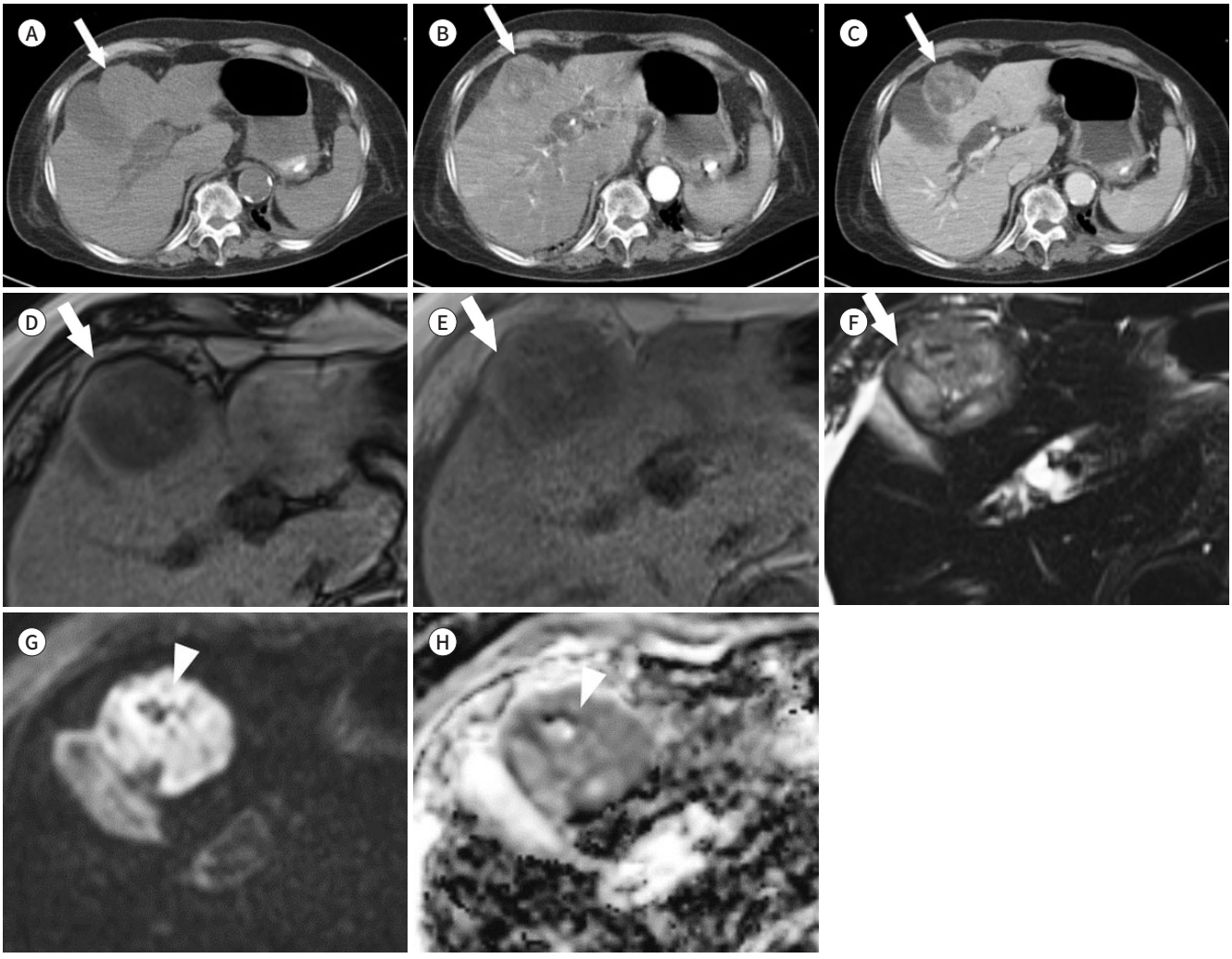


Fig. 6. A ruptured hepatocellular carcinoma with progressive enhancement patten in a 76-year old female patient presenting with hypotension and no risk factor for hepatocellular carcinoma.
A-H. Pre (A), arterial (B), and portal venous (C) phase CT images show a mass (arrows) with peripheral nodular arterial enhancement and progressive enhancement on portal venous phase, mimicking hemangioma. However, the nodule shows hemoperitoneum in the left perihepatic space (not shown) owing to focal rupture, which suggested a malignant nodule, such as hepatocellular carcinoma. Gadoxetic acid-enhanced MRI images reveal a mass (arrows) with a mosaic appearance comprising fat-containing lesions that show signal intensity loss on the opposed-phase (D), compared with the in-phase MR images (E), hemorrhage on a T2-weighted MR image (F), and diffusion restriction (arrowheads) on the diffusion-weighted (G) and apparent diffusion coefficient map (H) images, suggesting hepatocellular carcinoma.

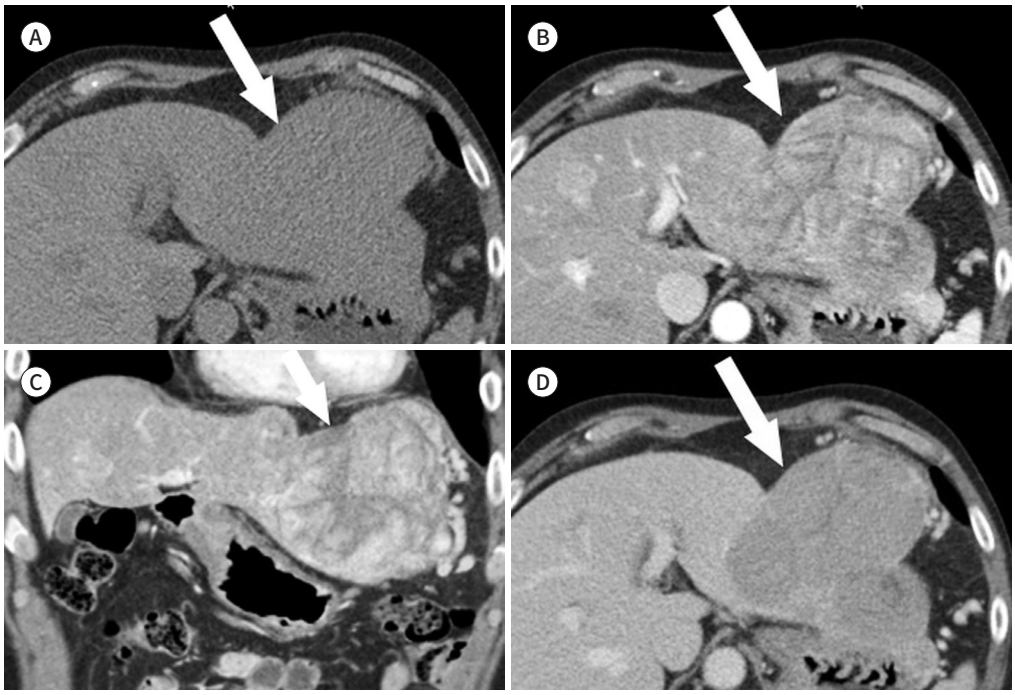


CT, especially in high-risk patients.

DIFFERENTIATION OF HCC WITH EXOPHYTIC NATURE FROM THE EXTRAHEPATIC TUMORS WITH LIVER INVASION

A few previous studies have reported exophytic HCC (22, 23). Exophytic HCC is often difficult to diagnose because the mass can mimic an extrahepatic tumor in imaging studies due to its exophytic/pedunculated nature (Fig. 7) (24, 25). Differential diagnosis of exophytic HCC includes gastrointestinal stromal tumors (GISTs) from other origins, such as the stomach, mesentery, omentum, mesenteric sarcomas, and other tumors of adjacent organs. Subasinghe et

Fig. 7. A 12-cm surgically-proven hepatocellular carcinoma with huge exophytic nature in a 57-year old male patient with chronic hepatitis B and sudden elevation of serum α-fetoprotein on regular check-up.
A-D. On pre (A), arterial (B, C), and portal (D) phase CT examination images, a huge exophytic mass (arrows) with arterial hyperenhancement appears in the left lateral segment of the liver and shows a washout appearance on the portal venous phase. However, due to its exophytic nature, hepatic invasion of an extraluminal gastrointestinal stromal tumor mimicking the primary hepatic tumor is possible.



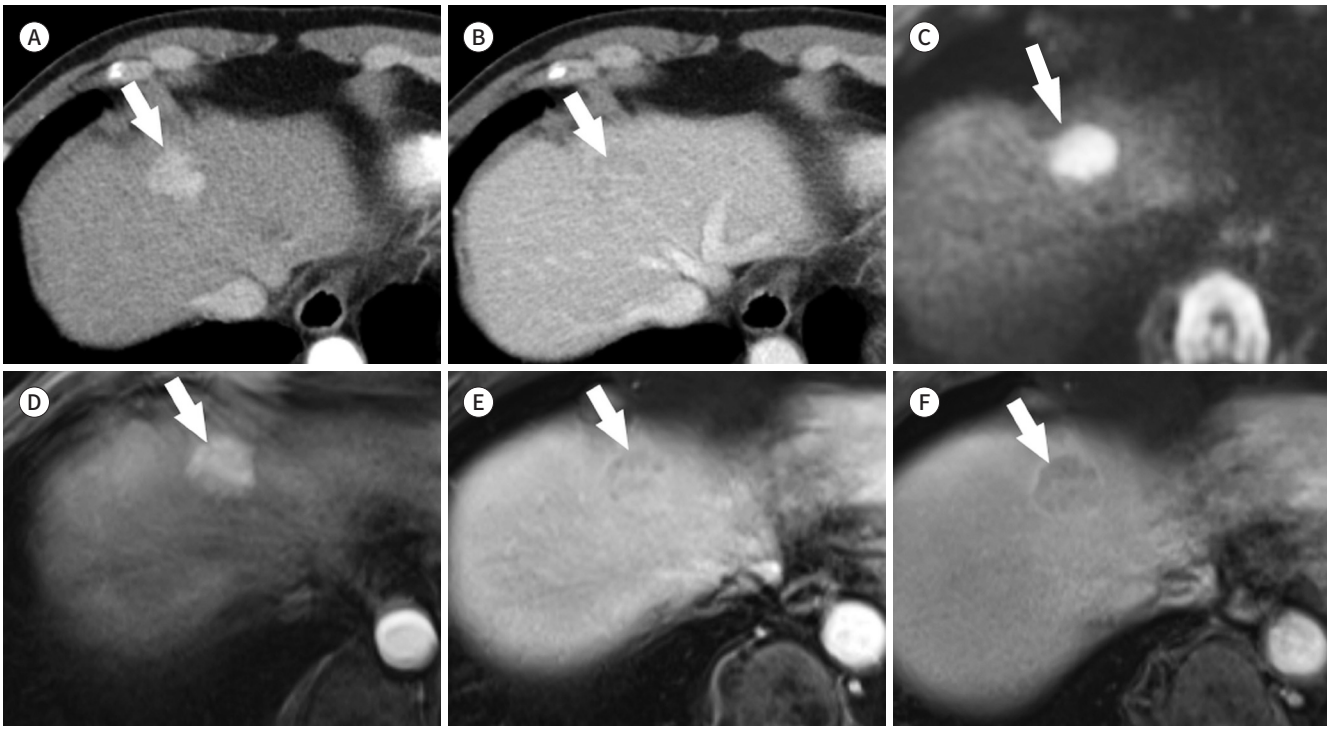
al. (26) reported that a patient with gastric GIST was misdiagnosed as an HCC of the left lobe of the liver, because the mass was in contact with the surface of the liver and showed arterial enhancement and washout on dynamic CT. Imaging diagnosis is often challenging owing to difficulties in determining tumor origin when a huge mass abuts multiple adjacent organs. The 'beak sign' and the 'prominent feeding artery sign' are helpful in identifying the origin of the tumor (27, 28).

INCIDENTAL LIVER LESION IN PATIENT ACCORDING TO THE RISK FACTOR FOR HCC

HCC surveillance is an effective secondary prevention strategy that enables early detection and increases the chance of curative resection according to current guidelines (29, 30). Unlike other malignancies, HCC has well-known risk factors including chronic hepatitis B, chronic hepatitis C, and underlying liver cirrhosis. Because over 90% of HCC cases are related with these risk factors, current international guidelines recommend HCC surveillance in high-risk patients with liver ultrasound and serum AFP measurement (30, 31). If there is a newly developed lesion during surveillance in patients with high-risk for HCC, liver multiphasic CT or dynamic contrast-enhanced MRI can be performed (30).

A small (< 1 cm) incidental hepatic lesion generally does not require further workup and can be considered benign (32, 33). However, given the high incidence of HCC in East Asia, in-

Fig. 8. Incidentally detected nodule with a 2.5-cm surgically-proven HCC in a 66-year old male patient with anemia and no risk factor for HCC.
A-F. On the examination of the arterial (A) and portal (B) phase CT images, a mass (arrows) with arterial hyperenhancement appears in segment IV of the liver and shows subtle washout on the portal venous phase. Gadoxetic acid-enhanced MR images reveal a mass (arrows) with diffusion restriction (C), hyperenhancement on arterial phase (D) mild washout appearance on the portal venous phase (E), and capsular enhancement on the transitional phase (F), which suggest a malignant liver mass, such as HCC or hypervascular liver metastasis.
HCC = hepatocellular carcinoma



cluding Korea, it may be necessary to consider further imaging work-up using contrast-enhanced CT or MRI for initially indeterminate nodules on the imaging examination in patients without known risk factors for HCC, or follow-up of the lesions to evaluate interval change (Figs. 8, 9).

HCC MIMICKING OTHER HEPATIC MALIGNANCY

INTRAHEPATIC MASS-FORMING CHOLANGIOCARCINOMA

Intrahepatic mass-forming cholangiocarcinoma (IHCC) is the second most common primary liver malignancy. Typical imaging findings of IHCC are lobulated contoured masses with hypo-enhancement or peripheral rim enhancement (34, 35). However, atypical IHCCs can show diffused arterial hyperenhancement mimicking HCC, especially when the mass is small (< 3 cm in diameter) and arises from the cirrhotic liver (34). Because hypervascular IHCC usually shows progressive or persistent enhancement in delayed phases, lack of washout is an important clue for distinguishing it from HCC (Fig. 10) (35).

COMBINED HCC-CHOLANGIOCARCINOMA

Combined HCC-cholangiocarcinoma (cHCC-CC) is a rare and aggressive primary hepatic malignancy and one of the most false-positive imaging diagnoses for HCC (36, 37). Because

Fig. 9. A 2.2-cm biopsy-proven a HCC in a 48-year old male patient with an incidental liver nodule on screening ultrasonography and no risk factors for HCC.
A-D. On ultrasonography (A), a small hyperechoic mass (arrowhead) appears in segment VIII of the liver. On the examination of the pre (B), arterial (C), and portal (D) phase CT images, a mass (arrows) with an arterial enhancing lesion appears in segment IV/VIII of the liver and shows no definite washout on the portal venous phase. Our initial differential diagnosis was focal nodular hyperplasia or hepatic adenoma on CT images.
E, F. On gadoxetic acid-enhanced MR images, the mass (arrows) shows arterial enhancement (E) and a fat-containing lesion, with no portal washout (F).
G-J. The mass (arrows) shows hypointensity on the transitional phase (G), mild diffusion restriction (H), and signal drop between the opposed-phase (I) and in-phase (J) MR images, suggesting malignancy, such as HCC.
HCC = hepatocellular carcinoma

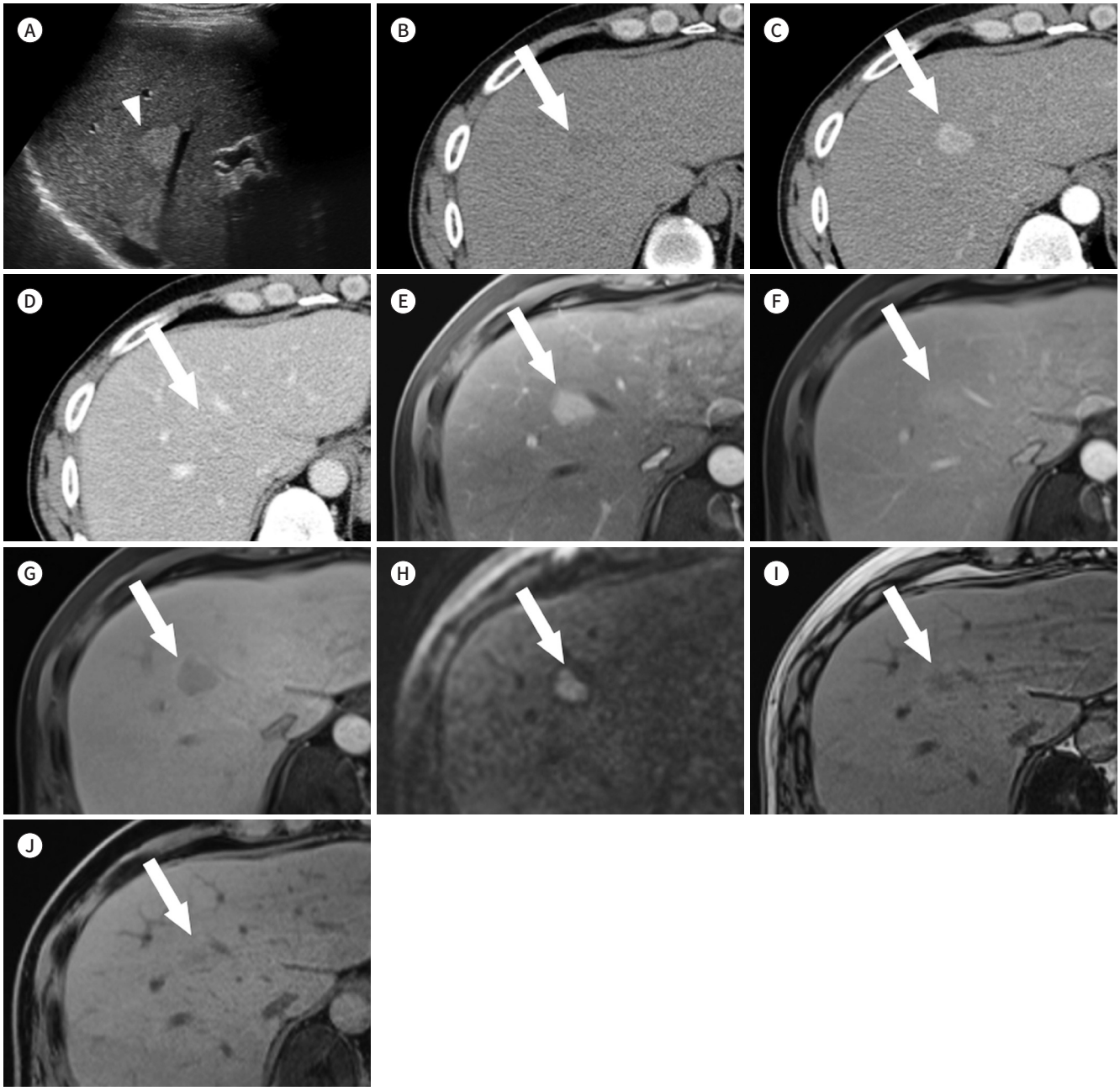


Fig. 10. A 2.4-cm biopsy-proven IHCC in a 56-year old male patient with liver cirrhosis and chronic hepatitis C.
A-D. On the examination of the pre (A), arterial (B), portal (C), and delayed (D) phase CT images, a newly developed lesion (arrows) with arterial phase hyperenhancement appears in segment V/VIII of the liver. The mass shows a persistent enhancement pattern during the portal venous and delayed phase, suggesting a hemodynamic change, such as an AP shunt, rather than a tumorous condition.
E-H. Gadoxetic acid-enhanced arterial (E), portal (F), transitional (G), and hepatobiliary (H) phase MR images show a bilobulated contoured arterial hyperenhancing lesion, with progressive enhancement during portal and transitional phases and a hepatobiliary phase defect at segment V/VIII of the liver (arrows).
I. The diffusion-weighted image shows subtle restricted diffusion, suggesting a tumorous condition such as atypical hepatocellular carcinoma or hypervascular IHCC (arrow).
J-L. The pre (J) and dynamic (K, L) phase contrast-enhanced ultrasound images reveal a hypoechoic mass (arrows) with mild hyperenhancement on arterial phase and venous phase washout. The mass was finally diagnosed as mass-forming IHCC.
IHCC = intrahepatic cholangiocarcinoma

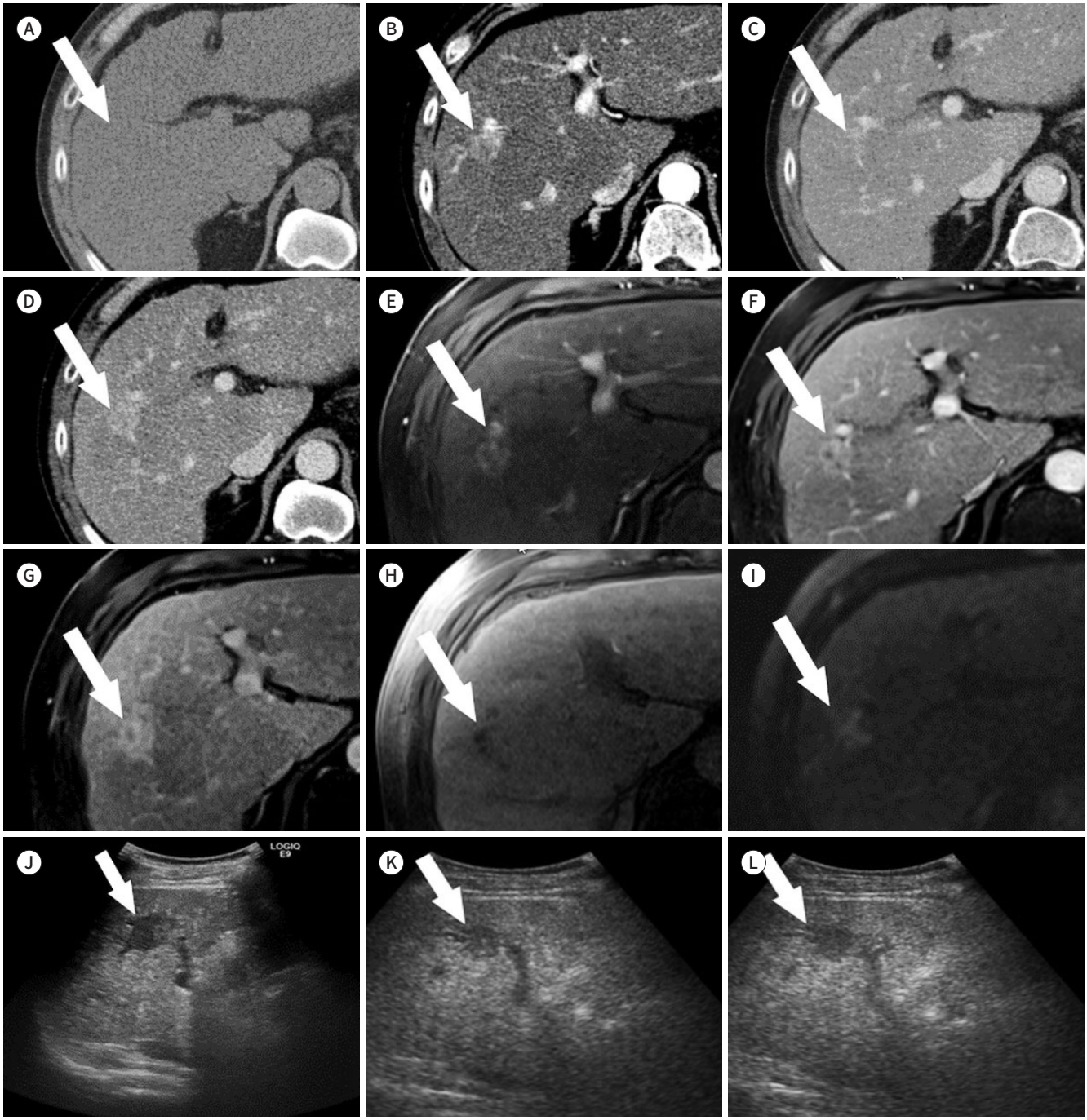
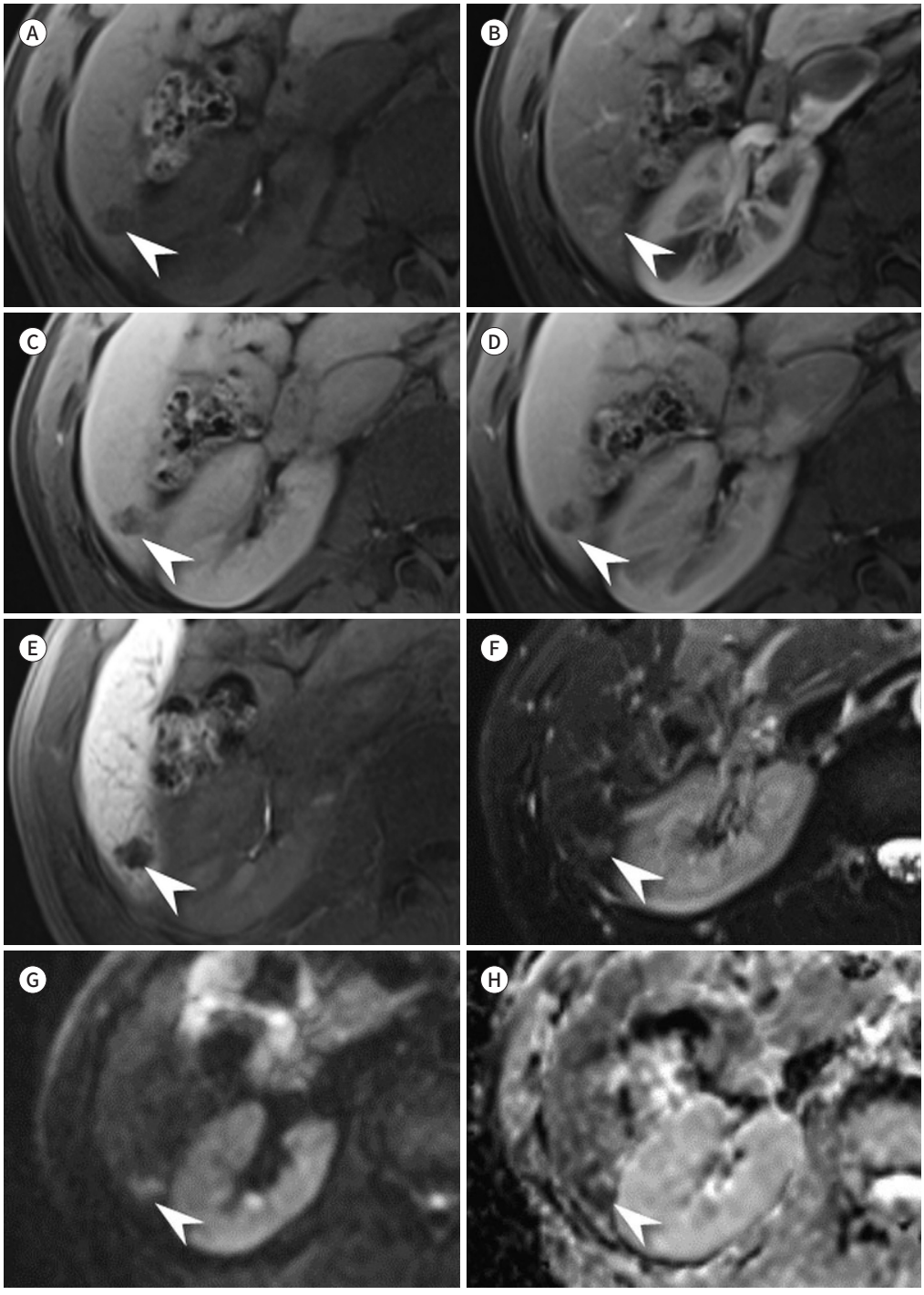


Fig. 11. A 1.3-cm surgically-confirmed combined hepatocellular-cholangiocarcinoma (cHCC-CCA) in a 53-year old male patient with chronic hepatitis B.
A-E. Gadoxetic acid-enhanced pre (A), arterial (B), portal (C), transitional (D), and hepatobiliary (E) phase MR images show a 1.3-cm mass (arrowheads) with arterial phase hyperenhancement and washout and hepatobiliary phase hypointensity.
F. T2-weighted fast spin-echo shows a mass (arrowheads) with mild-to-moderate hyperintensity.
G, H. The diffusion-weighted image (G) and apparent diffusion coefficient map (H) image show a mass with diffusion restriction (arrowheads). The mass did not contain fat on the T1-weighted dual echo sequence (not shown).

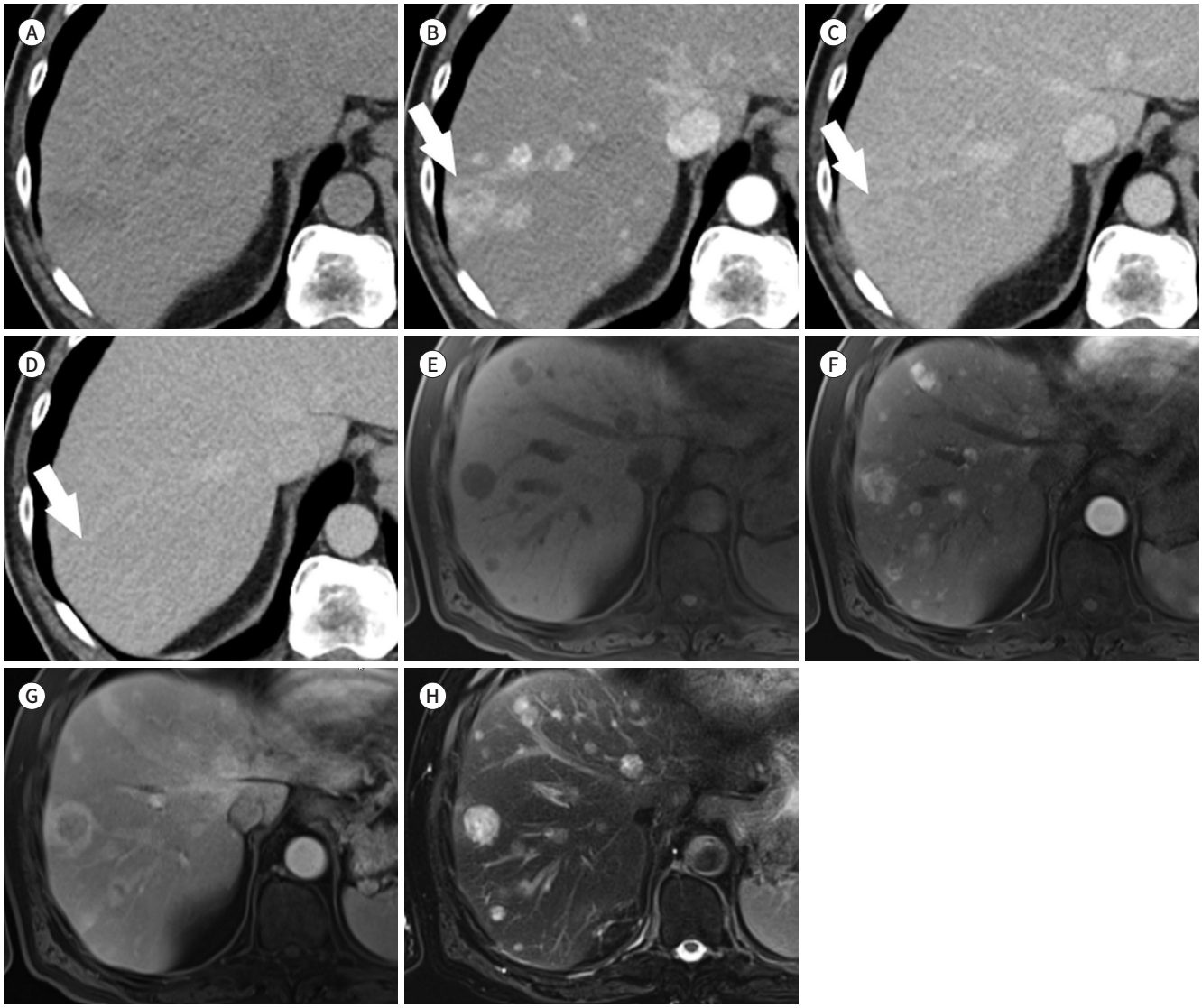


cHCC-CC contains histological components of both HCC and CC, it generally shows indeterminate imaging features and variable enhancement patterns reflecting the proportion and distribution of HCC and CC mixtures (Fig. 11) (36, 38). Therefore, differentiation of cHCC-CC from HCC is challenging based on imaging studies alone.

HEPATIC METASTASIS

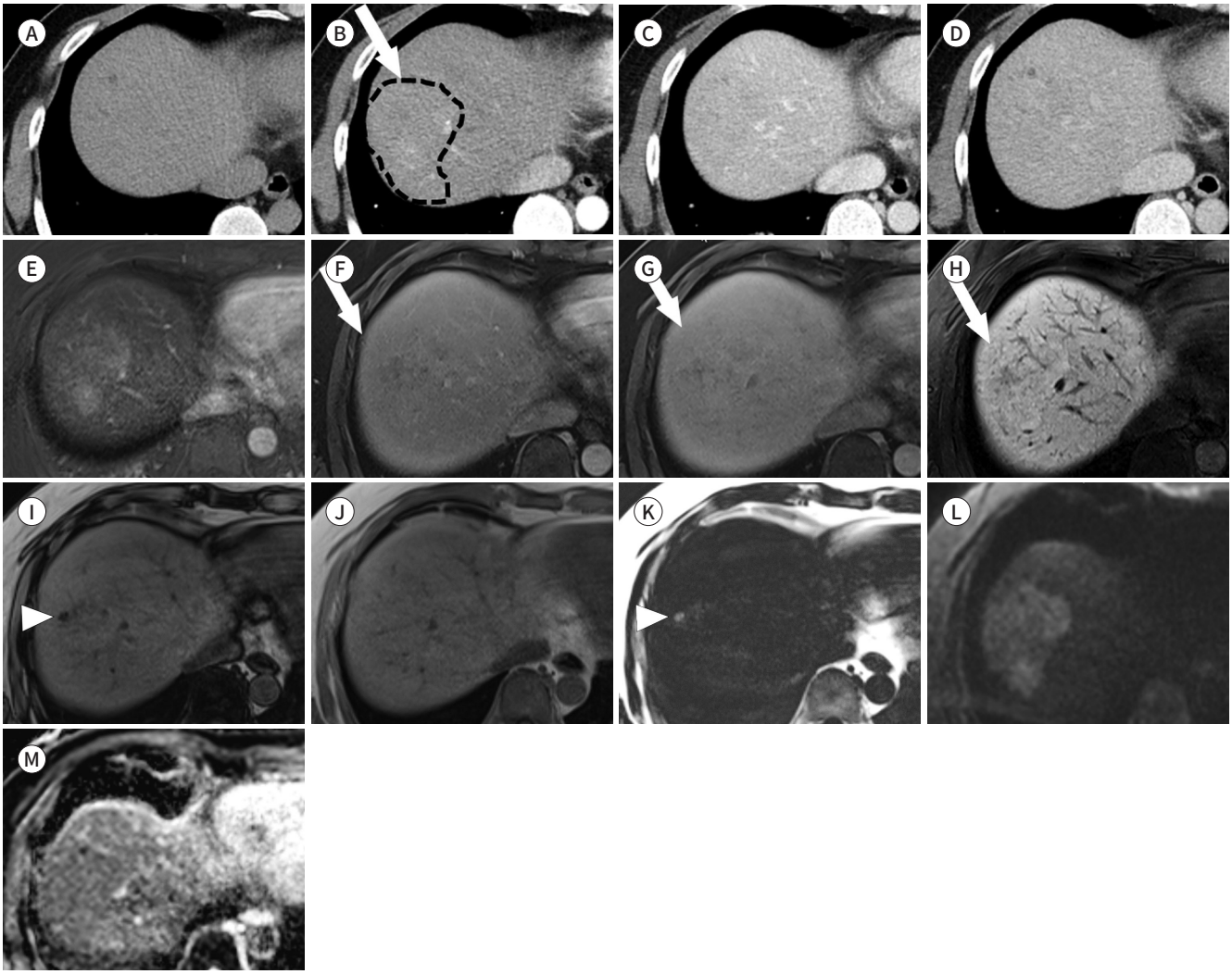
Metastasis is the most common malignant liver lesion, and the liver is the most common organ involved in metastatic disease (39, 40). Most liver metastases are typically hypoattenu-

Fig. 12. Multiple variable sized, biopsy-confirmed hypervascular hepatic metastasis of a pancreatic neuroendocrine tumor in a 65-year old male patient with chronic hepatitis B with multiple liver nodules on outside sonography.
A-D. Axial pre (A), arterial (B), portal (C), and delayed (D) phase images of multiphasic CT show multiple arterial enhancing nodules (arrows) with subtle washout in both hemi-livers. The CT images also show a 5-cm mass lesion in the pancreatic tail (not shown).
E-G. Gadoxetic acid-enhanced pre (E), arterial (F), and portal (G) phase MR images show multiple hypervascular nodules in both hemi-livers, with a 5-cm heterogeneous enhancing lesion in the pancreatic tail (not shown).
H. T2-weighted fast spin-echo shows nodules with hyperintensity portions, suggesting internal cystic portions.



ating on unenhanced CT and poorly enhanced during the arterial phase (39). However, some primary malignancies, such as neuroendocrine tumor, renal cell carcinoma, and melanoma, tend to have hypervascular metastases (40). Hypervascular hepatic metastases show arterial hyperenhancement and a variable degree of washout on delayed images, mimicking HCC (Fig. 12). Therefore, the radiologist should suspect hypervascular metastases for arterial-enhancing hepatic lesions, especially when the patient has a primary tumor origin.

Fig. 13. A 6-cm surgically-confirmed hepatocellular adenoma, β-catenin-activated type in a 36-year old male patient with liver function test abnormality.
A-D. Axial pre (A), arterial (B), portal (C), and delayed (D) phase images of multiphasic CT show an ill-defined low density lesion at S8 of the liver with minimal arterial hyperenhancement and subtle wash out (arrow), which is an incidental liver lesion of indeterminate malignancy. The dotted lines on the arterial phase image indicate the tumor margin.
E-K. Gadoxetic acid-enhanced arterial subtraction image (E), portal venous (F) transitional (G), and hepatobiliary (H) phase MR images reveal an arterial hyperenhancing mass (arrows) with internal fat deposition (arrowheads) on opposed-phase (I), in-phase (J), and fat-only (K) images by Dixon techniques and iso- or hyperintensity on the hepatobiliary phase (arrow) at the right hepatic dome, suggesting β-catenin activated hepatocellular adenoma.
L, M. The diffusion-weighted (L) and apparent diffusion coefficient map (M) images show a mass with mild diffusion restriction.



MALIGNANCY MIMICKING BENIGN LESIONS

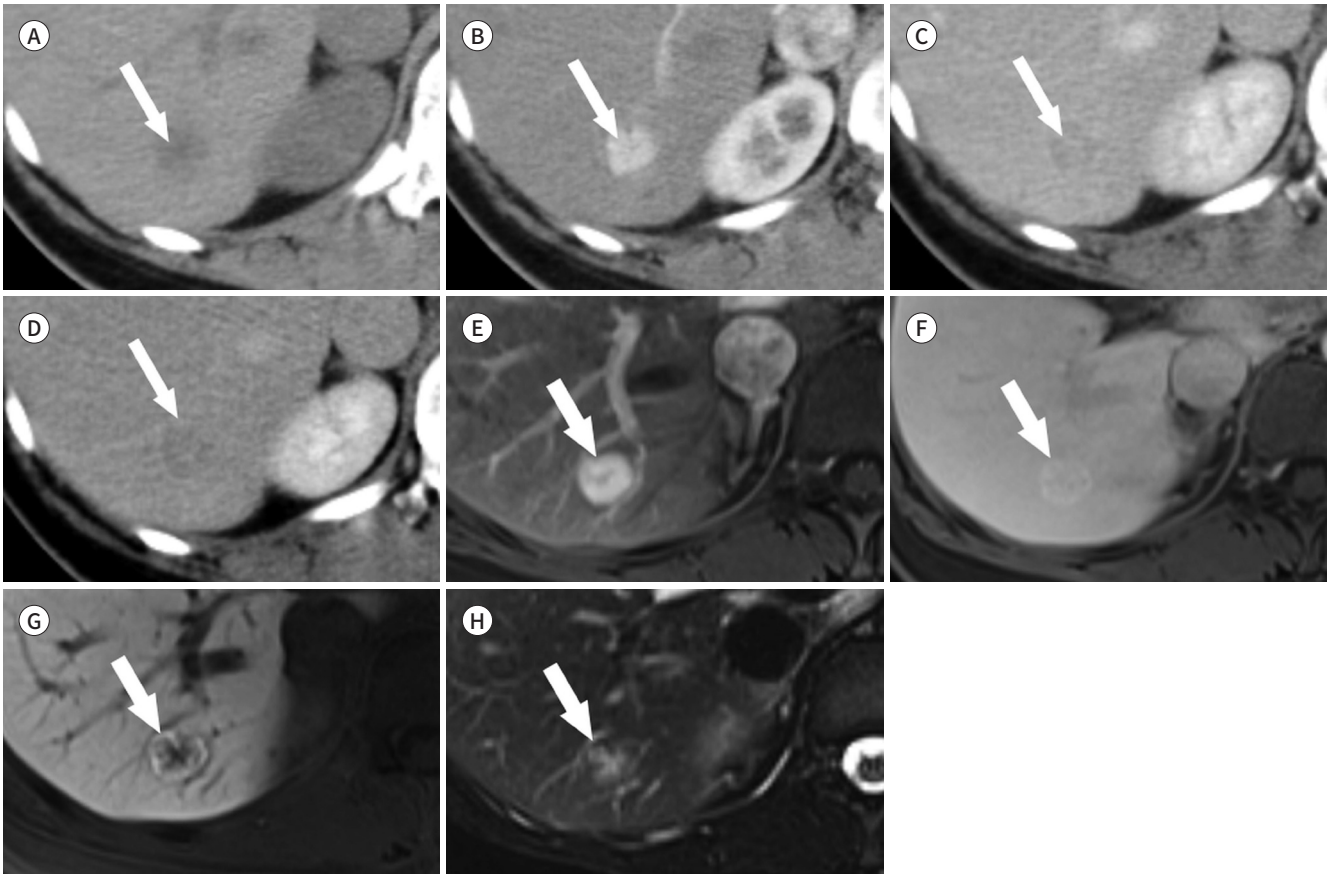
HEPATOCELLULAR ADENOMA

Hepatocellular adenoma (HCA) is the third most common benign liver tumor, with female predominance associated to the use of oral contraceptives (41). Most HCAs demonstrate hypervascular features and hypointensity in the HBP, mimicking HCC. In particular, β-catenin–activated HCA, a subtype of HCA, typically presents arterial hyperenhancement with washout and iso- or high SI in the HBP owing to increased expression of nuclear β-catenin, glutamine synthetase, and OATP1B3 (Fig. 13) (42). Although the majority of HCA typically occurs in noncirrhotic livers in female of child-bearing age, it remains difficult to distinguish early HCCs from HCAs.

FOCAL NODULAR HYPERPLASIA

Focal nodular hyperplasia (FNH) is the second most common benign hepatic tumor and

Fig. 14. A 1.6-cm FNH in a 28-year old female patient with liver function test abnormality and no risk factors for hepatocellular carcinoma.
A-D. Axial pre (A), arterial (B), portal (C), and delayed (D) phase multiphasic CT images show a small nodule (arrows) at segment VI/VII of the liver with arterial hyperenhancement and washout (arrows).
E-G. Gadoxetic acid-enhanced arterial (E), transitional (F), and hepatobiliary (G) phase MR images reveal a hypervascular nodule (arrows) with peripheral rim uptake on hepatobiliary phase.
H. The T2-weighted image shows a mass (arrow) with high signal intensity of a central scar, suggesting FNH.
FNH = focal nodular hyperplasia

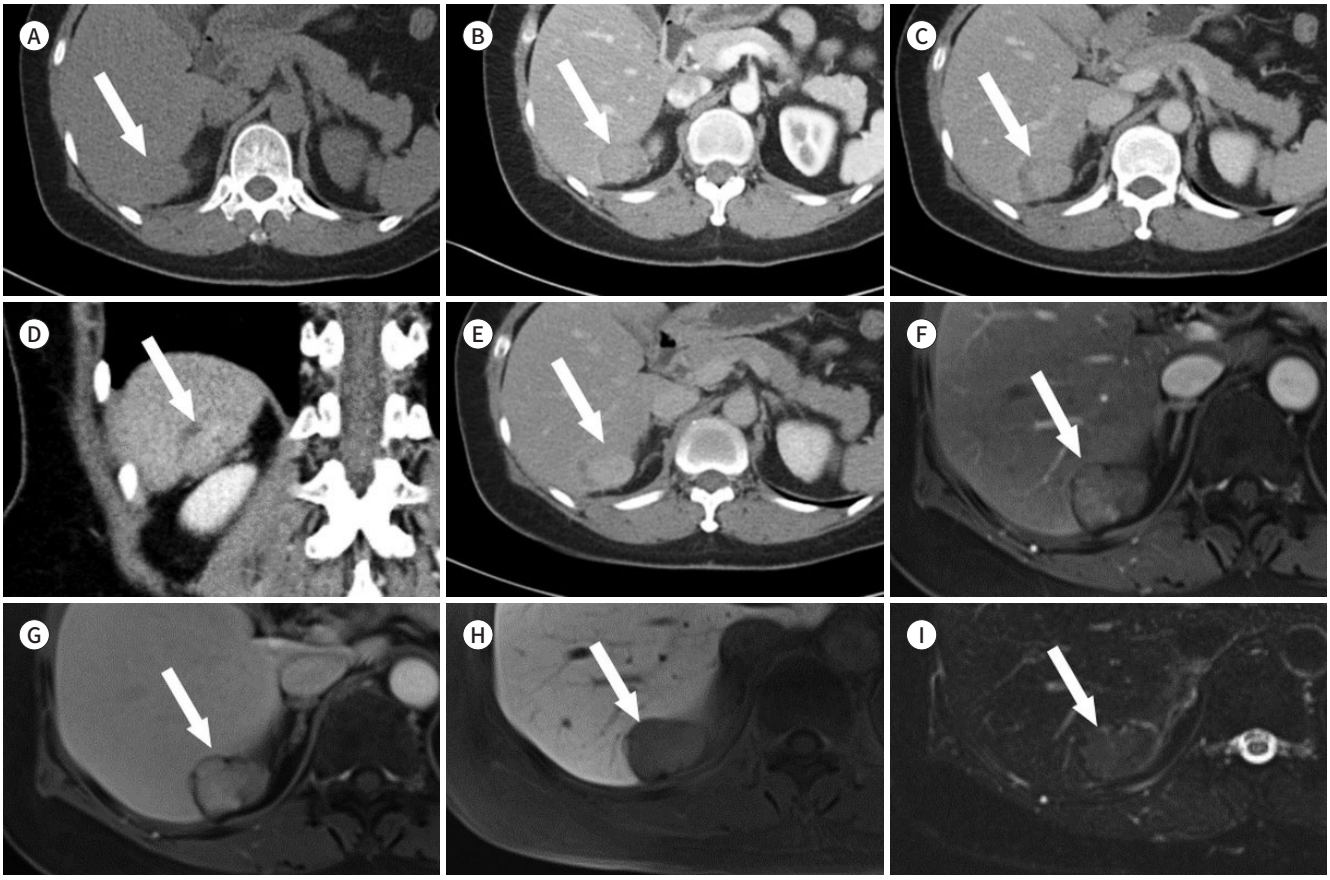


usually occurs in the non-cirrhotic liver of middle-aged female (42, 43). FNH usually presents with arterial hyperenhancement and central scar enhancement in the delayed phase, and shows ring-like enhancement in the HBP owing to surrounding hyperplastic hepatocytes with decreased OATP expression (Fig. 14) (43). Because atypical HCCs can also show hyperintensity on HBP, it may be necessary for differentiating FNHs from HCCs with hyperintensity on HBP images.

ADENOMYOMA

Extrauterine adenomyomas are extremely rare and located outside the uterus, such as in the abdominal wall or liver (44). Hepatic extrauterine adenomyoma appears as a solid mass with small cystic lesions, hemorrhagic foci, and weak persistent enhancement (Fig. 15) (45). Most patients with extrauterine adenomyoma have a prior history of pelvic endometriosis, and the lesions are typically in the subcapsular location of the right hemiliver in all previous-

Fig. 15. A 4-cm surgically-confirmed extrauterine adenomyoma in a 47-year old female patient with a history of hysterectomy for uterine leiomyomas.
A-E. Axial pre (A), arterial (B), portal (C, D), and delayed (E) phase multiphasic CT images show a lobulated contoured arterial enhancing lesion with progressive enhancement (arrows) at segment VI of the liver.
F-H. Gadoxetic acid-enhanced arterial (F), transitional (G), and hepatobiliary (H) phase MR images reveal an arterial enhancement with persistent enhancement and defect (arrows) on the hepatobiliary phase.
I. The T2-weighted image shows an ill-defined area of low signal intensity at the peripheral portion, with mild high signal intensity in the mass (arrow).



ly reported cases (45). Nonetheless, HCC can also show a solid mass with cystic lesions and intratumoral hemorrhage, which needs to be evaluated carefully.

SCLEROSED HEMANGIOMA

Sclerosed hemangioma is a rare subtype of hepatic hemangioma characterized by degeneration and fibrous replacement (46). Given that the imaging findings of sclerosed hemangiomas are nonspecific, it is often challenging to differentiate them from other lesions, such as atypical HCC or IHCC, before pathologic confirmation (46, 47). There are some helpful imaging findings suggestive of sclerosed hemangiomas, including capsular retraction, geographic pattern, decrease or unchanged in size over time, decrease in previously seen regions of enhancement (Fig. 16) (47).

Fig. 16. A 10.0-cm biopsy-proven sclerosed hemangioma in a 60-year-old female patient with an incidentally detected lesion during the evaluation of a nonspecific abdominal pain.
A-C. Axial pre (A), arterial (B), and portal (C) phase CT images present a lobulating contour mass with capsular retraction containing peripheral calcification, a partial non-enhancing area, and progressive nodular enhancement.
D-F. Gadoxetic acid-enhanced arterial (D), portal (E), and transitional (F) images also show the mass consisting of a focal non-enhancing area and an enhancing portion with progressive enhancement and a geographic pattern.
G-I. The T2-weighted (G) image shows mixed signal intensity, including high and intermediate signal intensity, in the mass with partial diffusion restriction on the diffusion-weighted image and apparent diffusion coefficient map (H, I).

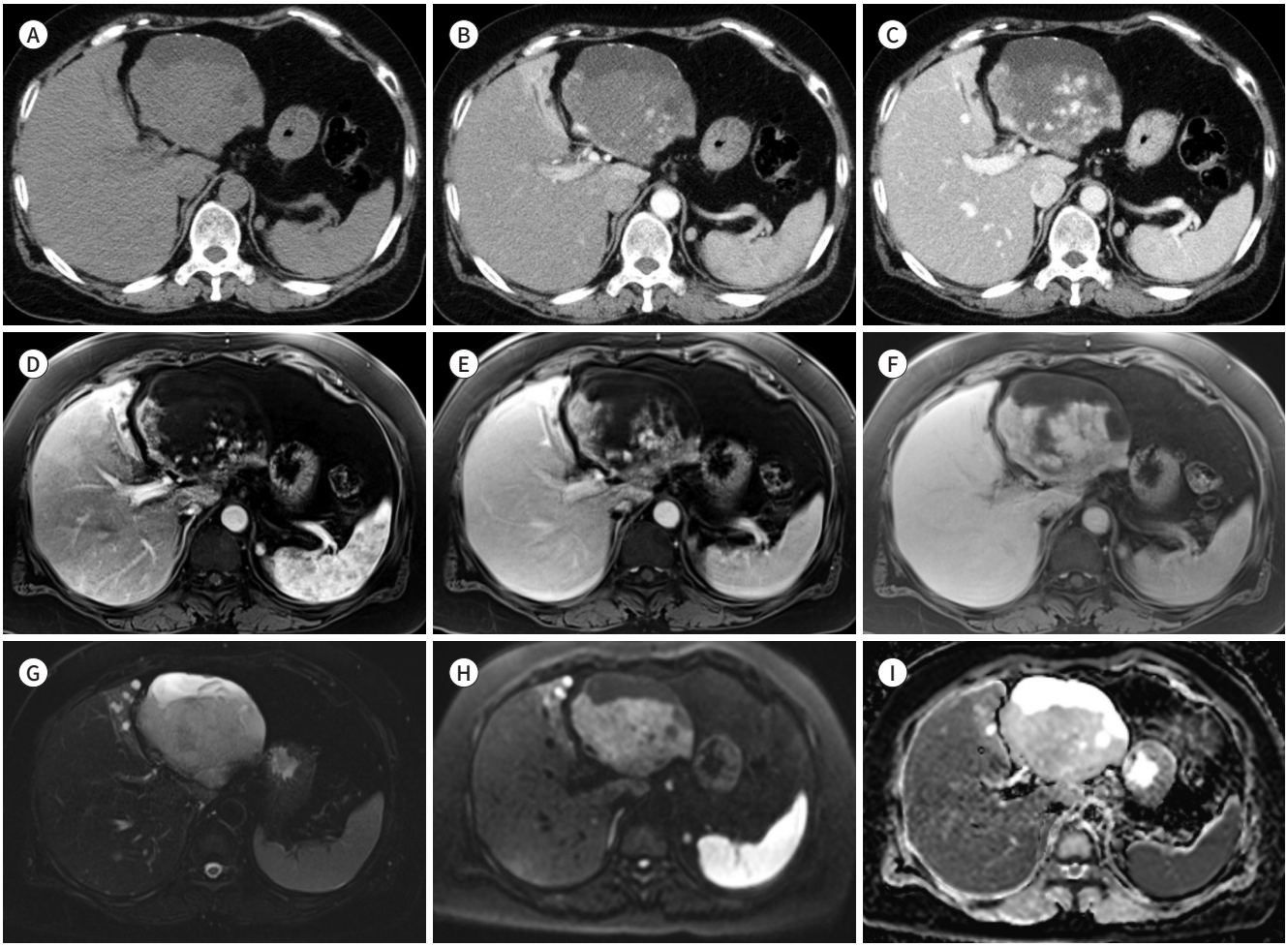
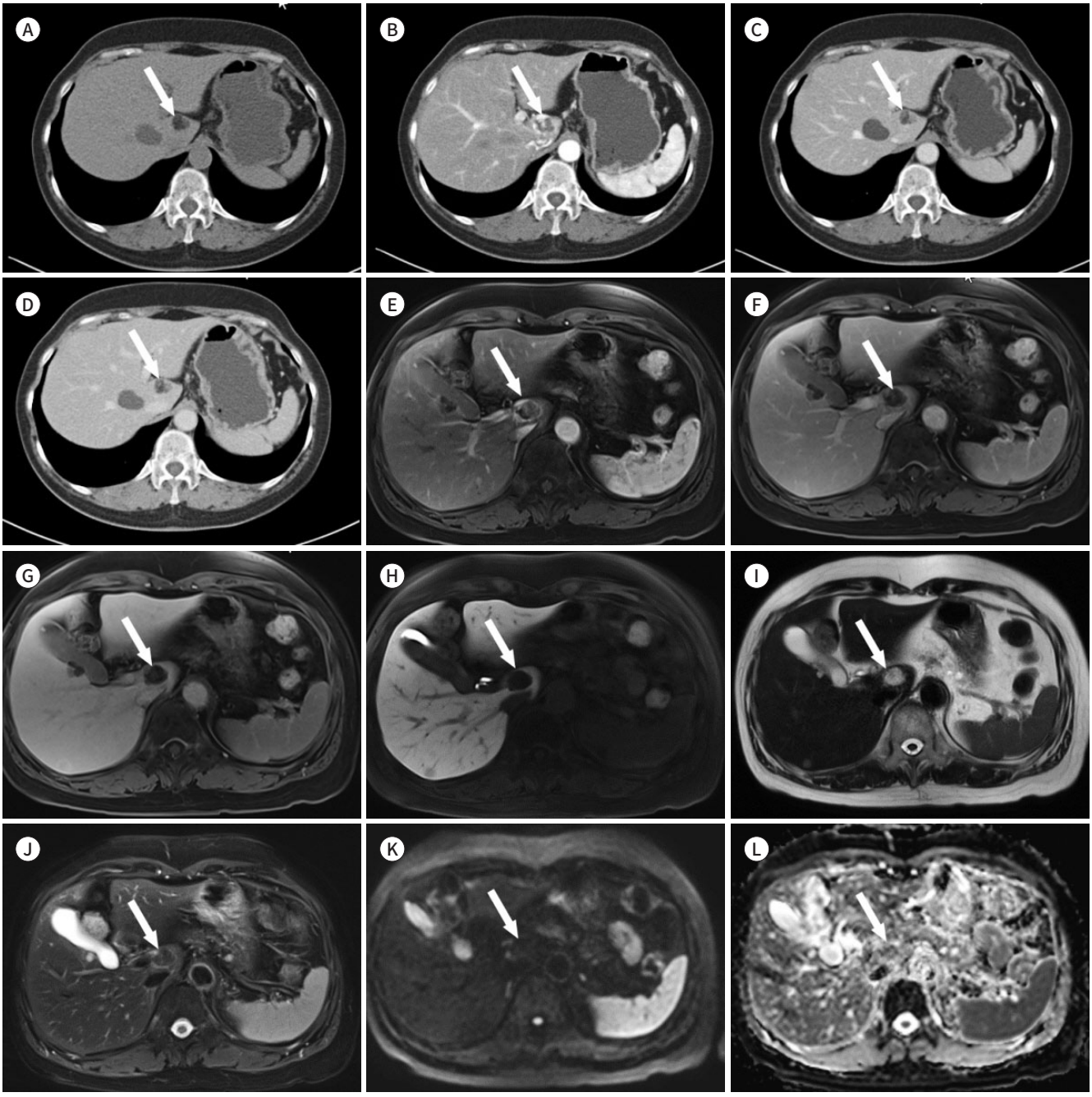


Fig. 17. A 2.2-cm biopsy-proven hepatic angiomyolipoma in a 62-year-old female patient with an incidental hyperechoic liver lesion on outside sonography and no risk factors for hepatocellular carcinoma.
A-D. Axial pre (A), arterial (B), portal (C), and delayed (D) phase images of multiphasic CT show a fat-containing mass (arrows) with prominent arterial nodular enhancement and washout on the portal venous phase at segment I of the liver.
E-H. Gadoxetic acid-enhanced arterial (E), portal venous (F), transitional (G), and hepatobiliary (H) phase MR images reveal an arterial enhancing mass (arrows) with washout and marked hypointensity in the hepatobiliary phase.
I, J. Although the T2-weighted image without fat saturation (I) shows high signal intensity, the T2-weighted image with fat saturation (J) shows aT2 iso-to-mild low signal intensity mass (arrows) that suggests an abundant fat component.
K, L. The diffusion-weighted (K) and apparent diffusion coefficient map (L) images show no diffusion restriction (arrows).



ANGIOMYOLIPOMA

Angiomyolipoma (AML) is a benign mesenchymal tumor comprising vessels, smooth muscle cells, and varying amounts of fat (48). AML often shows arterial enhancement and washout, mimicking HCC. The presence of fat is one of the key diagnostic features of AML; however other hepatic lesions, such as HCC, can also contain fat components (48, 49). AML presents with marked low SI in the HBP on gadoxetic acid-enhanced MRI (Fig. 17) in patients without risk factors for HCC due to the absence of hepatocytes in AML in comparison with HCC, which may consist of dysplastic foci showing mild hypointensity in the HBP. Thus, marked homogeneous low SI in the HBP could be helpful in distinguishing AML from HCC (49).

CONCLUSION

HCC is the only malignancy diagnosed on non-invasive imaging criteria without histological confirmation in at-risk patients. However, some HCCs reveal atypical imaging features, which poses a diagnostic challenge for radiologists. And we reviewed the presence of HCC mimicking lesions such as hemangioma, AP shunt, hepatic metastasis, IHCC, cHCC-CC, etc. The interpretation should be made carefully, not only using MR imaging and enhancement pattern on dynamic study, but also considering the patient's history, laboratory findings, and demographic characteristics. In addition, radiologists should be aware of the diverse imaging characteristics of HCC and other hepatic neoplasms as a differential diagnosis and should be able to suggest proper management and better patient outcomes.

Author Contributions

Conceptualization, P.S.H.; data curation, Y.J., P.S.H.; formal analysis, Y.J., P.S.H.; investigation, A.S.J., S.Y.S.; supervision, P.S.H.; visualization, Y.J.; writing—original draft, Y.J.; and writing—review & editing, Y.J., P.S.H.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Funding

None

REFERENCES

1. European Association for the Study of the Liver. EASL clinical practice guidelines: management of hepatocellular carcinoma. *J Hepatol* 2018;69:182-236
2. Choi JY, Lee JM, Sirlin CB. CT and MR imaging diagnosis and staging of hepatocellular carcinoma: part I. Development, growth, and spread: key pathologic and imaging aspects. *Radiology* 2014;272:635-654
3. Yoon JH, Park JW, Lee JM. Noninvasive diagnosis of hepatocellular carcinoma: elaboration on Korean Liver Cancer Study Group-National Cancer Center Korea practice guidelines compared with other guidelines and remaining issues. *Korean J Radiol* 2016;17:7-24
4. Kim JH, Joo I, Lee JM. Atypical appearance of hepatocellular carcinoma and its mimickers: how to solve challenging cases using gadoxetic acid-enhanced liver magnetic resonance imaging. *Korean J Radiol* 2019;20:1019-1041
5. Chernyak V, Fowler KJ, Kamaya A, Kielar AZ, Elsayes KM, Bashir MR, et al. Liver imaging reporting and data system (LI-RADS) version 2018: imaging of hepatocellular carcinoma in at-risk patients. *Radiology* 2018; 289:816-830

6. Cannella R, Fraum TJ, Ludwig DR, Borhani AA, Tsung A, Furlan A, et al. Targetoid appearance on T2-weighted imaging and signs of tumor vascular involvement: diagnostic value for differentiating HCC from other primary liver carcinomas. *Eur Radiol* 2021;31:6868-6878
7. Kim YY, Kim MJ, Kim EH, Roh YH, An C. Hepatocellular carcinoma versus other hepatic malignancy in cirrhosis: performance of LI-RADS version 2018. *Radiology* 2019;291:72-80
8. Asayama Y, Yoshimitsu K, Nishihara Y, Irie H, Aishima S, Taketomi A, et al. Arterial blood supply of hepatocellular carcinoma and histologic grading: radiologic-pathologic correlation. *AJR Am J Roentgenol* 2008;190:W28-W34
9. Gu KW, Kim YK, Min JH, Ha SY, Jeong WK. Imaging features of hepatic sarcomatous carcinoma on computed tomography and gadoxetic acid-enhanced magnetic resonance imaging. *Abdom Radiol (NY)* 2017;42:1424-1433
10. Park HJ, Kim YK, Cha DI, Ko SE, Kim S, Lee ES, et al. Targetoid hepatic observations on gadoxetic acid-enhanced MRI using LI-RADS version 2018: emphasis on hepatocellular carcinomas assigned to the LR-M category. *Clin Radiol* 2020;75:478.e13-478.e23
11. Park MJ, Kim YK, Park HJ, Hwang J, Lee WJ. Scirrhous hepatocellular carcinoma on gadoxetic acid-enhanced magnetic resonance imaging and diffusion-weighted imaging: emphasis on the differentiation of intrahepatic cholangiocarcinoma. *J Comput Assist Tomogr* 2013;37:872-881
12. Hwang SH, Yu JS, Kim KW, Kim JH, Chung JJ. Small hypervascular enhancing lesions on arterial phase images of multiphase dynamic computed tomography in cirrhotic liver: fate and implications. *J Comput Assist Tomogr* 2008;32:39-45
13. Byrnes V, Shi H, Kiryu S, Rofsky NM, Afdhal NH. The clinical outcome of small (<20 mm) arterially enhancing nodules on MRI in the cirrhotic liver. *Am J Gastroenterol* 2007;102:1654-1659
14. Choi BI, Lee KH, Han JK, Lee JM. Hepatic arterioportal shunts: dynamic CT and MR features. *Korean J Radiol* 2002;3:1-15
15. Motosugi U, Ichikawa T, Sou H, Sano K, Tominaga L, Muhi A, et al. Distinguishing hypervascular pseudolesions of the liver from hypervascular hepatocellular carcinomas with gadoxetic acid-enhanced MR imaging. *Radiology* 2010;256:151-158
16. Park SH, Kim B, Kim SY, Choi SJ, Huh J, Kim HJ, et al. Characterizing computed tomography-detected arterial hyperenhancing-only lesions in patients at risk of hepatocellular carcinoma: can non-contrast magnetic resonance imaging be used for sequential imaging? *Korean J Radiol* 2020;21:280-289
17. Lee JH, Lee JM, Kim SJ, Baek JH, Yun SH, Kim KW, et al. Enhancement patterns of hepatocellular carcinomas on multiphasicmultidetector row CT: comparison with pathological differentiation. *Br J Radiol* 2012;85:e573-e583
18. Okano H, Shiraki K, Inoue H, Ito T, Yamanaka T, Deguchi M, et al. Natural course of cavernous hepatic hemangioma. *Oncol Rep* 2001;8:411-414
19. Yeh WC, Yang PM, Huang GT, Sheu JC, Chen DS. Long-term follow-up of hepatic hemangiomas by ultrasonography: with emphasis on the growth rate of the tumor. *Hepatogastroenterology* 2007;54:475-479
20. Hasan HY, Hinshaw JL, Borman EJ, Gegios A, Leverson G, Winslow ER. Assessing normal growth of hepatic hemangiomas during long-term follow-up. *JAMA Surg* 2014;149:1266-1271
21. Liu Z, Yi L, Chen J, Li R, Liang K, Chen X, et al. Comparison of the clinical and MRI features of patients with hepatic hemangioma, epithelioid hemangioendothelioma, or angiosarcoma. *BMC Med Imaging* 2020;20:71
22. Horie Y, Katoh S, Yoshida H, Imaoka T, Suou T, Hirayama C. Pedunculated hepatocellular carcinoma. Report of three cases and review of literature. *Cancer* 1983;51:746-751
23. Kimura H, Inoue T, Konishi K, Tsuneda A, Tazawa K, Earashi M, et al. Hepatocellular carcinoma presenting as extrahepatic mass on computed tomography. *J Gastroenterol* 1997;32:260-263
24. Jung HI. Giant pedunculated hepatocellular carcinoma masquerading as a pelvic mass: a case report. *Korean J Hepatobiliary Pancreat Surg* 2014;18:56-59
25. Roumanis PS, Bhargava P, Kimia Aubin G, Choi JI, Demirjian AN, Thayer DA, et al. Atypical magnetic resonance imaging findings in hepatocellular carcinoma. *Curr Probl Diagn Radiol* 2015;44:237-245
26. Subasinghe D, Rathnasena BN, Medagodahetti US, Bhishman T. Gastrointestinal stromal tumour of the stomach mimicking a hepatic tumour: a case report. *BMC Res Notes* 2014;7:147
27. Kim HJ, Lee DH, Lim JW, Ko YT, Kim KW. Exophytic benign and malignant hepatic tumors: CT imaging fea-

tures. *Korean J Radiol* 2008;9:67-75
28. Nishino M, Hayakawa K, Minami M, Yamamoto A, Ueda H, Takasu K. Primary retroperitoneal neoplasms: CT and MR imaging findings with anatomic and pathologic diagnostic clues. *Radiographics* 2003;23:45-57
29. European Association for the Study of the Liver. EASL clinical practice guidelines: management of hepatocellular carcinoma. *J Hepatol* 2018;69:182-236
30. Korean Liver Cancer Association (KLCA), National Cancer Center (NCC). 2018 Korean Liver Cancer Association-National Cancer Center Korea Practice Guidelines for the management of hepatocellular carcinoma. *Korean J Radiol* 2019;20:1042-1113
31. Yang JD, Hainaut P, Gores GJ, Amadou A, Plymoth A, Roberts LR. A global view of hepatocellular carcinoma: trends, risk, prevention and management. *Nat Rev Gastroenterol Hepatol* 2019;16:589-604
32. Dietrich CF, Sharma M, Gibson RN, Schreiber-Dietrich D, Jenssen C. Fortuitously discovered liver lesions. *World J Gastroenterol* 2013;19:3173-3188
33. Gore RM, Pickhardt PJ, Mortele KJ, Fishman EK, Horowitz JM, Fimmel CJ, et al. Management of incidental liver lesions on CT: a white paper of the ACR Incidental Findings Committee. *J Am Coll Radiol* 2017;14:1429-1437
34. Min JH, Kim YK, Choi SY, Kang TW, Lee SJ, Kim JM, et al. Intrahepatic mass-forming cholangiocarcinoma: arterial enhancement patterns at MRI and prognosis. *Radiology* 2019;290:691-699
35. Rimola J, Forner A, Reig M, Vilana R, de Lope CR, Ayuso C, et al. Cholangiocarcinoma in cirrhosis: absence of contrast washout in delayed phases by magnetic resonance imaging avoids misdiagnosis of hepatocellular carcinoma. *Hepatology* 2009;50:791-798
36. Choi SH, Lee SS, Park SH, Kim KM, Yu E, Park Y, et al. LI-RADS classification and prognosis of primary liver cancers at gadoxetic acid–enhanced MRI. *Radiology* 2019;290:388-397
37. Jeon SK, Joo I, Lee DH, Lee SM, Kang HJ, Lee KB, et al. Combined hepatocellular cholangiocarcinoma: LI-RADS v2017 categorisation for differential diagnosis and prognostication on gadoxetic acid-enhanced MR imaging. *Eur Radiol* 2019;29:373-382
38. Park SH, Lee SS, Yu E, Kang HJ, Park Y, Kim SY, et al. Combined hepatocellular-cholangiocarcinoma: gadoxetic acid-enhanced MRI findings correlated with pathologic features and prognosis. *J Magn Reson Imaging* 2017;46:267-280
39. Sica GT, Ji H, Ros PR. CT and MR imaging of hepatic metastases. *AJR Am J Roentgenol* 2000;174:691-698
40. Gore RM, Thakrar KH, Wenzke DR, Newmark GM, Mehta UK, Berlin JW. That liver lesion on MDCT in the oncology patient: is it important? *Cancer Imaging* 2012;12:373-384
41. Park YS, Lee CH, Kim JW, Shin S, Park CM. Differentiation of hepatocellular carcinoma from its various mimickers in liver magnetic resonance imaging: what are the tips when using hepatocyte-specific agents? *World J Gastroenterol* 2016;22:284-299
42. Yoneda N, Matsui O, Kitao A, Kozaka K, Kobayashi S, Sasaki M, et al. Benign hepatocellular nodules: hepatobiliary phase of gadoxetic acid–enhanced MR imaging based on molecular background. *Radiographics* 2016;36:2010-2027
43. Hussain SM, Terkivatan T, Zondervan PE, Lanjouw E, de Rave S, Ijzermans JN, et al. Focal nodular hyperplasia: findings at state-of-the-art MR imaging, US, CT, and pathologic analysis. *Radiographics* 2004;24:3-17; discussion 18-19
44. Paul PG, Gulati G, Shintre H, Mannur S, Paul G, Mehta S. Extrauterine adenomyoma: a review of the literature. *Eur J Obstet Gynecol Reprod Biol* 2018;228:130-136
45. Won YJ, Woo JY, Byun J, Hong ME. Extrauterine adenomyoma of the liver mimicking a hepatic adenoma: a case report. *J Korean Soc Radiol* 2019;81:197-202
46. Li T, Klar MM, Alawad M, Abdul R, Zahiruddin A, Salifu MO, et al. Hepatic sclerosing hemangioma mimicking malignancy: a case and literature review. *Am J Med Case Rep* 2021;9:144-146
47. Doyle DJ, Khalili K, Guindi M, Atri M. Imaging features of sclerosed hemangioma. *AJR Am J Roentgenol* 2007;189:67-72
48. Lee SJ, Kim SY, Kim KW, Kim JH, Kim HJ, Lee MG, et al. Hepatic angiomyolipoma versus hepatocellular carcinoma in the noncirrhotic liver on gadoxetic acid–enhanced MRI: a diagnostic challenge. *AJR Am J Roentgenol* 2016;207:562-570
49. Kim R, Lee JM, Joo I, Lee DH, Woo S, Han JK, et al. Differentiation of lipid poor angiomyolipoma from hepatocellular carcinoma on gadoxetic acid-enhanced liver MR imaging. *Abdom Imaging* 2015;40:531-541

원발성 간세포암의 비특이적 영상 소견 및 간암으로 오인될 수 있는 병변에 대한 영상의학적 고찰

윤지영 · 박소현* · 안수좌 · 심영섭

간세포암종은 역동적 조영증강 컴퓨터단층촬영이나 자기공명영상에서의 동맥기 조영증강 및 문맥기 또는 지연기 씻김현상과 같은 전형적 영상 소견을 기반으로 비침습적으로 진단할 수 있다. 그러나 일부 간세포암종은 비전형적인 영상 소견을 나타내기 때문에 영상의학과 의사는 진단에 있어 어려움에 직면하게 된다. 더욱이 동맥 문맥 단락, 혼합 간세포-담관암, 간내 담관암, 혈관종과 같이 많은 간세포암 유사 병변들이 다수 존재하여 영상을 통한 감별 진단에 난항을 겪는다. 초기 영상 검사에서 간세포암종과 이러한 유사 종양을 구별하는 능력은 적절한 관리 및 치료 결정에 중요하다. 따라서 본 임상화보에서는 간세포암종의 비전형적 영상 소견과 간세포암종을 모방하는 악성 및 양성 병변들의 영상 소견을 제시하고 감별 진단을 좁히는 데 도움이 될 수 있는 중요한 단서들에 대해 알아보고자 한다.

가천대학교 의과대학 길병원 영상의학과