Original Article

Hepatic angiomyolipoma: a series of six cases with emphasis on pathological-radiological correlations and unusual variants diagnosed by core needle biopsy

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Abstract: Hepatic angiomyolipoma is rare and may pose differential diagnostic difficulty, particularly if encountered in core needle biopsy. We studied 6 cases from 5 males and one female (median age, 48.6 yrs). All presented with non-specific symptoms or an incidentally discovered tumor mass. Two patients had a remote history of chemotherapy for hematological neoplasms (acute lymphoblastic leukemia and Hodgkin lymphoma respectively) and another had clear cell renal cell carcinoma and anaplastic pancreatic carcinoma diagnosed at autopsy without definable syndrome. None of the patients had evidence of the tuberous sclerosis complex or renal or other extra-renal angiomyolipoma. Three tumors were resected completely and three have been only biopsied and followed up. None of the resected cases recurred at a mean follow-up of 35 months. Histologically, tumors were classified as classical triphasic (1), lipomatous (2), epithelioid/oncocytoid (1), epithelioid trabecular (1) and myelolipoma-like (1). The adjacent liver parenchyma was normal in 3 cases, showed pigment cirrhosis in one case and mild fatty change in another case. One case had clinically diagnosed but histologically unverified cirrhosis. The initial diagnostic impression/ frozen section was misleading in 5 of the cases and included vascular lesion, focal fatty change, myelolipoma, hepatocellular tumor and oncocytic neoplasm. All tumors expressed HMB45 and variably desmin. One epithelioid lesion expressed HMB45 and TFE3, but lacked desmin expression. In conclusion, hepatic angiomyolipomas are increasingly recognized as incidental findings during surveillance for cirrhosis or investigations for unrelated conditions. Awareness of their diverse morphological spectrum in liver biopsy is necessary to avoid misdiagnosis as hepatocellular carcinoma, metastatic melanoma or other malignant neoplasms.

Keywords: Angiomyolipoma, liver, HMB45, myelolipoma, PEComa, TFE3

Introduction

Benign tumors and tumor-like lesions of the liver are uncommon. They may display either a hepatocellular (liver cell adenoma, focal nodular hyperplasia and nodular regenerative hyperplasia), mesenchymal (hemangiomas, fibrous tumors, smooth muscle tumors and others) or a mixed (angiomyolipoma) line of differentiation [1]. Currently, wide-spread use of high resolution imaging modalities and establishment of surveillance programmes for early detection of hepatocellular carcinoma (HCC) in patients with liver cirrhosis resulted in enhanced detection of otherwise asymptomatic benign liver lesions [2].

Angiomyolipoma (AML) is the prototype of a heterogeneous family of lesions unified by the presence of HMB45-positive myoid cells referred to as perivascular epithelioid cell (PEC) [3]. These lesions (collectively referred to by the rubric PEComas) encompass renal and extra-renal AML, pulmonary and extra-pulmonary clear cell sugar tumor, lymphangioleiomyomatosis, clear cell myomelanocytic tumor of the falciform ligament/ligamentum teres and neoplasms classified as PEComas not otherwise specified and occurring at different somatic soft tissue sites or within parenchymatous organs [4]. Since its first description by Ishak in 1976 [5], approximately 300 cases of hepatic AML have been reported to date [6-11].

Table 1. Clinicopathological features of hepatic angiomyolipoma (n=6)

	Age Sex	Symptoms	Clinical diagnosis	Treatment	Initial diagnostic consideration/ frozen section	Size cm, site	Histological subtype	IHC	Liver parenchyma	Associated diseases	Follow-up
1	41 M	Non-specific, on follow-up for Hodgkin lymphoma	Teratoma?	Segment resection	AML	7 cm, partially cystic	Lipomatous	SMA+desmin+ HMB45+ MelanA+S100+ TFE3-	Normal	Recurrent Hodgkin lymphoma at age 21 & 22, radiotherapy	12 mo ANER or new tumors
2	45 M	Incidental to traumatic rib fracture	Unclear lesion	Hemihepatectomy left	Benign probably angiomatous tumor	18 cm, segment II/III	Classic / mixed	HMB45- MelanA+	Normal, mild fatty change	Nicotin and alcohol abuse	57 mo ANER or other tumors
3	63 F	Nausea, deteriorating general condition	MRI: metastatic adenocarcinoma or carcinoid	Segment resection	Hepatocellular tumor	2 cm, Seg. II/III	Monotypic epithelioid	SMA(+)HMB45+ MelanA+S100- TFE3-	Normal	None	37 mo ANER or new tumors
4	60 M	On surveillance for cirrhosis	HCC?	Core needle biopsy	Focal fatty change, DD lipoma-like AML	1.1 cm, left lobe	Lipomatous		Pigment cirrhosis, mild alcoholic steatosis,	Anaplastic carcinoma pancreas, RCC autopsy	Died of multiorgan failure 9 mo later
5	21 M	On follow-up for hematological malignancy	Unclear lesions	Core needle biopsy	Rhabdoid neoplasm	Multiple (x8) both lobes	Monotypic oncocytic	HMB45+++ MelanA+S100- TFE3+++	Normal	LCH age 1 yr, Ph+ cALL at age 14, ABMT age 15, complete remission	Recent case, Slight progression on imaging
6	62 M	Incidental to investigation for sigmoid diverticulitis	HCC?	Core needle biopsy	Myelolipoma, DD AML with hematopoesis	2 cm Segment V/ VI	lipomatous Prominent extramedullary hematopoesis (myelolipoma-like)	HMB45+++ S100- Desmin+ TFE3-	Liver cirrhosis suspected on CT and lab investigation, no liver histology	None	Recent case, conservative follow-up

HCC, hepatocellular carcinoma; ANER, alive with no evidence of recurrence; AML, angiomyolipoma; MRI, magnetic resonance imaging; Mo, month; DD, differential diagnosis; LCH, Langerhans cell histiocytosis; ALL, acute lymphoblastic leukemia; ABMT, allogenic bone marrow transplantation; RCC, renal cell carcinoma.

Figure 1. Large mixed angiomyolipoma of the left liver lobe. Inhomogeneous appearance on contrast-enhanced CT with large fatty areas and interspersed dilated vessels (left side) and relatively homogenous soft tissue (smooth muscle) component to the right.

Figure 2. Right: This lipid rich hepatic angiomyolipoma appeared on CT as a well circumscribed hypodense lesion with small isodense streak (arrow) which corresponded to a mixed component on histological examination at autopsy. Left: On ultrasound examination the lesion was round shaped and sharply delineated with a homogenous hyperechoic echotexture.

Nevertheless, in our experience, hepatic AML is still under-recognized by both clinicians and pathologists and seldom included in the differential diagnosis of focal liver lesions. Accordingly, a majority of hepatic AML (especially monotypic variants) have been misinterpreted as HCC on imaging [11, 12]. Thus, awareness of the diverse histology of hepatic AML is mandatory for appropriate biopsy interpretation. The purpose of this study is to illustrate the heterogeneity of hepatic AML and their immunohistochemical phenotypes with emphasis on diagnosis by core needle biopsy.

Material and methods

Cases have been retrieved from the routine surgical pathology files of our institution by a computer-based search for liver lesions classified as "angiomyolipoma", "perivascular epithelioid cell tumor" or "PEComa". Follow-up data were obtained from patient's treating physicians. All specimens have been originally fixed in 4% buffered formalin and embedded routinely for histological examinations. Paraffin blocks were available for all cases. In addition to hematoxylin and eosin (H&E) stain, sections were stained with periodic-Schiff-stain (PAS) with and without diastase predigestion, reticulin stain, Prussian blue stain and Sirius stain. Immunohistochemical stains were performed on newly cut 5 µm sections using a polymer Kit purchased from Zytomed systems Ltd. (Berlin,

Germany) according to the manufacturer's instructions and the following antibodies: vimentin (clone V9, 1:100, DakoCytomation), pancytokeratin (clone KL-1, 1:200, Beckmann-Coulter), HepPar-1 (clone OCH1E5, 1:200, Dako, Hamburg, Germany), HMB45 (clone HMB45, 1:50, Loxo, Dossenheim Germany), S100 protein (polyclonal, 1:2500, Dako), alpha-smooth muscle actin (ASMA, clone 1A4, 1:200, Dako), desmin (clone D33, 1:250, Dako), CD34 (clone QBEnd10, dilution 1:1000, Beckman Coulter, Krefeld, Germany) and Ki67 (MIB-1, 1:20 dilution, DAKO). Case 6 was stained also for CD61 (clone Y2/51, 1:400, Dako) and glycophorin A (clone Snp88, 1:50, Biogenex). Five cases were stained for TFE3 (clone MRQ-37, prediluted, Medac).

Results

The clinicopathological features are summarized in **Table 1**. Patients were 5 males and one female aged 21-63 yrs (mean, 48.6 yrs; median, 52 yrs). They presented either with non-specific abdominal symptoms or incidentally detected tumor mass. Two patients had lesions detected incidentally on surveillance for liver cirrhosis. Treatment was complete tumor resection in 3 patients. Of them, none had evidence of new tumors or recurrent disease at a mean follow-up of 35 months (range, 12-57 months). Three patients received only core needle biopsy of the lesion followed by conservative monitoring. One of these three patients died of multiorgan failure 9 months later. He had no evidence of malignant progression on autopsy or further AMLs in other organs. The other two are recent cases.

T1w in-phase   T1w out-phase   VIBE arterial   T2w TSE FS

T2wTSE   Non-enhanced CT   Contrast-enhanced US   B-mode ultrasound
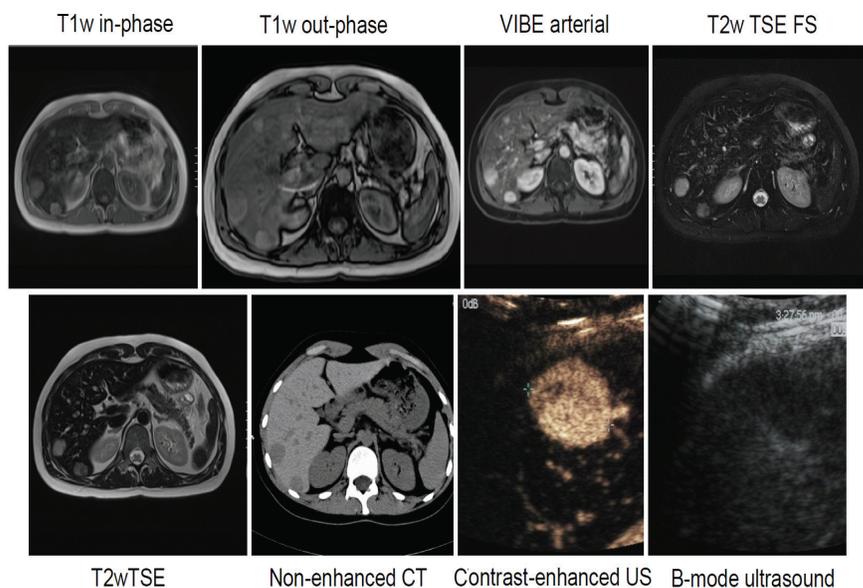
Figure 3. Multiple well circumscribed round lesions with high SI on both T2-w TSE images with and without fat saturation. The lesions were moderately hyperintense on T1-w images and demonstrate avid enhancement after contrast injection. Vessels can be delineated within the lesions as curvilinear structures. In contrast-enhanced ultrasound, capillary flow can be visualized (lower right panel).

Associated diseases

None of the patient was known to have renal or other extra-renal AML or stigmata of the tuberous sclerosis. Three patients had interesting associated neoplastic diseases: one patient (21 yrs old) had a history of Langerhans cell histiocytosis at age 1 yr, followed by a Philadelphia+ acute lymphoblastic leukemia (cALL) at age 14 that was then treated by chemotherapy and allogenic bone marrow transplantation. He presented currently (7 years after bone marrow transplantation) with slightly progressive multiple liver lesions; one of them has been biopsied. Another patient had a history of classical Hodgkin lymphoma 21 yrs earlier that has been treated by radiochemotherapy. A third patient who was diagnosed with mutation-negative hemochromatosis died of complicated cirrhosis with multiorgan failure 9 months later. At autopsy a giant cell-rich anaplastic carcinoma was detected in the pancreas and a clear cell renal cell carcinoma in the kidney. This patient has no extra-hepatic AML, clear-cut evidence of specific syndromic disease or stigmata of the tuberous sclerosis complex.

Imaging characteristics

Examples of the different imaging modalities are depicted in **Figures 1-3**. Contrast-enhanced CT scan of classical
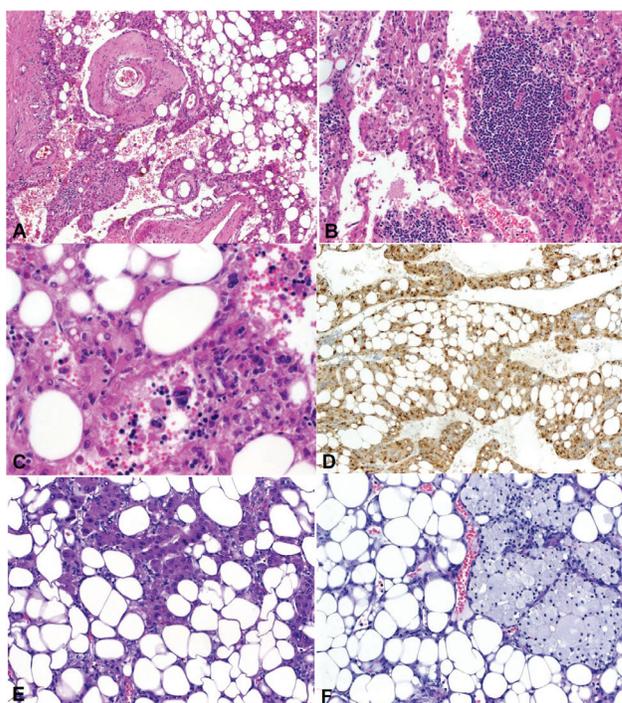
Figure 4. Example of classical (A-E, case 2) and lipomatous (F, case 1) hepatic angiomyolipoma. A. Admixture of fat, thick-walled vessels and smooth muscle cells. B. Prominent dilates sinusoids surrounded by hematopoietic tissue and lymphoid follicles. C. Hematopoietic tissue seen at higher magnification. D. Macrotrabecular growth highlighted by HMb45 immunostaining, note dilated sinusoids bordering macrotrabeculae. E. Entrapment of hepatocytes was common at the periphery of lesions. F. foamy cell aggregates (histiocytes) were prominent in one large fat-rich tumor.
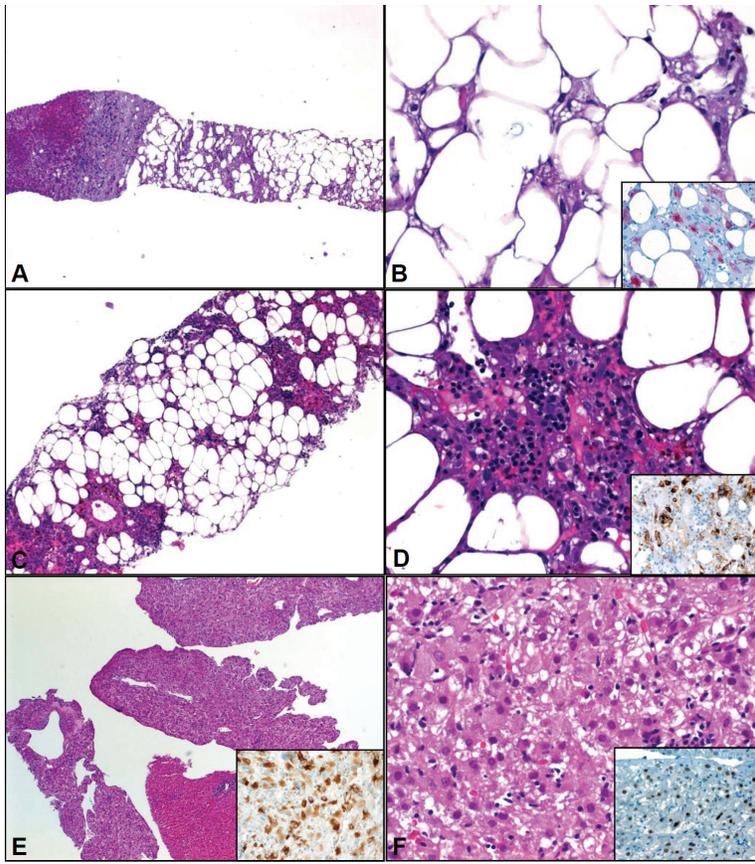
Figure 5. Unusual variants diagnosed by core needle biopsy. A, B: case 4 (inset HMB45 stain). C, D: case 6 (inset: HMB45 stain). E, F: case 5. (Inset in E: HMB45 stain; inset in F: TFE3 stain).

variants showed inhomogeneous appearance with large irregular fatty areas and interspersed dilated vessels blending with relatively homogenous soft tissue component (**Figure 1**). One lipomatous lesion diagnosed by core needle biopsy showed a streak-like soft tissue component that proved to represent a minor classical variant in the whole-tumor specimen obtained from this patient at autopsy (**Figure 2**). On the other hand, monotypic fat-poor variants displayed a homogenous soft tissue texture (**Figure 3**).

On ultrasound examination, hepatic AML appeared as round shaped sharply delineated lesions with a homogenous hyperechoic echotexture in nonsteatotic liver parenchyma (**Figure 2**, left panel). On power-Doppler ultrasound, they appeared avascular due to the low sensitivity of Doppler techniques to detect capillary blood flow. In contrast-enhanced ultra-sound, capillary flow can be visualized in AML (**Figure 3**, lower panel). The enhancement pattern in contrast-enhanced ultra-sound of high flow AML shows the typical features of a benign liver lesion characterized by contrast enhancement in the late phase. However, most of these features are shared by hemangioma making reliable distinction by ultra-sound impossible. The different phases of magnetic resonance tomography (MRT) of one patient with multifocal fat-poor lesions are shown in **Figure 3**.

Pathological findings

All tumors were well circumscribed but unencapsulated grossly. The cut-surfaces of resected tumors were described as yellow-brown to dark brown with occasional areas of hemorrhage and small cystic degeneration. Size was 2 cm, 7 cm and 18 cm for the three surgically resected tumors. One patient had a 1.1 cm lesion that has been diagnosed by biopsy and confirmed at autopsy. Size of the author biopsied but not resected cases ranged from 1-3 cm according to the imaging examination. One patient had multiple lesions in both liver lobes.

Histological features

Histologically, the tumors could be classified as classical (n=1) closely similar to renal AML and non-classical/variant (n=5). The classical variant of hepatic AML displayed variable admixture of mature macrovesicular fat cells interrupted by haphazardly distributed spindled to polygonal myoid cells with pale-eosinophilic granular cytoplasm containing variable cytoplasmic glycogen and variable number of thick-walled dysplastic vessels (**Figure 4A**). Foci of extramedullary hematopoesis were prominent
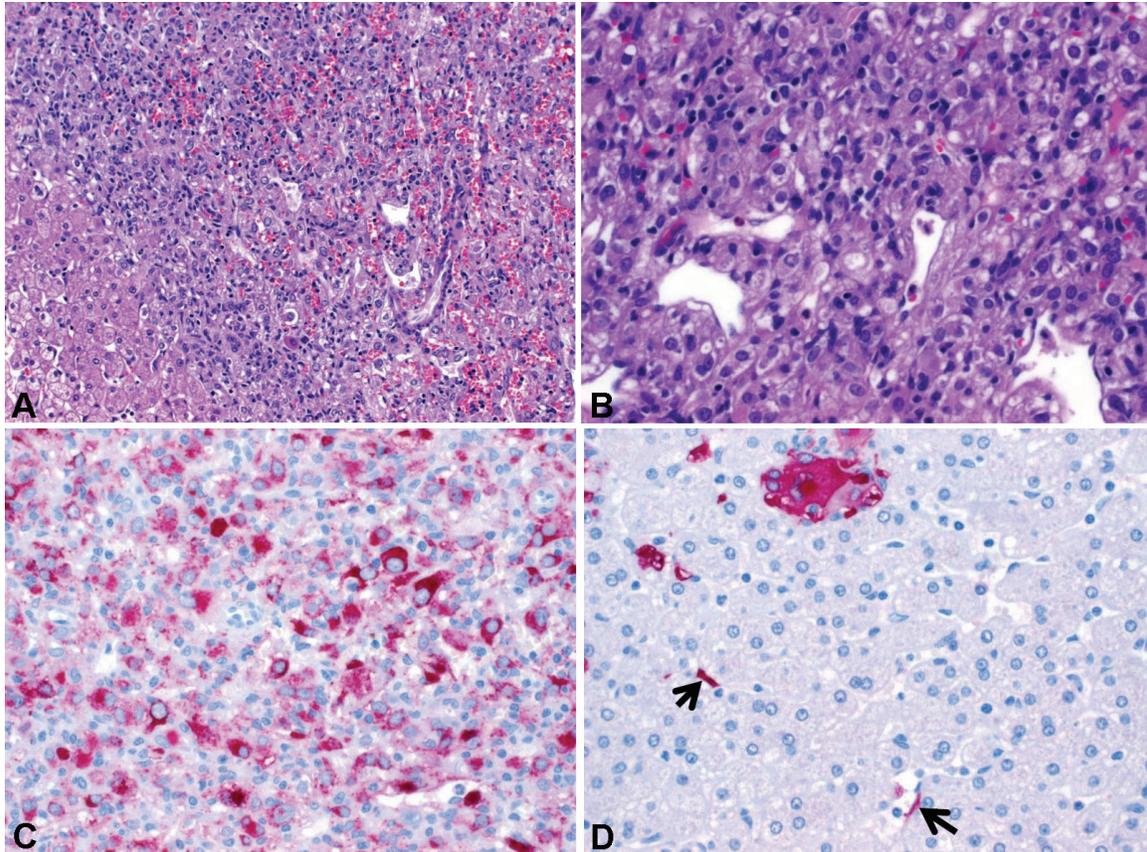
Figure 6. Trabecular hepatic AML (case 3). A. The lesion was well circumscribed peripherally but not encapsulated, note prominent vascularity and absence of thick-walled vessels. B. At higher magnification, note close similarity to HCC. C. Prominent expression of HMB45. D: Melan A (MART-1) stained slender sinusoidal-like cells within adjacent liver tissue (these cells however did not stain with HMB45).

and were occasionally accompanied by lymphoid aggregates (**Figure 4B** and 4**C**). The fatty component occasionally showed a macrotrabecular arrangement of cells that was better highlighted with the HMB45 immunostaining (**Figure 4D**). The interphase to the surrounding liver parenchyma was sharp to irregular suggesting gradual replacement of the liver parenchyma by tumor cells. Entrapment of hepatocytes was seen at the periphery of the lesion mimicking focal fatty change (**Figure 4E**). One resected large lipomatous tumor showed prominent aggregates of foamy histiocytes (**Figure 4F**). The two lipomatous cases (one biopsied only) showed variably sized fat-cells closely mimicking lipoma. However, isolated large polygonal cells that displayed pink granular cytoplasm with occasionally spider cell-like appearance were seen (**Figure 5A** and **5B**). Some fat cells showed multiple cytoplasmic vacuoles with lipoblast-like appearance and

others displayed a hibernoma-like morphology with granular eosinophilic cytoplasm. The myelolipoma-like lesion (biopsy material) was strikingly similar to adrenal myelolipoma as a result of prominent extra-medullary hematopoesis and the correct diagnosis was only possible on immunohistochemical staining for HMB45 (**Figure 5C** and **5D**). One of the two fat-poor lesions showed polygonal to short-spindled strikingly eosinophilic (oncocytoid) glycogen-rich cytoplasm that closely resembled a granular cell tumor (**Figure 5E** and **5F**). The other case was also completely devoid of fatty tissue and displayed monotonous epithelioid cell morphology and a solid trabecular growth architecture (**Figure 6A-B**). Multinucleated giant cells were seen scattered within the tumor, particularly at the periphery. The initial diagnosis or impression either at frozen section or during permanent histological evaluation

was generally misleading in 5 of the cases and included vascular lesion, focal fatty change, myelolipoma, hepatocellular tumor and rhabdoid neoplasm. Immunohistochemistry showed prominent granular cytoplasmic expression of HMB45 (6/6) and Melan A (5/5) (**Figure 6C**-**D**) (**Figure 4D**, **Figure 5B**, **5D**-**E** insets). Desmin and SMA expression was more variable in 4 cases and negative in 2. Of 5 cases stained with TFE3, one lesion showed strong nuclear expression in almost all tumor cells (**Figure 5F**, inset). This case was an epithelioid lesion with oncocytoid cellular features lacking any adipocytic differentiation or expression of myogenic markers.

Associated liver pathology

The tumor interphase was sharp to the surrounding liver but there was no true encapsulation. Most lesions showed entrapment of hepatocytes at the periphery of the lesion. The adjacent liver parenchyma was normal in 3 cases. In one other case, only mild fatty change was seen but no fibrosis or inflammation. Two patients had complete cirrhosis; one associated with heavy iron deposition in hepatocytes and in the biliary epithelium of the portal areas making hemochromatosis very likely. However, genetic analysis of this patient to confirm hemochromatosis was negative as was his family history. In the other patient, liver cirrhosis was diagnosed by ultrasound and laparoscopic examination. The submitted liver biopsy from this patient contained only AML tissue but no normal liver tissue. Except for one patient with a left-lobe AML and a small hemangioma in the right liver lobe diagnosed by ultrasound, none had an associated other liver neoplasm. Immunostaining for Melan A showed spindled sinusoid-cell like positivity in 2 cases (**Figure 6D**), but these cells did not express HMB45.

Discussion

Hepatic AML was once considered a very rare lesion with a limited number of reported cases in the old literature. Up to 1984, only 14 cases have been reported in the English literature. [6] The largest series published at that time comprised only 12 cases submitted from 7 different countries over a long period of time. [6] Interestingly, that series showed similar frequency of surgical and autopsy cases (6 cases each), probably because most hepatic AML remain asymptomatic and imaging investigations were not wide-spread at that time. However, the establishment of active surveillance programs for early detection of HCC in patients with liver cirrhosis and the wide use of high resolution imaging have significantly influenced the detection of hepatic AML. As a consequence, larger series have appeared in the recent literature [11]. Nevertheless, in our experience, hepatic AML, particularly non-classical variants, is still under-recognized by general surgical pathologists and encountering them particularly in core needle biopsy might pose a diagnostic challenge. This is due to the greatly varied and heterogeneous morphological appearance of hepatic AML that may mimic a variety of primary or metastatic liver neoplasms and tumor-like lesions [7, 12-14].

In our series which reflects the experience of a large academic hospital with a focus on gastrointestinal diseases, hepatic AML tends to show variant histology more frequently than their renal counterparts [15]. They deviate from the classical pattern of renal AML by: 1) being more frequently composed of a predominant cell type (adopting a monotypic pattern); 2), displaying variant cell morphology (monotonous epithelioid or rhabdoid cell appearance), and 3) containing additional tissue component, particularly hematopoietic elements and mixed inflammatory response [7, 15]. All these features might (either alone or in combination) largely mask the nature of the lesion and preclude diagnosis of AML. To date, a variety of cellular and architectural variants of hepatic AML have been delineated including in particular lipomatous, leiomyomatous, angiomatous, angiomyomatous, angiolipomatous, oncocytic, epithelioid, inflammatory and mixed variants [7, 12-14]. Lipomatous variants with prominent hematopoesis closely mimic adrenal myelolipoma, hence designated "angiomyelolipoma" by some authors [16]. In our series, the lipomatous variant is most common followed by the epithelioid variant.

While it may be of no significant clinical relevance to misdiagnose a hepatic AML as myelolipoma, lipoma or another benign lesion, misinterpreting hepatic AML as HCC [12], atypical lipomatous neoplasm, or, in the case of inflammatory AML, as a malignant lymphoma would

have a disastrous prognostic and therapeutic consequence for the patient. Thus, awareness of the wide morphological diversity of hepatic AML is necessary for correct diagnosis.

The differential diagnosis of hepatic AML should be individually judged based on the predominant cell type and growth pattern seen in a given lesion. Classical AML should pose no diagnostic difficulty. However, the intermixing of caliber-varying adipocytes and epithelioid or polygonal myoid cells together with entrapment of normal hepatocytes towards the periphery of the lesion and the presence of prominent sinusoid-like vascular channels and trabecular pattern all may closely mimic HCC, particularly the fat-rich variant of HCC. However, the haphazard arrangement of the myoid cells admixed with spindled cells and lack of cellular atypia should suggest AML. Furthermore, perivascular accentuation of epithelioid cells with clear or granular cytoplasm (PEC pattern) is not a feature of HCC. The monotonous epithelioid variant of AML may represent the most challenging diagnosis given its close resemblance to HCC. In equivocal cases, hepatocellular differentiation should be excluded by immunohistochemistry (expression of pancytokeratin and HepPar-1, canalicular staining for CEA and CD10). Hepatic AML invariably expresses HMB45 but expression of myogenic markers may vary greatly.

The pathogenesis of hepatic AML is unknown. Similar to renal AML, it may be a manifestation of the tuberous sclerosis (~10% of cases) [15-17], but several observations suggest a distinct histogenesis that differs from renal AML. The common occurrence of hematopoietic elements in hepatic AML is a feature shared by other primary hepatic neoplasms (HCC; adenoma, FNH) and strongly contrasts with their renal counterpart [1]. Several hepatic AMLs affected patients with a history of aggressive chemotherapy for child hood sarcomas [18, 19] and others were associated with benign liver tumors (hemangioma, FNH and bile duct adenoma) with or without a history of other malignancy [19, 20]. One patient with tuberous sclerosis developed concurrent hepatic AML and HCC [21]. A recent gene expression profile study showed similarities between hepatic stellate cells and hepatic AML which is consistent with a liver-specific histogenesis [22]. Molecular studies have demonstrated a clonal origin of hepatic AML but no loss of heterozygosity or microsatellite instability could be detected [23,24]. Similar to a subset of PEComas [25], a recent report demonstrated expression of TFE3 in a hepatic AML in a 25-year-old man with a history of chemotherapy (CHOP regimen) for mediastinal B-cell lymphoma [26]. His resected tumor displayed a monotypic epithelioid morphology and lacked myogenic markers [26] as in our case. Further, Malinowska et al showed that TFE3 expressing PEComas lack TSC alterations characteristic of conventional AML and PEComas [27]. Based on these recent observations, it is likely that rearrangement of the TFE3 gene locus plays a pathogenetic role in a distinct subset of monotypic AML/PEComa irrespective of anatomic site. Based on current knowledge, this rare subset of TFE3-positive PEComas/epithelioid AML has a tendency for occurrence at a younger age, absence of association with tuberous sclerosis, predominant alveolar architecture and epithelioid cytology, minimal or absent expression of muscle markers, and strong TFE3 immunoreactivity [25]. The vast majority of reported hepatic AML in larger recent series behaved in a benign fashion and recurrence was exceedingly rare [6-11]. However, the natural history and malignant potential of hepatic AML/PEComas harboring TFE3 gene alterations remains to be delineated in future studies. Only rare reports have documented a malignant course in hepatic AML [28, 29].

From a clinical view point, hepatic AML is commonly asymptomatic and half of the cases are detected incidentally on imaging for unrelated diseases. Although previous series have shown a predilection for women (~70%), in our small case series men were overrepresented. The correct preoperative diagnostic rate of hepatic AML by the different imaging modalities ranged from 0-23% [8-11]. Most were diagnosed as HCC or hemangioma on imaging [11]. Hepatic AML showed enhancement on arterial phase but were hypoattenuating to the surrounding liver at non-enhanced CT [11, 30, 31]. Hepatic AML presents usually as solitary, well circumscribed round or lobulated lesions on ultrasound, CT and MRI. Multiple lesions have also been described. Using ultrasound, hepatic AML are characterized as round shaped, sharply delineated lesions with a homogenous hyperechoic texture (in a non-steatotic liver). However due to identical B-mode features, hepatic AML

can´t be distinguished from hemangiomas. The same applies for the power-Doppler ultrasound as both hemangioma and AML appear avascular due to the low sensitivity of Doppler techniques to detect capillary blood flow. However, in contrast-enhanced ultrasound capillary flow can be visualized in AML as well as in hemangiomas. AML may be classified on the basis of fat content into lipomatous (≥70% fat), mixed, myomatous (≤10% fat), and angiomatous subtypes [7]. The lipomatous type is easy to diagnose because of the typical imaging features of fat (MRI: high SI on T1-w and T2-w TSE sequences with signal loss after fat-saturation; CT: hypodense lesion with negative HU-numbers on non-contrast CT). The most important differential diagnoses are hepatic lipoma and focal fatty change. Contrast enhancement varies but may be minimal in lesions with high fat content. Tubular or curvilinear structures with high SI on T2-w TSE and low SI on T1-w images may be detected in mixed and angiomatous types, representing vessels with slow blood flow. Avid contrast enhancement after injection of Gd-based contrast agents is also common in these lesions. AML with a small fat component are difficult to diagnose. T1-w gradient echo recalled (GRE) in- and opposed phase imaging can demonstrate subtle amounts of fat not detectable with CT. Differentiation of AML with a small fat component from other both benign or even malignant liver lesions including fat-containing hepatocellular carcinomas can be problematic [32-34].

Conflict of interest statement

None.

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