International Journal of Radiology and Diagnostic Imaging

Nobukata Kazawa
MD Ph.D. Department of Radiology and Pathology, Nagoya City University Hospital, Japan

Yoriko Yamashita
MD Ph.D. Department of Radiology and Pathology, Nagoya City University Hospital, Japan

Primary hepatic leiomyosarcoma (PHLS): A case report and literature review

Nobukata Kazawa and Yoriko Yamashita

Abstract
We encountered a rare case of HLMS.US and plain CT showed ill-defined para-caval hepatic tumor in the caudate lobe. The contrast enhanced CT showed a relatively poorly enhanced tumor with non-enhanced area suggesting necrosis. On MRI, the tumor presented with low signal intensity on T1 in-phased image and heterogeneously high signal intensity on T2WI. On T1-opposed-phase, the tumor showed the slight elevation of the signal compared with T1 in -phased image. This phenomenon suggested shortening of T2* effects caused by faint hemorrhage .On dynamic enhanced MRI, the lesion showed gradually mild enhancement from the arterial to the venous phase with some necrotic area.   By the CT-guided biopsy, the diagnosis of leiomyosarcoma with faint hemorrhage was made on immunohistochemical stain.

Keywords: Hepatic Leiomyosarcoma (HLMS) Intra-tumoral hemorrhage Opposed phase-MRI T1WI

Introduction
Hepatic leiomyosarcoma (HLMS) is an infrequent aggressive malignant tumor which usually presents para-IVC (Inferior vena cava) soft tissue tumor extending from the confluence of hepatic veins3）. Usually conventional HLMSs are almost always metastatic, although EBV-associated LMS is known.These tumor showed low incidence in daily practice, they also occur at ligament teres besides para caval area. EBV virus was reported to be associated in the genesis especially in HIV patient or iatrogenic (usually organ transplantation associated) conditions.   The diagnosis is often delayed until they reach a large size leading to dismal prognosis. We herein report a case of HLMS occurring in paracaval area. HLMS accounts for 3.6% (range: 0.9%–14%) of all liver malignancies [2]. The imaging findings of HLMS are often nonspecific and are not precisely differentiated from those of other benign and malignant hepatic tumors. Here, we describe the imaging findings of HLMS showing faint hemorrhage suspected by the high signal on T1-opposed-phased magnetic resonance imaging. Furthermore, we discuss the CT and MR imaging findings of HLMS in the past literature.

Case Report
A 86-year-old woman was referred to our hospital with chief complaining of abdominal pain with hypertension. She had no history of liver disease or alcohol abuse. Her past medical history and family history were unremarkable. Laboratory analysis revealed normal liver function tests including serum albumin level and prothrombin time. White blood cell count, platelet, α-fetoprotein, CA 19-9 and CEA, were also normal. Both antibody to hepatitis C virus and hepatitis B surface antigen were negative. The ICG clearance at 15 min was 12%. Abdominal ultrasonography revealed a para-caval hypoechoic mass, measuring 4x3.4 cm in diameter, in the hepatic caudate lobe. Abdominal computed tomography (CT) showed an indistinct iso-hypodense area (Figure1a) which was gradually enhanced from arterial (Figure1b) to delayed portal venous phase (Figure1c) occupying the segments 1 ventral to IVC. The tumor encased IVC mildly. The border of the ventral limbs and head of rt. adrenal gland was obliterated in tumor.

On MRI, the tumor exhibited hypo signal intensity on T1-in-phased weighted image (Figure2a) and a heterogeneously high signal intensity (Figure2b) on T2WI. IVC was mildly compressed and deformed.

Corresponding Author:
Nobukata Kazawa
MD Ph.D. Department of Radiology and Pathology, Nagoya City University Hospital, Japan

On T1-opposed phase (Figure2c), the several parts showed the elevation of signal suggesting faint hemorrhage or iron deposition. On dynamic Gd-DTPA enhanced MRI, the lesions showed gradual mild enhancement from the arterial to the venous phase with non-enhanced area suggesting necrosis. On DWI (diffusion weighted image), it showed heterogeneously high & low signal intensity with faint several intrahepatic metastatic tumors (Figure3) as high signal intensity foci around the main tumor.

Surgical exploration was not undertaken by her family desire, then the CT- guided-biopsy of the tumor from the dorsal part of the liver segment 1was performed. On both CT and MRI, no apparent fat nor fibrous capsule were observed. The histopathological examination revealed non-epithelial mesenchymal tumor composed with spindle atypical cells intersecting each other (Figure 4a).

On immunohistochemistry, SMA (smooth muscle actin: Figure 5) and desmin were positive, and they were negative for S-100、vimentin、NSE、calretinin. neurofilament, and CD34.Those findings confirmed the diagnosis of LMS (leiomyosarcoma)
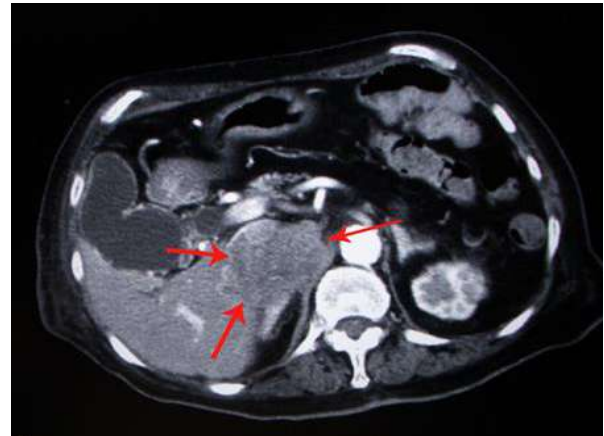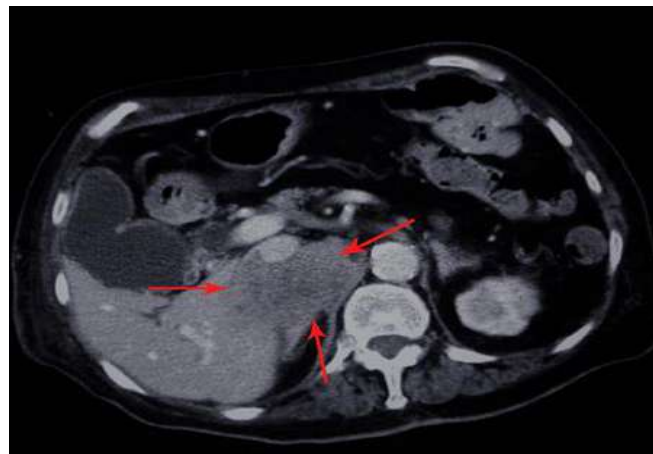

Fig 1a

Fig 1b

Fig 1c

Fig 1 a, b, c: (a) Computed Tomography (CT) scan of the abdomen revealed an ill-defined soft tissue mass (arrows) in the caudate hepatic lobe partially en-circulating IVC. Dynamic CT scan of early arterial phase showed faint heterogeneous enhancement (b) and delayed portal venous phase (c) showed a persistently enhancing tumor measuring $5.2 \times 4.5 \times 3.8$cm (arrows). The mass was thought to be a cholangiocarcinoma. Careful clinical and radiological examination did not reveal any other primary tumor site. IVC was deformed with mild compression and/or wall invasion by tumor. The border of the ventral limbs and head of rt. adrenal gland was obliterated.
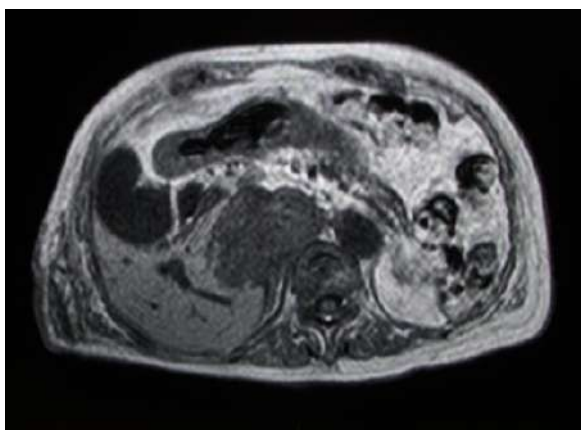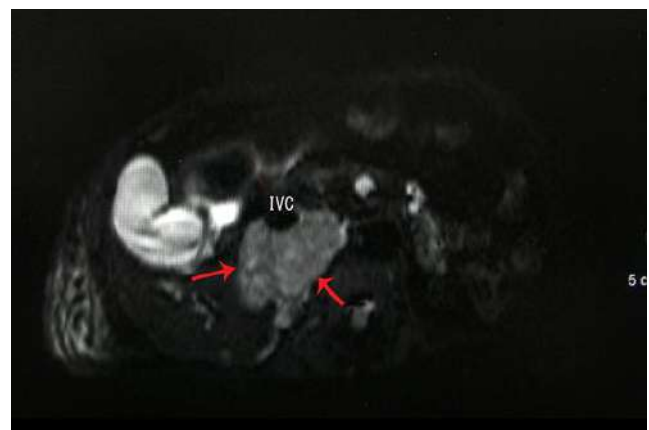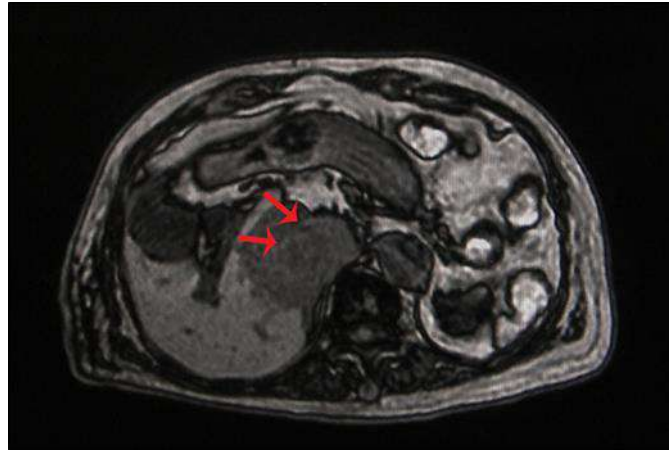

Fig 2a

Fig 2b

Fig 2c

Fig 2 a, b, c: On MRI, the tumor presented with a low signal intensity on T1WI-in-phased weighted image (2a) and a heterogeneously high signal intensity (2b) on T2WI. IVC was slightly compressed and deformed. On T1-opposed-phased image (2c), the tumor showed the slight elevation of the signal suggesting faint hemorrhage. On dynamic Gd-DTPA enhanced MRI, the lesions showed gradual mild enhancement from the arterial to the venous phase with non-enhanced area suggesting necrosis (not shown).

Fig 3: On DWI (diffusion weighted image), it showed heterogeneously high & low signal intensity. It also showed faint intraparenchymal metastatic tumors as high signal intensity foci throughout all hepatic lobe. The low signal foci assumed to be caused by T2* susceptibility effect of hemosiderin. Several faint intrahepatic metastatic foci were also revealed as high signal intensity foci. On both CT and MRI, no fat density nor apparent fibrous capsule were observed
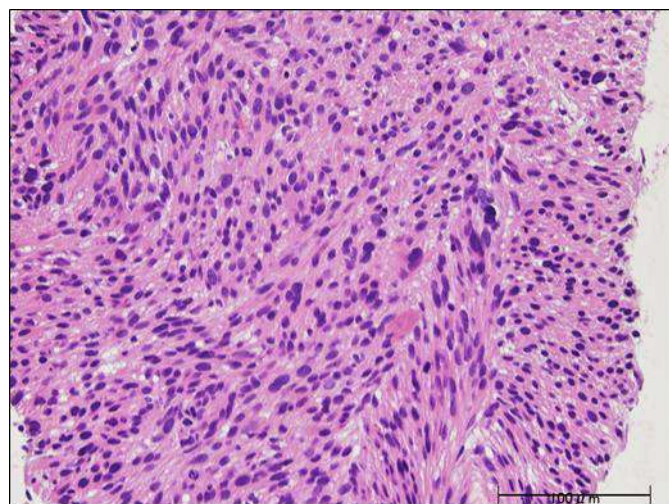
Fig 4: The histopathological examination suggested non-epithelial mesenchymal cells obtained by the cutaneous biopsy composed with spindle atypical tumors intersecting each other. Light microscopy demonstrated the typical growth pattern of LMS, that is, predominantly fascicular, with tumor bundles intersecting each other at wide angles and merging of tumor cells. Several mitoses and intratumoral faint hemorrhage (hematoma) were also present
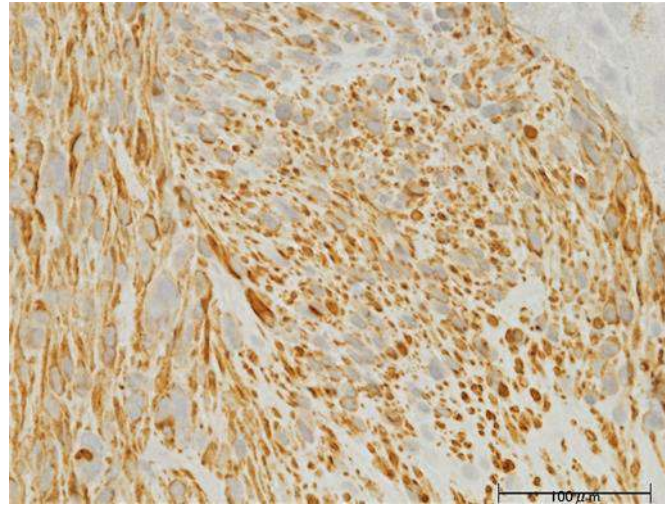
Fig 5: On immunohistochemical (IHC) studies, SMA and desmin were positive. S-100, vimentin, NSE, calretinin, neurofilament and CD34 were negative .Those IHC findings established the diagnosis of LMS (leiomyosarcoma)

Discussion

The clinical manifestation of primary HLMS (hepatic leiomyosarcoma) is usually non-specific, such as abdominal pain, weight loss, vomiting and jaundice and/or hepatomegaly or a palpable mass on physical examination. Acute bleeding is a rare symptom in patients with HLMS [2]. Some patients may have abnormal liver function tests but essentially the α-fetoprotein and other serological markers are negative. The absence of serological markers and non-specific clinical manifestations often delay diagnosis. Histological pre-operative diagnosis of HLMS is controversial as with other liver tumors, because most of the tumors have propensity for tumor seeding along the needle track.

HLMS is a rare tumor that is difficult to diagnose clinically. Different primary hepatic sarcomas may have different clinical, morphologic, and radiological features. Sarcomas constitute only 1 to 2% of all primary malignant tumors of the liver with the majority being either hepatocellular carcinoma or cholangiocarcinoma. The two major primary sarcomas of the liver are angiosarcoma [3] and epithelioid hemangioendothelioma [4].

Other reported sarcomatous tumors occurring in the liver parenchyma are as follows: undifferentiated embryonal sarcoma (UES), fibrosaroma, malignant fibrous histiocytoma (MFH), liposarcoma, rhabdomyosarcoma, malignant peripheral nerve sheath tumor (MPNST) and carcinosarcoma (including cystadenocarcinosarcoma). The other mesenchymal tumor are angiomyolipoma, LCH (histiocytosis X) and solitary fibrous tumor, leiomyoma, lipoma, myeolipoma, pseudolipoma, myxoma, chondroma, and benign multicystic mesothelioma.

No underlying etiologic factors including hepatitis C virus are known, But concomitant association of trohotorast, acquired immunodeficiency syndrome [5]. Epstein-Barr virus [6] prior history of immunosuppression in post renal transplant were reported. The mean age of diagnosis is 52-58 years with sporadic occurrence of the tumor in the younger age group [7]. The laboratory data showed leukocytosis with elevation of CRP and hepatic enzyme, but rarely showed the elevation of tumor marker [8].

The mean survival time was less than 1 year in untreated patients, and the occurrence of metastasis is about 40% cases, and the reported mean size was 8.7cm [12].

Macroscopically, leiomyosarcoma (LMS) often tended to degenerate. The necrosis and/or hemorrhage were commonly seen, therefore, cut-surface specimen exhibited pinkish white collar with yellowish area of necrosis or dark red hemorrhagic foci8, [10]. Microscopically, they are composed of intersecting bundles of elongated, spindle shaped cells and faint longitudinal striations. Nuclei are hyperchromatic and elongated. Mitotic activity is variable, typically less differentiated.

Immunohistochemical staining revealed that the tumor cells were positive for smooth muscle actin (SMA; Fig. 5) and desmin; by contrast, these tumor cells were negative for c-kit (CD117) suggesting gastrointestinal stromal tumors, human melanoma black 45 (HMB45), PNL2 and Ki-67.Demonstration of nuclear EBER is reported as more specific immunological tests [11]. In some cases, anti-viral treatment and restoration of immune response have resulted in tumor regression and long term survival. Histologically, smooth muscle tumors containing 5 or more mitoses per 50 –high-power fields are classified as malignant. The presence of necrosis is also strongly suggestive finding of malignancy. The pleomorphic LMS shows numerous pleomorphic giant cells intimately admixed with a component of more uniform appearing spindle and round neoplastic cells, bizarre mitotic figures and irregular zones of necrosis [17]. Our case was interpreted as conventional low grade LMS due to absence of necrosis and relative paucity of bizarre pleomorphic neoplastic cells. Typically the cut-surface showed uniform, gray-white color with streaks and strands and a whorled appearance in places. It might show areas of hemorrhage or necrosis.

Histological evaluation is indispensable not only for determining histological type but also for grading and predicting biological behavior. Conventional LMS invariably show reactivity for smooth muscle markers such as smooth muscle actin in 90 to 95 %, and desmin in 70-90% of the cases.. HLMS carries a poor prognosis; with the longest disease free survival being 20 months. LMS of adrenal gland is one of exclusion and is based on radiological, biochemical, histomorphological and immunohistochemical evaluation. It carried a poor prognosis when morphologically they are large in size and histologically show lympho-vascular invasion and high grade nuclear features.

Although, the origin of tumor was indeterminate whether stem cells of liver parenchyma or smooth muscle cells of IVC wall, LMS usually arises from vessel wall (such as IVC or hepatic vein). Other mass invading IVC includes renal cell carcinoma, adrenal tumor such as adrenocortical carcinoma and HCC. The dynamic contrast enhanced CT pattern in previously reported cases was almos similar to that of cholangiocarcinoma, a hypoperfusional mass with a heterogeneous nature. Most hepatic leiomyosarcoma are metastatic tumors from other sites, such as soft tissue, gastrointestinal tract, uterus, retroperitoneum and lung. In retroperitoneal region, it is the second common tumor following after liposarcoma. So, exclusion of metastatic LMS is essential in making a diagnosis of primary hepatic LMS and multifocal lesions do not necessarily indicate metastasis.

In previously published cases of LMS, they also arose from smooth muscle cells of hepatic vein, bile ducts or ligamentum tere in addition to IVC. Tumor arising from the hepatic vein may develop Budd-Chiari syndrome and have a worse prognosis, while tumor arising from the ligamentum teres having a better prognosis due to its increased resectability [7]. On CT, a large, well-defined heterogeneous hypodense mass with internal and peripheral dominant enhancement or a cystic mass with an enhanced thickened wall and/or fibrous capsule were reported [13]. In the present case, the plain CT scan showed an ill-defined hypodensity mass adjacent to IVC in the caudate lobe of the liver. The border of the ventral limbs and head of rt. adrenal gland was obliterated. And then on CE-CT and MRI showed multiple satellite nodular lesions. On the basis of these imaging findings, highly or moderately differentiated hepatocellular carcinoma (HCC) and liver hemangioma were excluded. Therefore, practical imaging differential diagnosis were cholangiocellar carcinoma, poorly or undifferentiated HCC, combined or sclerotic HCC, metastatic tumors (metastatic MPNST, GIST and primary retroperitoneal sarcoma), and IVC-or adrenal origin LMS. Adrenal LMS is an extremely rare mesenchymal tumor which usually originates from the smooth muscle wall of the central adrenal vein and its branches [14]. Hepatic adrenal rest tumor (HART) is composed of low columnar or cuboidal clear cells, similar to adrenocortical tumor. At imaging, HART is typically demonstrating a hypervascular, round, well demarcated mass of the right posterior segment of liver.

On dynamic Gd-DTPA enhanced MRI, the lesions showed gradual mild enhancement from the arterial to the venous phase with non-enhanced area suggesting necrosis. This tumor was then subjected to CT-guided transcutaneous puncture biopsy. Microscopic examination showed that the tumor was characterized by intersecting bundles of spindle-shaped cells, with eosinophilic cytoplasm and nuclear atypia. These findings are similar to those recorded in previously reported studies [1, 2, 4]. Soyer et al. [15] reported the case of one patient with HLMS who was subjected to MRI; the results showed that the tumors exhibited homogeneous or heterogeneous slightly hypointensity on T1WI and hyperintensity on T2WI with occasional necrosis/degeneration. In previous studies, most patients were subjected to unenhanced MRI. However, complete MRI sequences, including plain MRI, DWI and dynamic contrast-enhanced MRI, were performed in our case. On DWI, the almost all viable tumor showed hyperintensity, suggesting a limited diffusion of water molecules with

intraparenchymal metastatic tumors. They showed low intensity on corresponding ADC map representing relatively high cellularity of LMS on DWI.

In our case, it showed heterogeneously high & low signal intensity. The low signal foci assumed to be caused by T2* susceptibility effect of hemosiderin. Several faint several intrahepatic metastatic foci were also revealed as high signal intensity foci around the main tumor, it showed heterogeneously high & low signal intensity with faint several intrahepatic metastatic tumors as high signal intensity foci around the main tumor (Figure 3). On the dynamic contrast-enhanced MRI, the masses were not evidently enhanced during the arterial phase. However, the masses were gradually enhanced through the portal phase to the 5-min delayed imaging. This result could be a characteristic MRI finding of HLMS [16], In a previous report describing the DSA, no apparent tumor stain was found during the arterial and portal venous phases, whereas weak stain was detected during the delayed phase [16].

In the literature, they preferentially occur at para/intra-caval area [5, 6, 17] in the liver; and multiple satellite lesions were also observed in the remaining portion of the liver. PET-CT can be applied to sensitively detect primary tumors and metastases in which increased uptake of FDG [18]. The cause of HLMS is unknown, but hepatic smooth muscle cell tumors probably arise from hepatic vein, IVC, or bile ducts. Chronic hepatitis and cirrhosis are not causative factors because the rate of HLMS with cirrhosis is lower than that of HCC.LMS is generally larger and show more rapid growth than leiomyoma [18]. Some authors have suggested the presence of irregular margins, necrosis, and rapid growth as the most suggestive features of malignancy [19]. Diffusion-weighted imaging (DWI) has the potential to delineate malignant lesions as hyperintense areas with excellent tissue contrast, providing quantitative measurements of apparent diffusion coefficient (ADC) values. Tamai et al. [20] reported significant differences in mean ADC values of LMS compared with normal myometrium and degenerated leiomyomas, without any overlap. Namimoto et al. [21] showed that overlap in ADC values between leiomyosarcomas and ordinary leiomyomas (attributed to the "T2 blackout effect," i.e., hypointensity on DWI caused by hypointensity on T2-weighted images) could be resolved with the evaluation of tumor-myometrium contrast ratio on T2-weighted images.

Thomassin-N et al. [22] reported that by combining the analysis of T2 signal intensity, b1000 images and ADC map, MRI achieved 92.4% accuracy in distinguishing benign and uncertain or malignant myometrial tumors. Generally, the mitotic index and number of mitoses are prognostic indicators for most non-epithelial malignant tumors. DWI shows an heterogeneously high signal suggesting mild cellularity showing proliferation of spindle-shaped cells with a high nucleus-to cytoplasm ratio. Nowadays, T1WI-IP and-OP sequences are easily acquired during a standard protocol, using a dual gradient-echo technique with T1 weighting. Protocol for IP and OP MRI differs depending on the strength of the magnetic field: with a 1.5 T magnet, the interval on TE (time to echo) between IP and OP images are 4.6 and 2.3ms, respectively.

When lipid and water exist simultaneously in a lesion, the result is a drop in signal on OP (opposed-phase) images when compared to IP images of the same lesion. Iron

storage causes significant local distortion of the nearby magnetic field, resulting in significant shortening of T2*. Therefore, hemochromatosis or hemosiderosis can be identified and characterized with a high level of confidence. In cases of iron storage disease, the hepatic parenchymal signal intensity increases on the image with T1WI-OP [24]. In our case, several parts showed the elevation of signal suggesting iron (hemosiderin) deposition such as old faint hemorrhage on T1WI-OP.

CT findings of HLMS have been described as a large, well-defined, heterogeneous-hypo density mass with internal and peripheral enhancement or cystic mass with an enhancing thick wall. Cystic variant of LMS may be misdiagnosed as hydatid cyst or liver abscess [25]. On MR imaging the tumor may display occasional encapsulation [26].

LMS grows slowly with no symptoms, but after it reached a certain size, it enlarges aggressively.

It often invades bile ducts, as well as the portal and hepatic veins. The lung was the most common metastatic site followed by the liver. The prognosis of patients in whom surgical resection was performed was relatively better than the un-operated cases. A total resection and optimal treatment of recurrence improved the prognosis [27] although 66% patients would have died without treatment.

Due to the rarity of primary hepatic sarcoma, standard care of HLMS in particular, has not been defined. However surgical resection followed by adjuvant chemotherapy is being widely followed as an empirical manner [4, 5].

Resection surgery forms the cornerstone of successful management of HLMS with an intention of R0 resection. All patients with potentially resectable tumors with adequate remnant liver volume should undergo surgical exploration and liver resection. Criteria for inoperability would include extrahepatic tumor spread, diffuse intrahepatic tumor making the patient not a candidate for complete tumor removal, and impaired liver function precluding the planned hepatic resection. Liver transplant has been attempted sporadically in HLMS29.

Immune status manipulation may play an important role in prolonging survival in the post transplant period by preventing recurrence [30].

Although, LMS of the inferior vena cava extending into the hepatic veins and right atrium is described, radical surgical excision with reconstruction of the inferior vena cava by synthetic graft could be performed [31] if patient wants to be surgically managed.

In conclusion, in the present study, HLMS was found to be a hypovascular tumor, which showed poorly enhanced during the arterial and portal venous phases, heterogeneously enhanced during the delayed phase of enhanced CT/MRI. Intratumoral hemorrhage and necrosis were suggested by the findings of the slight elevation of signal on T1 opposed phase and non-enhanced foci on Gd-enhanced MRI. It was mainly located in the caudate hepatic lobe adjacent to IVC. We believe that these findings represented the imaging characteristics of HLMS.

References

1. Boudjema K, Sulpice L, Levi Sandri GB, et al. Portal vein leiomyosarcoma, an unusual cause of jaundice. Dig Liver Dis 2014;46:1053-4.
2. Jeong TY, Kim YS, Park KJ, et al. A case of primary leiomyosarcoma of the liver presenting with acute bleeding. Korean J Gastroenterol 2008;51:194-8.
3. Hur CJ, Min BR, Lee YJ, et al. Clinical courses of primary hepatic angiosarcoma: retrospective analysis of eight cases.Korean J Gastroenterol 2015;65:229-35.
4. Mehdi Afrit, Meher Nasri, Soumaya Labidi, et al. Aggressive primary hepatic epithelioid hemangioendothelioma: a case report and literature review. Cancer Biol Med 2017;14:187-190.
5. Haritha Chelimilla, Kanthi Badipatla, Ariyo Ihimoyan, Masooma Niazi. A Rare Occurrence of Primary Hepatic Leiomyosarcoma Associated with Epstein Barr Virus Infection in an AIDs Patient. Case Rep Gastrointest Med 2013;2013:691862. Published online 2013 Aug 19. doi: 10.1155/2013/691862
6. Epstein-Barr virus infection-associated smooth-muscle tumors in patients with AIDS. Suankratay C, Shuangshoti S, Mutirangura A, et al. Clin Infect Dis 2005;40:1521-8.
7. Laskin WB, Fanburg-Smith JC, Burke AP et al. Am J Surg Pathol 2010;34:873-819.Leiomyosarcoma of the inferior vena cava: clinicopathologic study of 40 cases.
8. Wei-Fu LV, Jian-KH, Dejlei Cheng, et al. Imaging features of primary hepatic leiomyosarcoma: A case report and review of literature Oncol Lett. 2015; 9:2256–2260.
9. Qiu LL, Yu RS, Chen Y, et al. Sarcomas of abdominal organs: computed tomography and magnetic resonance imaging findings. Semin Ultrasound CT MR 2011;32:405-21.
10. Gates LK, CameronAJ, Nagorney DM, et al. Primary leiomyosarcoma of the liver mimicking liver abscess. Am J Gastroenterol 1995;90:649-52.
11. Bonatti H, Hoefer D, Rogatsch H, et al. Successful management of recurrent Epstein barr virus associated multilocular leiomyosaroma after cardiac transplantation. Transplant Proc 2005;37:1839-1844.
12. Laskin WB, Fanburg-Smith JC, Burke AP, et al. Leiomyosarcoma of the inferior vena cava: clinicopathologic study of 40 cases. Am J Surg Pathol 2010;34:873-81.
13. Ferrozai Fm, Bova D, Zangrandi A, Garlaschi. Primary liver leiomyosarcoma: CT appearance. Abdominal Imaging 14 1996;21:157-160.
14. Deshmukh SD, Babanagare SV, Anand M, et al. Primary adrenal leiomyosarcoma: a case report with immunohistochemical study and review of literature. J Cancer Res Ther 2013;9:114-6.
15. Soyer P, Blanc F, Vissuzaine C, et al. Primary leiomyosarcoma of the liver MR findings. Clin Imaging 1996;20:273-5.
16. Hayashi T, Tagawa T, Ashizawa K, et al. Contrast-Enhanced Dynamic Magnetic Resonance Imaging of Primary Pulmonary Leiomyosarcoma.Tohoku J Exp Med 2006;210:263-267.
17. Liu C, Zheng Y, Yang X,Surgical resection of the inferior vena cava for leiomyosarcoma. Ann Vasc Surg. 2010 ;24:822.e11-5.
18. Xie P, Zhuang H. DG PET/CT Findings of Primary Hepatic Leiomyosarcoma in an Immunocompetent Pediatric Patient. Clin Nucl Med 2017;42:323-324.
19. Kumar S, Devana SK, Kuthe S, et al. Giant leiomyosarcoma of inferior vena cava. A surgical challenge. Asian Cardiovasc Thorac Ann 2014;22:858-61.
20. Tamai K, Koyama T, Saga T. The utility of diffusion-

weighted MR imaging for differentiating uterine sarcomas from benign leiomyomas. Eur Radiol 2008;18:723-30.

21. Namimoto T, Yamashita Y, Awai K, *et al*. Combined use of T2-weighted and diffusion-weighted 3-T MR imaging for differentiating uterine sarcomas from benign leiomyomas.Eur Radiol 2009;19:2756-64.

22. Thomassin-Naggara I, Dechoux S, Bonneau C, *et al*. How to differentiate benign from malignant myometrial tumours using MR imaging. Eur Radiol 2013;23:2306-14.

23. Barry EK, Christina J G, Alan WR. Utility of opposed-phase magnetic resonance imaging in differentiating sarcoma from benign bone lesions. J Bone Oncol 2015;4:110-114.

24. Merkle EM, Nelson RC. Dual gradient-echo in-phase and opposed-phase hepatic MR imaging: a useful tool for evaluating more than fatty infiltration or fatty sparing. Radiographics 2006;26:1409-18.

25. Ferrozzi F, Bova D, Zangrandi A, Garlaschi G. Primary liver leiomyosarcoma: CT appearance.Abdom Imaging 1996;21:157-60.

26. Nairuthya Shivathirthan, Junji Kita, Yukihiro Iso, *et al*. Primary hepatic leiomyosarcoma: Case report and literature review.World J Gastrointest Oncol 2011;3:148-152.

27. Yu RS, Chen Y, Jiang B, *et al*. Primary hepatic sarcomas: CT findings. Eur Radiol 2008;18:2196-2205.

28. Hoffbrand AV, lloyd-thomas HG. Leiomyosarcoma of the inferior vena cava leading to obstruction of the tricuspid valve. Br heart J 1964;26:709-15.

29. Husted TL, Neff G, Thomas MJ, *et al*. Liver transplantation for primary or metastatic sarcoma to the liver. Am J Transplant 2006;6:392-3.

30. Shamseddine A, Faraj W, Mukherji D, *et al*. Unusually young age distribution of primary hepatic leiomyosarcoma: case series and review of the adult literature. World J Surg Oncol 2010;8:56.

31. Babatasi G, Massetti M, Agostini D, *et al*. Leiomyosarcoma of the heart and great vessels. Ann Cardiol Angeiol 1998;47:451-8.