

[Case Report]

**HEPATIC ADENOMATOUS HYPERPLASIA WITH HYPERATTENUATION
ON CT DURING ARTERIAL PORTOGRAPHY :
A CASE REPORT**

SHUZO SATO, TSUYOSHI RAI, HIROMASA OHIRA,
KAZUMICHI ABE, HIRONOBU SAITO, ATSUSHI TAKAHASHI,
NATSUMI SAKAMOTO, NAMIKO HOSHI, EIJI SUZUKI
and YUKIO SATO

*Department of Internal Medicine II, Fukushima Medical University School of Medicine,
Fukushima, 960-1295, Japan*

(Received September 7, 2005, accepted October 17, 2005)

Abstract : We report a 72-year-old man who was admitted to our department with multiple nodules of hepatocellular carcinoma (HCC) in a cirrhotic liver because of HCV infection. Unlike most of the nodules, one in segment 2 (S2) showed hypoattenuation on computed tomography (CT) during hepatic arteriography (CTA), and hyperattenuation on CT during arterial portography (CTAP). Fine needle aspiration biopsy of the nodule established the diagnosis of hepatic adenomatous hyperplasia.

Why the S2 nodule showed hyperattenuation on CTAP is not clear. Two possibilities are considered : i) greater portal blood flow into the nodule than into the surrounding cirrhotic parenchyma, ii) existence of a period during the course of hepatocarcinogenesis when the portal blood flow into the nodule is higher in density on CTAP.

Key words : CTAP, CTA, adenomatous hyperplasia, HCC

INTRODUCTION

CT during hepatic arteriography (CTA) and CT during arterial portography (CTAP) are used to detect small nodular hepatic lesions, such as early small hepatocellular carcinoma (HCC) or advanced HCC^{1-5,9,11,12-20}. Typical HCC nodules show hyperattenuation on CTA, and hypoattenuation on CTAP, indicating

佐藤秀三, 雷 毅, 大平弘正, 阿部和道, 斎藤広信, 高橋敦史, 坂本夏美, 星奈美子, 鈴木英二,
佐藤由紀夫

Correspondence to: Shuzo Sato, Department of Internal Medicine II, Fukushima Medical University School of Medicine, Fukushima City 960-1295, Japan.

E-mail : shuzo@fmu.ac.jp

hypervascularity and decrease or absence of portal blood flow into the nodules^{2,6,9,11,20}). However, we encountered a nodule that showed an untypical pattern, hypoattenuation on CTA, and hyperattenuation on CTAP. We report this rare case, and attempt to determine the reason why the phenomenon occurred.

CASE REPORT

A 72-year old man was referred to Department of Internal Medicine II, Fukushima Medical University Hospital, in May 2002, because HCC nodules were detected by abdominal enhanced CT at another hospital near his house. He had been diagnosed with liver cirrhosis with a HCC nodule at 64 years of age. HCV infection was also detected. He underwent posterior segmentectomy of the liver for HCC at Department of Surgery I, Fukushima Medical University Hospital, at 65, and was followed up at another hospital. In July 2002, two months after the referral, he was admitted to Department of Internal Medicine II for additional investigation and treatment. On physical examination, the liver and spleen were palpable, indicating hepatosplenomegaly. Laboratory findings were as follows. He had liver dysfunction, AST was 106 (10–30) IU/l, and ALT was 123 (6–29) IU/l. Total bilirubin was 1.7 (0.4–1.2) mg/dl. Gamma GTP was 156 (7–55) IU/l. Platelet count was $9.3 (14.7-34.1) \times 10^4/\mu\text{l}$, indicating thrombocytopenia. Indocyanine green clearance time prolonged to 31 (normal <10) %. Alpha-fetoprotein (AFP) level was 46.0 (<8.5) ng/dl. Abdominal ultrasonography (US) revealed a low-echogenic mass, 20 mm in diameter, in segment 2 (S2). Two other HCC nodules, 50 mm and 20 mm in diameter, were seen in S8.

Magnetic resonance imaging (MRI) was not performed. On angiography the S2

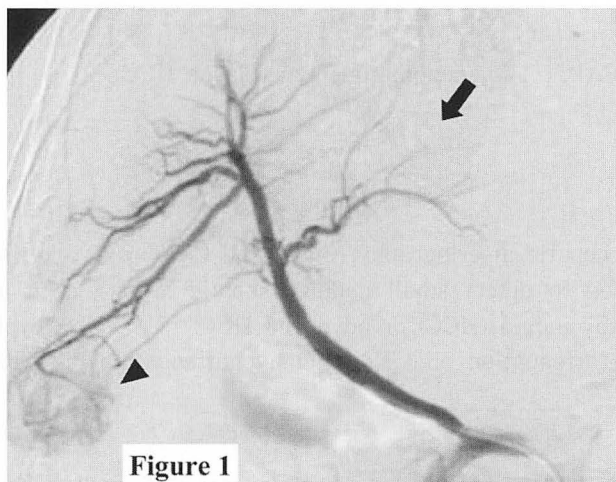


Fig. 1. Angiography. The S2 nodule did not show tumor stain (arrow). The S8 nodule was shown as a strong enhancement, and revealed tumor stain (arrow head).

nodule did not show tumor stain, but the S8 nodules did (Fig. 1). CTAP and CTA were performed in the IVR-CT room, using a multislice CT scan system (Aquilion™, TSX-101A, TOSHIBA). For CTAP, about 30 ml of iohexol (Omnipaque; 300 mg/ml, Daiichi, Tokyo) was used, and was injected into the superior mesenteric artery (SMA) from a 5Fr angiographic catheter tip. CTAP scan was taken 25 seconds after contrast medium injection at the rate of 3 ml/sec. CTA was performed 6 seconds after injection of contrast medium at 1 ml/sec through a 4F angiographic catheter placed in the common or proper hepatic artery. The S8 nodules showed hypoattenuation on CTAP, and hyperattenuation on CTA compared with the surrounding cirrhotic parenchyma (Fig. 2A, B). The S2 nodule, however, showed hyperattenuation on CTAP, and hypoattenuation on CTA (Fig. 3A, B).



Fig. 2. CTA and CTAP images (arrow) of S8 nodule. A. CTA showed hyperattenuation in the S8 nodule (arrow). B. CTAP demonstrated hypoattenuation in the same nodules (arrow). These findings represent the typical pattern of HCC nodules.

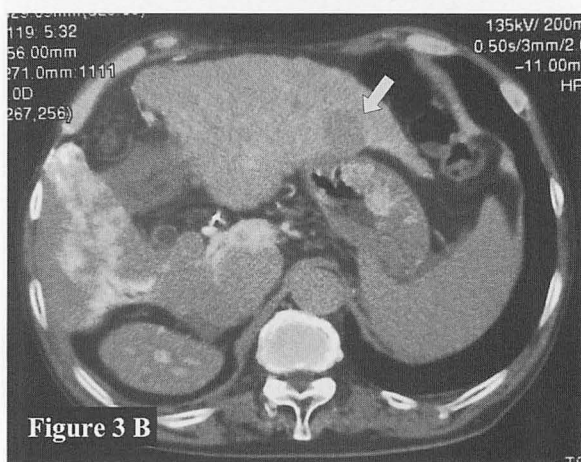
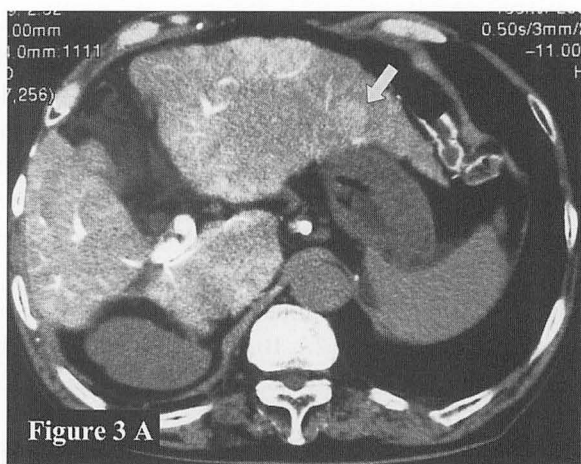


Fig. 3. CTAP and CTA images (arrow) of the S2 nodule. A. CTAP showed hyperattenuation in the S2 nodule (arrow). B. Conversely, CTA demonstrated hypoattenuation in the same nodule (arrow).

A specimen of the S2 nodule obtained by a fine needle aspiration biopsy (FNAB) was pathologically examined. The specimen showed a slightly increased cell density with an elevated nuclear/cytoplasmic ratio, various sizes of hepatocytes, but no structural variant (Fig. 3). So the diagnosis of hepatic adenomatous hyperplasia (AH) was established.

The advanced HCC nodules in S8 were treated with transcatheter arterial embolization, and the S2 nodule by percutaneous ethanol injection just after FNAB was performed. He was discharged in September 2002, and is being followed up as of April 2005.

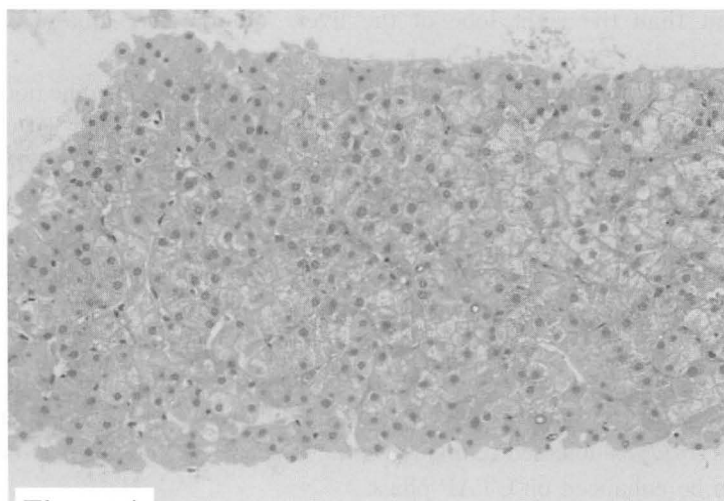


Figure 4

Fig. 4. FNAB of the S2 nodule. Specimen contained hepatocytes of various sizes, and showed slight increase in nuclear/cytoplasmic ratio, and cell density. No structural variant was detected. These findings are compatible with adenomatous hyperplasia. (H & E stain)

DISCUSSION

The normal liver parenchyma is mainly perfused by portal blood flow. HCC, however, is perfused by hepatic arterial flow (hypervascularity), and portal blood flow is decreased or absent in it^{2,6,9,11-19}. Therefore, HCC nodules demonstrate hyperattenuation on CTA, and hypoattenuation or absence of enhancement on CTAP. On the other hand, because AH nodules are usually similar in vascular construction to the surrounding hepatic parenchyma, they show isodensity on CTA, and iso- or slightly low density on CTAP. These differences in CT images of HCC and AH nodules are nowadays considered to be correlated with the prognosis (i.e., grade of malignancy) of hepatic nodules, and also with the pathologic conditions^{2,9,19}.

In Department of Internal Medicine II, Fukushima Medical University Hospital, CTAP was performed during the period from April 2002 to December 2004 in 156 consecutive patients with 268 nodules. Of these, only this one showed hyperattenuation on CTAP, and also this was the only histologically confirmed AH nodule of all subjected to angio-CT. There are very few such cases in the English literature^{1,3,4,5}.

Why the S2 nodule shows hyperattenuation on CTAP is not clear. There are 5 possibilities; one of them is that the surrounding cirrhotic parenchyma is demonstrated as relatively low in density because the portal blood flow in the segment or lobule decreases along with the development of liver damage, as reported by Takayasu *et al.*¹⁾.

In our case, the parenchyma surrounding the S2 nodule showed slightly lower

enhancement than the right lobe of the liver, and the left lobe was enhanced unevenly.

Another possibility is actually increased portal blood flow into the nodule caused by the perfusing vessels. Takayasu *et al.* report nodule-in-nodule HCC enhanced on both CTAP and CTA. However, their tumor was not enhanced uniformly, probably because there was biased vascular distribution. In our case, however, large portal veins were improbable, because angio-CT showed neither large portal veins nor arterial hypervascular appearance, and we were unable to observe large blood vessels in the FNAB specimen, even though it was too small.

A third possibility is the existence of abdominal arterial variation. Actually, Koops *et al.* report that anatomical arterial variations (common hepatic artery or right hepatic artery or accessory artery forking off from SMA) were found in 98 of 604 patients (16.2%) subjected to angiographic studies²⁰. Nodules perfused by such arteries can be enhanced on CTAP phase.

In our case, no arterial variation was observed in the celiac artery or SMA, and so this hypothesis does not hold.

A fourth possibility is concerned with technical problems when CTAP is performed. Some of the arteries that branch off from the SMA can contribute to the overflow of contrast medium into hepatic nodules through abnormal circulation to the portal blood system (i.e., from abnormal pancreatic arcade)¹¹. Another problem is that the prolonged enhancement of a HCC nodule taken from a different vessel line may be recognized as hyperattenuation on CTAP. However, we routinely perform CTAP first in the process of angiographic examination. Contrast medium is injected from the SMA trunk using a 5Fr catheter tip with low pressure (3 ml/sec.) to avoid regurgitation. Actually, we observed no abnormal arteries or regurgitation from the SMA, and there was no trouble during the test.

The last possibility is that CTAP findings represent only one period of vascular transformation from AH to advanced HCC. Histopathological studies have described multi-step carcinogenesis^{6,7,10}. In the course of carcinogenesis, vascular transformation is thought to occur as follows: (1) portal veins gradually decrease in number, (2) original normal arteries decrease in number, (3) abnormal arteries increase in number and portal blood flow further decreases, and finally (4) HCC with rich abnormal arterial blood flow and no portal blood flow develops. Thus, there should be a period when the portal blood flow is higher in density than the arterial flow or surrounding cirrhotic parenchyma. This view can also explain why a S2 nodule shows hypoattenuation on CTA.

In conclusion, because hepatic nodules that show hyperattenuation on CTAP can demonstrate various grades of malignancy, some other tests (e.g., MRI, color Doppler US) are necessary to rule out malignancy potential. Histological examination should be performed by all means. If a nodule grows very slowly, its grade of malignancy may be low. Further investigation is needed to explain this phenomenon.

ACKNOWLEDGMENT

We thank Dr. Tomoyuki Masuda, Department of Pathology II, Iwate Medical University School of Medicine, for his valuable advice on the histological diagnosis of this case.

REFERENCES

1. Takayasu K, Muramatsu Y, Wakao F, Mizuguchi Y, Iwata R, Maeda T, Moriyama N, Sakamoto M. Hepatic nodules with early enhancement during computed tomography portography: report of six cases. *J Gastroenterol Hepatol*, **17**: 779-784, 2002.
2. Hayashi M, Matsui O, Ueda K, Kawamori Y, Gabata T, Kadoya M. Progression to hypervascular hepatocellular carcinoma: correlation with intranodular blood supply evaluated with CT during intraarterial injection of contrast material. *Radiology*, **225**: 143-149, 2002.
3. Hirano K, Kondo Y, Teratani T, Obi S, Fujishima T, Hoshida Y, Tateishi R, Sato S, Koide Y, Shiina S, Imai Y, Shiratori Y, Omata M. Hepatocellular carcinoma depicted as hypoattenuation on CT hepatic arteriography and hyperattenuation on CT during arterial portography. *J Gastroenterol*, **36**: 346-349, 2001.
4. Honda H, Tajima T, Kajiyama K, Kuroiwa T, Yoshimitsu K, Irie H, Makisumi K, Takenaka K, Masuda K. Early HCC and adenomatous hyperplasia: evaluation of arterial and portal blood flow with CTA, CTAP, and pathologic correlation (in Japanese). *NIPPON ACTA RADIOLOGICA*, **57**: 678-680, 1997.
5. Onaya H, Itai Y, Satake M, Luo T, Saida Y, Haruno M, Hasebe T, Moriyama N. Highly enhanced hepatic masses seen on CT during arterial portography: early hepatocellular carcinoma and adenomatous hyperplasia. *Jpn J Clin Oncol*, **30**: 440-445, 2000.
6. Ueda K, Terada T, Nakamura Y, Matsui O. Vascular supply in adenomatous hyperplasia of the liver and hepatocellular carcinoma: a morphometric study. *Hum Pathol*, **23**: 619-626, 1992.
7. Takayama T, Makuuchi M, Hirohashi S, Sakamoto M, Okazaki N, Takayasu K, Kosuge T, Motoo Y, Yamazaki S, Hasegawa H. Malignant transformation of adenomatous hyperplasia to hepatocellular carcinoma. *Lancet*, **336**: 1150-1153, 1990.
8. International Working Group. Terminology of nodular hepatocellular lesions. *Hepatology*, **22**: 983-993, 1995.
9. Hayashi M, Matsui O, Ueda K, Kawamori Y, Kadoya M, Yoshikawa J, Gabata T, Takashima T, Nonomura A, Nakanuma Y. Correlation between the blood supply and grade of malignancy of hepatocellular nodules associated with liver cirrhosis: evaluation by CT during intraarterial injection of contrast medium. *Am J Roentgenol*, **172**: 969-976, 1999.
10. Takayasu K, Muramatsu Y, Furukawa H, Wakao F, Moriyama N, Takayama T, Yamasaki S, Sakamoto M, Hirohashi S. Early hepatocellular carcinoma: appearance at CT during arterial portography and CT arteriography with pathologic correlation. *Radiology*, **194**: 101-105, 1995.
11. Matsui O, Kadoya M, Kameyama T, Yoshikawa J, Takashima T, Nakanuma Y, Unoura M, Kobayashi K, Izumi R, Ida M, Kitagawa K. Benign and malignant nodules in cirrhotic livers: distinction based on blood supply. *Radiology*, **178**: 493-497, 1991.
12. Sonoda T, Shirabe K, Takenaka K, Kanematsu T, Yasumori K, Sugimachi K. Angiographically undetected small hepatocellular carcinoma: clinicopathological characteris-

- tics, follow-up and treatment. *Hepatology*, **10** : 1003-1007, 1989.
13. Takayasu K, Muramatsu Y, Mizuguchi Y, Moriyama N, Ojima H. Imaging of early hepatocellular carcinoma and adenomatous hyperplasia (dysplastic nodules) with dynamic CT and a combination of CT and angiography : experience with resected liver specimens. *Intervirology*, **47** : 199-208, 2004.
 14. Matsui O, Kadoya M, Suzuki M, Inoue K, Itoh H, Ida M, Takashima T. Dynamic sequential computed tomography during arterial portography in the detection of hepatic neoplasms. *Radiology*, **146** : 721-727, 1983.
 15. Matsui O, Takashima T, Kadoya M, Suzuki M, Hirose J, Kameyama T, Choto S, Konishi H, Ida M, Yamaguchi A, Izumi R. Liver metastases from colorectal cancers : detection with CT during arterial portography. *Radiology*, **165** : 65-69, 1987.
 16. Hayashi N, Yamamoto K, Nagara T, Shibata T, Itoh K, Fujisawa I, Nakano Y, Yamaoka Y, Kobayashi N, Mori K, Ozawa K, Torizuka K. Metastatic nodules of hepatocellular carcinoma : detection with angiography, CT, and US. *Radiology*, **165** : 61-64, 1987.
 17. Matsui O, Kadoya M, Kameyama T, Yoshikawa J, Arai K, Gabata T, Takashima T, Nakanuma Y, Terada T, Ida M. Adenomatous hyperplastic nodules in the cirrhotic liver : differentiation from hepatocellular carcinoma with MR imaging. *Radiology*, **173** : 123-126, 1989.
 18. Heiken JP, Weyman PJ, Lee JKT, Balfe DM, Picus D, Brunt EM, Flye MW. Detection of focal hepatic masses : prospective evaluation with CT, delayed CT, CT during arterial portography, and MR imaging. *Radiology*, **171** : 47-51, 1989.
 19. Nakashima Y, Nakashima O, Hsia CC, Kojiro M, Tabor E. Vascularization of small hepatocellular carcinomas : correlation with differentiation. *Liver*, **19** : 12-18, 1999.
 20. Koops A, Wojciechowski B, Broering DC, Adam G, Krupski-Berdien G. Anatomic variations of the hepatic arteries in 604 selective celiac and superior mesenteric angiographies. *Surg Radiol Anat*, **26** : 239-244, 2004.