Abdom Imaging 26:515–519 (2001)
DOI: 10.1007/s002610000207

Abdominal Imaging

Hepatic falciform artery: angiographic observations and significance

M. Gibo,[1]* K. Hasuo,[2] A. Inoue,[1] N. Miura,[1] S. Murata[1]

[1]Department of Radiology, Matsuyama Red Cross Hospital, 1 Bunkyo-machi, Matsuyama-shi 790-0826, Japan
[2]Department of Radiology, International Medical Center of Japan, 1-2-1 Toyama, Shinjuku-ku, Tokyo 162-8655, Japan

Received: 18 November 2000/Accepted: 27 December 2000

Abstract

Background: The purpose of this study was to assess the angiographic incidence and appearance of the hepatic falciform artery (HFA) and discuss its clinical significance.
Methods: Hepatic angiograms of 53 patients obtained with digital subtraction angiography were prospectively evaluated with regard to incidence, anatomic features, and flow speed of the HFA. We analyzed whether the background of chronic liver disease affected the incidence of the HFA. Transcatheter arterial chemoinfusion or chemoembolization for liver tumors was performed in 33 patients. We noted the occurrence of supraumbilical skin complications.
Results: The HFA was observed in 13 (24.5%) of 53 patients on celiac or common hepatic angiograms. The blood flow of the HFA was slower than that of the peripheral hepatic arteries in all patients. No significant difference in the incidence of HFA between the 34 patients with chronic liver disease and the 19 patients with normal livers was found. One treated patient with an HFA and a history of gastrectomy developed a supraumbilical red skin rash.
Conclusion: The angiographic incidence of the HFA is more common than previously reported. The delayed and persistent opacification of the HFA on hepatic angiograms caused by its slow blood flow is considered the key to its identification.

Key words: Angiography—Hepatic falciform artery—Transcatheter chemotherapy—Complication.

The hepatic falciform artery (HFA) arises from the left or middle hepatic artery and courses through the hepatic falciform ligament [1, 2]. Supraumbilical skin complications after transcatheter chemoinfusion or chemoembolization for liver tumors might be caused by the distribution of chemotherapeutic agents through the HFA [1, 3–6]. According to previous studies, the HFA is a small artery and so cannot be demonstrated by routine angiography [1, 2, 7]. The purpose of this study was to reexamine the true angiographic incidence and appearance of the HFA. We present a case of supraumbilical red skin rash after arterial infusion of chemotherapeutic agents for a hepatocellular carcinoma with a history of a gastrectomy and discuss the mechanism of supraumbilical skin complications after transcatheter chemotherapy for liver tumors.

Materials and methods

We performed hepatic angiography in 58 consecutive patients over 4 months. Five patients were eliminated from our study because the right or left hepatic arteries were occluded by previous chemoembolization for liver tumors. Therefore, 53 patients (35 men, 18 women; age range = 41–78 years, mean age = 66 years) were prospectively evaluated in this study. They underwent angiography for a variety of indications: 34 patients had hepatocellular carcinoma or possible hepatocellular carcinoma based on chronic liver disease, six had pancreatic disease, five had biliary tract disease, four had metastatic liver tumors, and four had gastric cancer. Nineteen patients, excluding those with hepatocellular carcinoma or possible hepatocellular carcinoma, had normal livers.

Angiograms were obtained with digital subtraction angiography (DSA; DAR-1200, Shimadzu, Kyoto, Japan). The matrix size of the DSA was 512 × 512. All patients underwent celiac or common hepatic angiography. In celiac angiography, 30–40 mL of contrast mate-

* *Present address:* Department of Radiology, Fukuoka Red Cross Hospital, 3-1-1 Ookusu, Minami-ku, Fukuoka-shi 815-8555, Japan

Correspondence to: M. Gibo

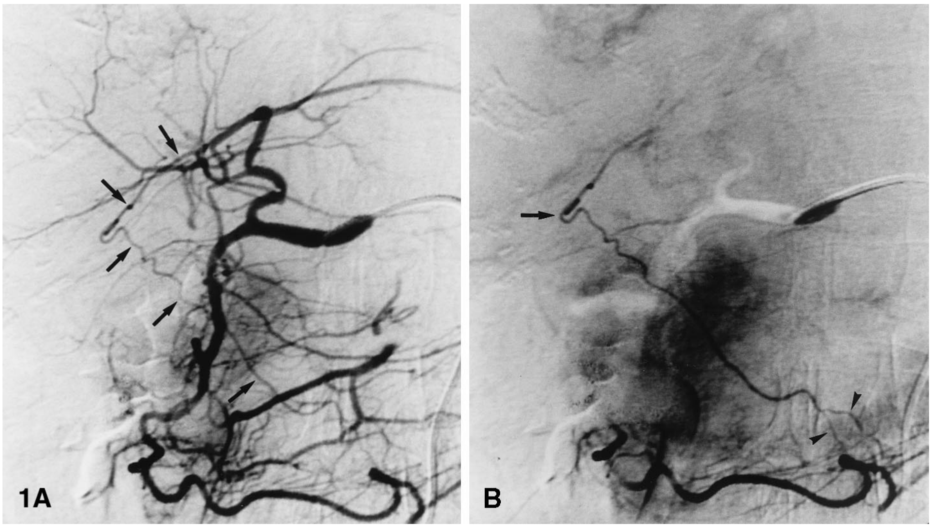

Fig. 1. A 51-year-old man with pancreatic cancer. **A** Common hepatic angiogram, arterial phase. The right hepatic artery is replaced with the superior mesenteric artery. The HFA (*arrows*) arises from the left hepatic artery and follows a caudal and medial L-shaped course. **B** Common hepatic angiogram, capillary phase. Contrast medium remains in the HFA until the capillary phase. An angulation of the HFA is partly tortuous (*arrow*). The main portion of this artery follows a straight course and the distal end forms branches (*arrowheads*).

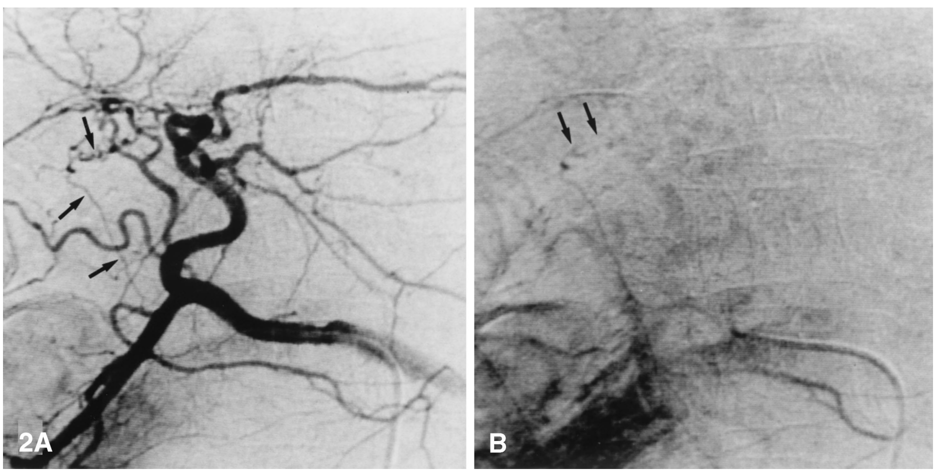

Fig. 2. A 72-year-old woman with liver cirrhosis. **A** Common hepatic angiogram, arterial phase. The right hepatic artery is replaced with the superior mesenteric artery. The HFA (*arrows*) arises from the left hepatic artery. Because the hepatic peripheral arteries had a corkscrew appearance, it was difficult to identify small HFAs. **B** Common hepatic angiogram, venous phase. The HFA is clearly visible because contrast medium remained within the HFA and ran off from the other arteries. Partial tortuousity (*arrows*) is seen on the proximal side of the HFA.

rial (iopamidol, 60% iodine, 300 mg/mL) was injected at a rate of 5–7 mL/s. In common hepatic angiography, 15–25 mL of contrast material was injected at a rate of 3–5 mL/s. We did not use superselective angiography of the left or middle hepatic artery only to describe the HFA.

Three radiologists analyzed the celiac or common hepatic angiograms in consensus fashion. The HFA was identified by its caudal and medial course, which showed an L-shape from its origin off the left or middle hepatic artery [1, 2]. The incidence, origin, size, and shape of the HFA were evaluated. The flow speed of the HFA and the peripheral hepatic arteries were compared.

We assigned our patients to two groups based on their backgrounds of chronic liver disease: 34 patients had chronic liver disease and 19 had normal livers. We examined whether chronic liver disease affected the angiographic incidence of the HFA.

Transcatheter chemoinfusion or chemoembolization for liver tumors was performed in 33 of 53 patients. Both procedures detected supraumbilical skin complications throughout the patient's stay in the hospital (3–31 days, mean = 8 days).

Results

The HFA was observed in 13 (24.5%) of 53 patients on celiac or common hepatic angiograms. The origin of the HFA was the left hepatic artery in eight patients (Figs. 1–3) and the middle hepatic artery in five patients (Fig. 4). The mean size of the HFA was 0.7 mm (maximum = 1.0 mm, minimum = 0.4 mm). An L-shaped angulation or proximal side of the HFA showed tortuousity in 11 patients. Distal branching of the HFA was found in five patients. The blood flow of the HFA was slower than that of the peripheral hepatic arteries in all patients, and so contrast medium remained in the HFA until the capillary or venous phase. In the group with chronic liver disease, the incidence of the HFA was nine of 34 (26.5%). In the group with normal livers, it was four of 19 (21.1%). No statistically significant difference between the two groups was found.

Of the 33 patients who underwent transcatheter chemotherapy for liver tumors, 10 had HFAs. Transcatheter chemoembolization was performed near the HFA in two of 10 patients and there was one incident of supraumbili-

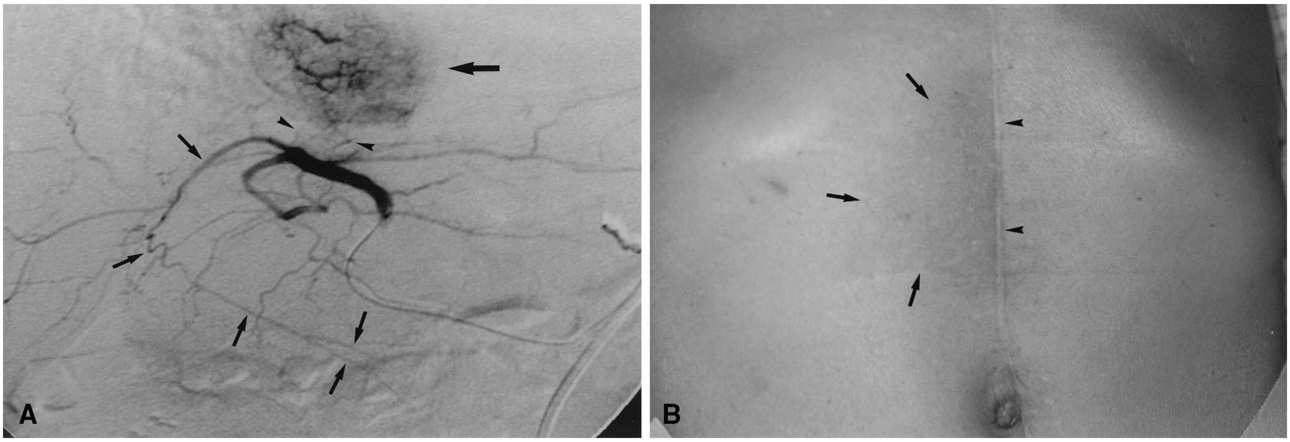

Fig. 3. A 70-year-old man with hepatocellular carcinoma. **A** Selective angiogram of the left hepatic artery. Partial tortuousity and distal branching of the HFA (*arrows*) are visible. A tumor stain (*large arrow*) is evident between the medial and lateral segments of the liver. Because the feeding arteries of the tumor are small and multiple (*arrowheads*), superselective catheterization to the feeding arteries cannot be achieved. A mixture of oily contrast medium and epirubicin hydrochloride was infused into the left hepatic artery. **B** Photograph of supraumbilical red skin rash (*arrows*) after transcatheter chemotherapy. *Arrowheads* point to an upper abdominal midline surgical scar. The medial edge of the skin rash is clearly marked by the scar.

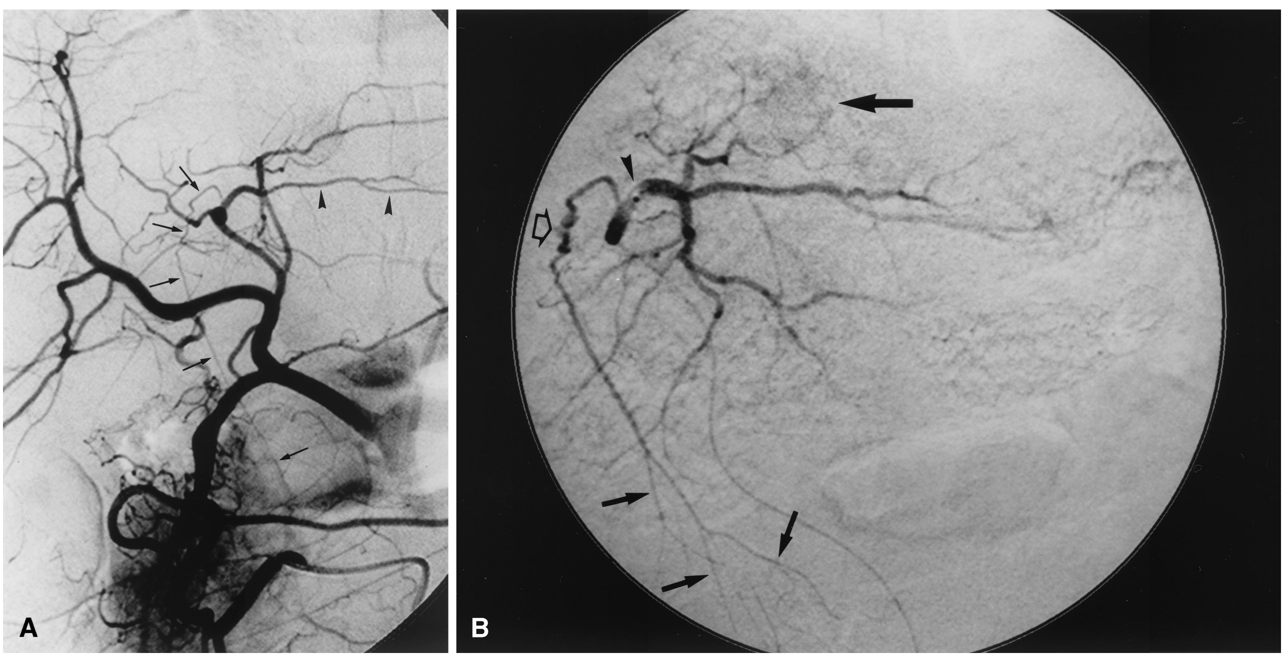

Fig. 4. A 55-year-old man with hepatocellular carcinoma. **A** Celiac angiogram shows the HFA (*arrows*) arising from the middle hepatic artery. The inferior branch to the left lobe of the liver (*arrowheads*) is replaced with the middle hepatic artery. **B** Superselective angiogram of the middle hepatic artery shows partial tortuousity (*open arrow*) and distal branching (*arrows*) of the HFA. A tumor stain is evident (*large arrow*). The inferior branch to the left lobe of the liver feeds the hepatocellular carcinoma. An *arrowhead* points to the tip of the micro-catheter. Transcatheter chemoembolization was performed successfully, without supraumbilical skin complications.

cal red skin rash. One patient had a history of an upper abdominal laparotomy for early gastric cancer 10 years previously. Many small arteries arising from the left hepatic artery from which the HFA also arose fed a hepatocellular carcinoma, so superselective introduction of a co-axial microcatheter (Tracker-18 infusion catheter; Target Therapeutics, Los Angeles, CA, USA) to the feeding arteries was not successful (Fig. 3). Therefore, we injected a mixture of oily contrast medium (lipiodol, Mitsui Kogyo Co., Tokyo, Japan) and epirubicin hydrochloride (farumorubicin, Kyowa Hakko Kogyo Co., Tokyo, Japan) into the left hepatic artery. Subsequential embolization with a gelatin sponge cube was not performed to prevent a potential skin necrosis. Posttherapy angiograms of the left hepatic artery were not obtained. Immediately after finishing the arterial injection, we confirmed that no supraumbilical skin eruption had occurred. However, about 20 min later, when the patient was taken out of the angiographic room, we observed that a supraumbilical red skin rash had appeared. This patient did not complain of any pain or itching. The skin rash gradually subsided but did not completely disappear over the next 10 days in the hospital. In the other patient, the inferior branch to the left liver lobe feeding a hepatocellular carcinoma and the HFA arose from the middle hepatic artery (Fig. 4). We superselectively introduced a co-axial microcatheter into the peripheral inferior branch over the point of HFA branching. A mixture of oily contrast medium and epirubicin hydrochloride was injected into the peripheral inferior branch, and then subsequent embolization with a few gelatin sponge cubes was performed. No supraumbilical skin complications appeared after the transcatheter chemoembolization. Eight patients had transcatheter chemotherapy through the hepatic branch from which the HFA did not arise, and none of them developed supraumbilical skin complications. In 23 patients who underwent transcatheter chemotherapy without HFAs, no supraumbilical skin complications occurred.

Discussion

The falciform ligament is the embryologic remnant of the ventral mesentery and marks the separation of the left lobe of the liver into the medial and lateral segments. The HFA arises from the left or middle hepatic artery and courses through the hepatic falciform ligament. This artery follows an L-shaped caudal and medial course on the posterior surface of the anterior abdominal wall [1, 2]. The clinical significance of the HFA on angiography has been discussed with reference to two aspects. First, regarding the angiographic diagnosis, tumors originating from the hepatic falciform ligament are fed by the HFA, so we can correctly diagnose the origin of the tumor [7]. Second, regarding interventional radiology, supraumbilical skin complications after transcatheter chemoinfusion or chemoembolization for liver tumors might be caused by ischemia and reaction of the HFA against therapeutic agents [1, 3–6].

Michels et al. reported that the HFA is found frequently during postmortem anatomic dissections and that the incidence of HFAs was 39 of 58 (67.2%) [8]. Conversely, others have reported that the frequency of visualizing HFAs on hepatic angiography is low. Williams et al. [1] found the incidence of the HFA to be two in 100 (2.0%), Ikeda et al. [2] found an incidence of three in 115 (2.6%), and Morita et al. [7] found an incidence of six in 289 (2.1%) in their retrospective studies of hepatic angiograms with conventional screen-film techniques. As a result, the HFA was believed to be too small to be depicted by routine angiography [1, 2, 7]. We previously examined the angiographic appearance of the HFA in the Japanese literature [9]. To compare our findings with the results of other studies, we also retrospectively evaluated the angiographic incidence of the HFA with conventional screen-film techniques. We found an incidence of 32 in 200 (16.0%). The discrepancy between the results of our previous study and those of other studies was large and suggest that it was caused by our paing attention to the slow blood flow of the HFA. The HFA is a small terminal branch and its blood flow is slower than that of the hepatic peripheral arteries. Many arteries are visualized in the arterial phase, so identifying small HFAs is difficult. In contrast, the HFA is easily recognized in the capillary or venous phase of angiography because the contrast medium remians within the HFA. This characteristic delayed and persistent opacification of the HFA has not been mentioned by other researchers discussing this artery. Other researchers probably assessed only the arterial phases of hepatic angiograms to identify the HFA. In this study, the slow blood flow of the HFA also was proven.

In recent retrospective studies using DSA, Ibukuro et al. [10] found an HFA incidence of 26 in 340 (7.6%) and Kim et al. [11] found an incidence of 16 in 127 (12.6%). In our previous retrospective study using conventional screen-film techniques, the HFA incidence was higher than that in both recent retrospective studies using DSA. Therefore, we believe that the high-contrast resolution of DSA contributes relatively little to the identification of the HFA. In this prospective study, the incidence of the HFA (24.5%) was higher than that in our previous retrospective study (16.0%). Therefore, we believe that the delayed and persistent opacification of the HFA can be observed more dynamically and clearly by a prospective rather than a retrospective evaluation.

Concerning the anatomic features of the HFA, its localized tortuousity with an L-shaped angulation course and/or proximal side was observed in 11 (84.6%) of 13 patients. In our opinion, the tortuousity of the HFA serves as an important landmark to its identification.

With regard to the relationship between the HFA and the hepatic disease state, Ibukuro et al. [10] and Kim et al. [11] suggested that their higher HFA incidences (7.6% and 12.6%, respectively) than in previous reports (approximately 2%) [1, 2, 7] is related to the chronic liver disease of their patients. However, both groups evaluated only the group with chronic liver disease and did not compare their findings with a group with normal livers. Our results suggest that the HFA incidence in patients with normal livers (21.0%) is even higher than those reported by Ibukuro et al. and Kim et al. We propose that the HFA has been overlooked on angiography, regardless of whether the patient had chronic liver disease.

Supraumbilical skin injury after transcatheter chemotherapy is a rare complication and only five cases have been reported [1, 3–6]. The rarity has been considered to be related to the observation that the incidence of angiographic depiction of the HFA is very low [1, 2, 7, 12]. However, based on our findings, the angiographic incidence of the HFA is more common than previously reported, so there must be another reason. Michels et al. [8] found that terminal branches of the middle and left hepatic arteries constantly anastomose with the internal thoracic and superior epigastric arteries through the falciform ligament. Ibukuro et al. [10] suggested that the direction of blood flow in such anastomoses ran from the internal thoracic or superior epigastric artery to the HFA in most patients. Therefore, chemotherapeutic agents might not reach the supraumbilical skin region in most patients, even if the HFA is found on angiography, because the blood supply of the supraumbilical skin region is maintained through the internal thoracic or superior epigastric arteries.

Our patient who developed a supraumbilical red skin rash had undergone gastrectomy for early gastric cancer. The medial edge of the red skin rash was clearly marked by an upper abdominal surgical scar. Therefore, the anastomosis between the HFA and the internal thoracic or superior epigastric artery was thought to have been interrupted by an abdominal incision. Supraumbilical skin injury marked by an abdominal surgical scar has not been reported. However, three of five cases concerning supraumbilical skin complications had histories of previous abdominal surgery [1, 4, 5]. Therefore, there might be a relationship between supraumbilical skin complications and prior laparotomy. In the remaining two cases without histories of laparotomy [3, 6], their HFAs were prominent on the presented hepatic angiograms. We assume that a chemotherapeutic agent reached the supraumbilical skin region through the HFA and caused skin injury.

In conclusion, we propose that the incidence of the HFA has been underestimated. The likely reason is that the characteristic delayed and persistent opacification of the HFA has received little attention in its recognition. Therefore, angiographers should examine the capillary or venous phase of the hepatic angiography to identify the HFA more accurately.

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