Splenic Infarction in Transcatheter Hepatic Arterial Embolization
— Angiographic findings for predisposing factors —

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Abstract

In order to study the predisposing factors of splenic infarction, a retrospective review was done with the hepatic angiograms taken before and immediately after transcatheter hepatic arterial embolizations (THAE). Splenic infarction occurred in 5 cases as a complication of 220 procedures of in 70 patients of hepatocellular carcinoma.

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이 논문은 1989년 4월 1일 접수하여 1989년 4월 24일에 채택되었습니다
Received April 1, Accepted April 24, 1989

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The CT findings of splenic infarction were well-defined peripheral low density of wedge shape in 2 patients, multiple low density areas in 2 patients and extensive inhomogeneous low density in one patient.

To prevent reflux of embolic material in THAE, the amount of the embolic material should be adjusted according to the vascular flow volume of the liver. Flow changes due to vascular anatomical variations, arterial occlusions with collaterals, arterial spasm and localized arterial dissection should be taken into consideration before injection of embolic material.

Introduction

Transcatheter hepatic arterial embolization (THAE) is widely accepted recently as a palliative or permanent treatment of hepatocellular carcinoma (HCC). Since the report of Iwai, et al. Lipiodol (Ethyl ester of the fatty acid of poppyseed oil: 38% iodine by weight. Andre-Gelbe Laboratory, France) also has been used in THAE as a media for chemoembolization, mixed with chemotherapeutic agents such Adriamycin and Mitomycin C. In addition, proximal occlusion with Gelfoam particles is recommended to enhance the effect of chemoembolization.

Other than usual post-embolization syndrome such as right upper quadrant pain, nausea, vomiting and fever, gallbladder infarction and splenic infarction were reported as severe complications of THAE. However, enough attention has not been paid yet especially to splenic infarction, an avoidable complication of THAE.

We present our experience for the splenic infarction in 5 cases of THAE and angiographic findings of predisposing factors for the complication.

Materials and Methods

Including repeated trials, two hundred and twenty procedures of THAE were carried out in 172 patients with HCC in the department of radiology, Seoul National University Hospital from January to December 1987. The diagnosis of HCC was based on findings of CT, ultrasound, celiac angiography, alpha-fetoprotein and histological studies.

Among the 172 patients, Gelfoam particle embolization followed slow infusion of Lipiodol emulsion mixed with Adriamycin 30 mg and Mitomycin 10 mg dissolved in Telebrix-30 (ioxithalamate meglumine 60%) in 138 procedures of THAE of 109 patients. Otherwise, same Lipiodol emulsion was given without Gelfoam embolization afterwards in 82 procedures of 63 patients.

With the 220 procedures in 172 patients, follow-up CT was done in 130 patients and evidences of splenic infarction were identified in post-embolization CT of 5 patients.

As our routine method for THAE, initial celiac angiography was done to confirm the diagnosis of the hepatoma and to evaluate the vascular anatomy. Superior mesenteric arteriography using prostaglandin E1 20μg and injection of 60 cc of Telebrix-30 was done to evaluate the patency of portal vein. With superselection technique, the catheter tip was placed at proper hepatic artery and Lipiodol emulsion mixed with the chemotherapeutic agents was infused. After the infusion, 300 to 1500 pieces of Gelfoam particles 1 to 2 mm in size suspended in the contrast media, were injected with the catheter tip at hepatic artery proper. After the injection, a follow-up celiac angiography was done with the catheter tip at common hepatic artery with smaller volume of contrast media to prevent mislodging of the Gelfoam particles during the angiography.

A retrospective review of the angiograms taken before and immediately after the THAE was made.
in the patients who showed evidences of splenic infarction in follow-up CT in order to evaluate the predisposing factors for the complication.

**Results**

Follow-up evaluation was made 1 to 9 weeks after the procedures in the patients (Fig. 1-5). In the CT evaluations a relatively well defined peripheral low density of wedge shape was seen in 2 patients and multiple low densities were noted in 2 patients (Table 1). In one patient, extensive in-homogeneous low density was demonstrated in 60 % area of the spleen. In the case 1, a small high density was identified proximally to the lesion probably due to the unresorbed Gelfoam particles soaked with contrast media (Fig. 1).

As for the doses of the embolic materials in the 5 cases, 6 to 12 cc of Lipiodol and 600 to 1300 particles of Gelfoam were used. In the case 5, only 11 cc of the Lipiodol emulsion was infused. In the case 3, localized dissection developed at celiac axis during the procedure (Fig. 3). As a result of the embolization, the hepatic arteries showed complete occlusion at the proximal hepatic arteries in 4 cases (Fig. 1-4).

Vascular anatomies of reflux pathway to splenic artery were variable. The characteristics of the vascular anatomy were summarized in Table 2. Small and short common hepatic artery originating from celiac axis were found in 3 cases (Fig. 2, 3, 4). Right hepatic artery originated from superior mesenteric artery in one case (Fig. 1) and left hepatic artery from left gastric artery in another case (Fig. 5).

As post-embolization complications, all 5 patients suffered from abdominal pain persisted for 3 to 10 days in addition to the usual post-embolization syndrome including nausea, vomiting and right upper quadrant pain for 2 to 3 days. In the case 4, severe left upper quadrant and left flank pain were complained for 6 days. Mild to moderate fever up to 38°C lasted for 5 days.

**Representative Case Reports**

**Case 1:**

A 52-year-old male was admitted to have THAE for the multinodular HCC which was identified in CT. In angiography the right hepatic artery was originated from superior mesenteric artery (Fig. 1A). An unusually enlarged artery, most likely a pancreatoduodenal artery, was noted to connect common hepatic artery and right hepatic artery (Fig. 1B). The tumor feeding artery arose

**Table 1.** CT Findings of Splenic Infarction and Related Symptoms in 5 Patients after THAE for Hepatocellular Carcinoma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex / Age</th>
<th>CT Findings</th>
<th>Symptoms &amp; Durations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>M / 52</td>
<td>Subcapsular well-defined low density</td>
<td>Abdominal pain, 3 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A high density embolic material</td>
<td>Mild fever, 9 days</td>
</tr>
<tr>
<td>2.</td>
<td>M / 48</td>
<td>Peripheral wedge shaped low density</td>
<td>LUQ pain, 10 days. Mild fever, 3 days</td>
</tr>
<tr>
<td>3.</td>
<td>F / 46</td>
<td>Multiple band-like and wedge-shaped low densities</td>
<td>Abdominal &amp; left flank pain, 5 days. Mild fever, 2 days</td>
</tr>
<tr>
<td>4.</td>
<td>M / 47</td>
<td>Extensive peripheral inhomogeneous low density</td>
<td>Severe abdominal pain, 1day. LUQ &amp; left flank pain, 6 days. Fever, 5 days</td>
</tr>
<tr>
<td>5.</td>
<td>M / 47</td>
<td>Two well-defined irregular low density areas</td>
<td>Abdominal pain, 7 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mild fever, 2 days</td>
</tr>
</tbody>
</table>

THAE: Transcatheter hepatic arterial embolization
LUQ: Left upper quadrant
Fig. 1. Case 1. A. Superior mesenteric arteriography reveals two hypervascular masses in right lobe supplied from right hepatic artery originated from superior mesenteric artery. B. Immediate follow-up angiography after THAE with Lipiodol emulsion and Gelfoam particles showed completely occluded right hepatic artery and an enlarged pancreaticoduodenal artery communicating right hepatic to common hepatic artery, as a possible pathway of reflux to splenic artery. C. In CT taken 6 weeks after THAE, two well defined subcapsular low density areas are noted in the spleen. A small high density at the proximal to the anterior low density is likely due to refluxed Gelfoam particle. Surgical defects are noted in the liver due to tumorectomies done 2 weeks after THAE.

Table 2. Angiographic Findings and Doses of Embolic Materials for THAE in 5 Patients of Hepatocellular Carcinoma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Pre-THAE Angiographic Findings</th>
<th>Embolization Doses</th>
<th>Selected artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Common origin of RHA and pancreatico-duodenal artery from SMA. Small HA</td>
<td>Lipiodol 7 cc+A/M 3 cc</td>
<td>RHA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gelfoam 1300 particles</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Small CHA and large SA. Occluded BHA with collaterals due to previous THAE. Catheter induced spasm</td>
<td>Lipiodol 12 cc+A/M 3 cc</td>
<td>HA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gelfoam 600 particles</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Short CHA</td>
<td>Lipiodol 10 cc+A/M 3 cc</td>
<td>RHA</td>
</tr>
<tr>
<td></td>
<td>Dissection of celiac axis &amp; CHA</td>
<td>Gelfoam 800 particles</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Small HA and large SA</td>
<td>Lipiodol 6 cc+A/M 3 cc</td>
<td>HA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gelfoam 1200 particles</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>LHA from LGA</td>
<td>Lipiodol 8 cc+A/M 3 cc</td>
<td>LHA</td>
</tr>
<tr>
<td></td>
<td>Small HA and post-lobectomy state</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THAE: Transcatheter hepatic arterial embolization, A/M: Adriamycin 30 mg and Mitomycin 10 mg dissolved in Telebrix30, C/R, L, B, HA: Common, right, left, both, hepatic artery, LGA: Left gastric artery, HA: Proper hepatic artery, SMA: Superior mesenteric artery, SA: Splenic artery
right hepatic artery but it was not enlarged. The catheter was introduced into the right hepatic artery.

Infusion of Lipiodol emulsion (7 cc Lipiodol mixed with Adriamycin 30 mg and Mitomycin 10 mg dissolved in 3 cc of water soluble contrast media, Telebrix–30) was followed by injection of 1300 particles of Gelfoam suspended in 30 cc of contrast media. Right hepatic artery showed complete occlusion after the embolization.

After the procedure abdominal pain continued for 3 days. However, it was well controlled with medications. Mild fever persisted for 9 days. Six weeks later, follow-up CT was done to identify the evidence of splenic infarction (Fig. 1C).

Case 2:

A 48-year-old male was admitted for follow-up evaluation and re-trial of THAE for his Known HCC. The 1st THAE was done 3 months ago.

Celiac angiography was done which revealed complete occlusion of both hepatic arteries and multiple collaterals (Fig. 2B). The catheter tip was introduced into hepatic artery proper through re-

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Fig. 2. Case 2. A. Celiac arteriography discloses a large hypervascular mass in right lobe of liver. B. In angiography taken 3 months after 1st THAE with Lipiodol emulsion and Gelfoam particles, both hepatic arteries are occluded with multiple collaterals and catheter induced multifocal spasms are noted at proper hepatic artery. C. Second THAE was done, using Lipiodol emulsion and Gelfoam particles. Lipiodol uptake at peripheral lesion and occlusion of collaterals are disclosed in immediate follow-up angiography. D. In CT taken 9 weeks later, a peripheral wedge-shaped low density is found in spleen. Partial loss of Lipiodol uptake is seen in the hepatic tumor.
relatively small common hepatic artery. Infusion of total of 12 cc Lipiodol emulsion followed by injection of 1300 particles of Gelfoam suspended in diluted contrast media was made.

During the procedure of THAE, focal spasms were induced by the catheter manipulation at hepatic artery proper. Both hepatic arteries and all collaterals were found to be occluded after the procedure on immediate follow-up angiography (Fig. 2B, C). Left upper abdominal pain developed for 10 days which was controlled medication. Follow-up CT taken after 9 weeks showed wedge-shaped peripheral low density in the spleen (Fig. 2D).

Discussion

As mild complication of THAE, post-embolization syndrome such as nausea, vomiting, abdominal pain, and fever develops frequently, but the symptoms usually disappear within a few days without specific treatment1,2,4).

As severer complications, gallbladder infarction and splenic infarction were reported9-11). The CT findings of the splenic infarction are multiple low density areas of wedge shape in most patients. In some cases multiple heterogeneous or massive hypodense lesions were noted11-12). Widely accepted technique in recent years THAE in Japan is the infusion of Lipiodol emulsion mixed with chemo-
Fig. 4. A. Common hepatic arteriography shows relatively small hepatic arteries, large splenic artery and short common hepatic artery. Multinodular hepatomas are identified. Metallic clips suggest previous tumorectomy. B. After THAE, both hepatic arteries and right gastric artery were occluded. C. In follow-up CT taken 3 weeks after THAE, an extensive peripheral inhomogeneous density is noted. Multiple nodules with Lipiodol uptake and linear radioacities due to embolic materials are noted in the liver.

Fig. 5. A. Celiac arteriography shows post-right lobectomy state and ligated right hepatic artery from superior mesenteric artery. Left hepatic artery arises from left gastric artery. B. One week after THAE with Lipiodol emulsion only, CT reveals Lipiodol uptake at resection margin of the liver. An irregular wedge-shaped low density is seen in the spleen.
therapeutic agent followed by Gelfoam particles\(^6\)\(^-\)\(^8\). With this technique, the blood flow becomes sluggish after infusion of Lipiodol emulsion. The determinants for reflux of embolic materials in THAE are vascular flow volume and amount of embolic material. One should be careful to check the danger of possible reflux of Gelfoam especially after infusion of large amount of Lipiodol emulsion.

In many patients with HCC in those countries, the liver is shrunk due to underlying liver cirrhosis and the blood flow to splenic artery is increased due to splenomegaly, inducing liability to reflux of embolic material into splenic artery.

To prevent the possible reflux, Gelfoam particles were suspended in contrast media, so the flow of which can be identified on fluoroscope. When the flow of contrast media into hepatic artery becomes sluggish, the injection rate should be reduced and stopped. While fluoroscope being done, possible reflux of contrast media or Lipiodol can be checked on the basis of vascular anatomy including anatomical variations, such as left hepatic artery from left gastric artery, right hepatic artery from superior mesenteric artery, or enlarged pancreaticoduodenal arcades.

In the case 5, possible reflux of large amount of Lipiodol are emulsion caused splenic infarction. So, if the vascular volume of the hepatic area including tumor vascularity is small, the amount of embolic material should be reuced and be infused slowly. Especially in the cases of arterial spasm and arterial obstruction with small collaterals, the injection should be done slowly and carefully.

With dissection at origin of celiac axis, the blood flow of pancreaticoduodenal arteries is reversed to supply hepatic and splenic territories from superior mesenteric artery. In such a condition the reflux of embolic material is prone to occur because of the reversal of blood flow at common hepatic artery.

When a patient suffers from persistent fever or abdominal pain, especially left upper quadrant pain after THAE, CT is valuable to diagnose splenic infarction.

In summary, to prevent such a severer complication in THAE, the followings should be considered before and during the procedure.

1) The amount of embolic material should be carefully measured considering the vascular flow volume of the liver.

2) Individual characteristics of vascular anatomy.

3) Notice for the arterial occlusion with multiple collaterals, arterial spasm and localized arterial dissection.

REFERENCES

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