Angiographic Features of Submucosal Tumors of the Stomach

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FUJII, K., YAMAGATA, S., SUZUKI, J., SASAKI, R., SHOJI, T., MAKABE, M., MEMEZAWA, H. and MAESAWA, S. Angiographic Features of Submucosal Tumors of the Stomach. Tohoku J. exp. Med., 1972, 107 (3), 287-299 — Selective celiac arteriography was performed on 18 patients with various submucosal tumors of the stomach, diagnoses of which were confirmed by surgical operation except for one case. Angiographic findings were reviewed in comparison with macroscopic and histologic findings of operative materials. It was found that there were characteristic angiographic features depending upon the sort of tumors. It is considered that this method is useful to determine the localization and the extent of the tumor, and is valuable to differentiate benign from malignant lesion. celiac arteriography; submucosal tumor

Recent development in the examination technique of the upper gastro-intestinal tract has been remarkable. These conventional methods, however, may clarify only mucosal changes, and efficacy of these method is limited within mucosal changes of the stomach. On the other hand, selective angiography was recently reported to possess diagnostic value for the diseases of the gastro-intestinal tract (Reuter et al. 1970, Shibata and Iwasaki 1970, Fujii 1971 a, b). It was emphasized that this method was a favorable technique for the diagnosis of changes of the submucosal, muscular or serosal wall of the stomach.

Submucosal tumor of the stomach is not a rare lesion, and its incidence appears to be increasing with the popularization of the gastric mass survey in Japan. But most of this lesion are frequently asymptomatic, so it is generally difficult to diagnose by the routine conventional methods, especially the exogastric type tumor even if the tumor is comparatively large. Biopsy and cytologic examination are not helpful for diagnosis of the case that is not accompanied with mucosal changes. Further, in the tumor with ulcerative changes, it is rare to make the
histological diagnosis of submucosal tumor preoperatively (McNeer and Pack 1967).

The authors have reviewed the angiograms of 18 patients with various submucosal tumors of the stomach, in comparison with histological pictures of operative materials. This report deals with angiographic features of submucosal tumors of the stomach, and various characteristic patterns which correspond to histological features of tumors.

**MATERIALS AND METHODS**

Selective celiac arteriography has been performed on 18 patients with various submucosal tumors of the stomach (7 leiomyosarcoma, 5 leiomyoma, 3 malignant lymphoma, 2 aberrant pancreas, 1 neurinoma). Accurate diagnoses were confirmed by surgical operations in all, except for an inoperable case of malignant lymphoma which confirmed only by biopsy. According to the Odman's general method (1956), KIFA green catheter was inserted to the celiac axis from the femoral artery. Forty to 50 ml of the contrast material (64% Conlaxin-L* or 60% Conray†) were injected by Gidlund power injector with a pressure of 4.5 kg/cm². As a rule, serial roentgenograms were filmed over 15 seconds, with 2 films exposed per second for the first 4 seconds and 1 film exposed per second for following 11 seconds. Before the roentgen exposure, stomach was inflated with an adequate amount (300–400 ml) of air for making clear the outline of the stomach.

**RESULTS**

The characteristic angiographic findings in cases with various submucosal tumors of the stomach are summarized in Table 1.

<table>
<thead>
<tr>
<th>Angiographic findings</th>
<th>Leiomyoma (5)*</th>
<th>Leiomyosarcoma (7)</th>
<th>Malignant lymphoma (3)</th>
<th>Aberrant pancreas (2)</th>
<th>Neurinoma (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumor vessels</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Arterial invasion</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Arterial irregularity</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Abrupt termination</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Contrast accumulation light</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Moderate</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dense</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Early venous return</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Venous invasion</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* ( ) Number of cases.

* 64% sodium methylglucamine iodamide
† 60% sodium iothalamate
Leiomyoma

Moderate accumulation of the contrast material and circular distribution of arteries surrounding the round tumor were characteristic angiographic findings in this series (Figs. 1–3). Tumor vessels, abrupt termination of arteries, arterial invasion were seen in 3 of 5 cases. No venous invasion and early venous return were seen. A round shape of tumor was indicated in a tomogram taken in one case of leiomyoma (Fig. 4). In leiomyoma, such a tumor shadow is frequently demonstrated in a plain film of the abdomen and the tumor rarely accompanies a calcification. Moderate accumulation of the contrast material in leiomyoma could be explained from the pooling of the contrast material in the tumor in addition to the density of the tumor shadow.

The correct angiographic diagnosis was made in 4 of 5 patients with leiomyoma. In one case, the marked irregularity and abrupt termination of arteries misled to the diagnosis of leiomyosarcoma.

Leiomyosarcoma

Many tumor vessels, abrupt termination of arteries, arterial invasion and irregularity were seen in all cases (Figs. 5–7). Light accumulation of the contrast material was seen in 4 of 7 patients with leiomyosarcoma. In one case, moderate accumulation of the contrast material was seen (Fig. 5). The direct invasion of

Fig. 1. A 61-year-old woman with leiomyoma.

a: Roentgenogram of the barium study: A round large tumor contour is observed from the subcardiac portion to the middle portion of the body of the stomach in the lesser curvature.

b: Celiac angiography: A round exogastric type of leiomyoma is demonstrated with moderate accumulation of the contrast material.
tumor to the splenic vein was present in one case. In this case, as the obstruction of the vein, multiple collateral ways of the draining veins developed (Fig. 6). No early venous return was seen.

A roentgen film of the barium study demonstrating a rare lesion of gastroduodenal invagination is shown in Fig. 7. Leiomyosarcoma originated from the anterior wall of the stomach was found to be invaginated to the duodenum. Black arrows indicate the contour of a large round tumor. On the celiac angiogram, the branches from the right gastric and the right gastroepiploic artery were extremely displaced to the curious direction of the right hypochondral region, and irregular tumor vessels and abrupt termination of arteries were demonstrated.

**Malignant lymphoma**

Three patients with malignant lymphoma of reticulum cell type were evaluated. Tumor vessels, arterial invasion and irregularity, abrupt termination of arteries and dense accumulation of the contrast material were characteristic findings in this series (Figs. 8 and 9). Early venous return was observed in one case. But the most significant findings were the characteristic tumor vessels and the unusual dense accumulation of the contrast material continuing until later phase in serial
Fig. 3. A 52-year-old man with leiomyoma.

a: Roentgenogram of the barium study: A round tumor contour is observed at the antral portion of the stomach.

b: Celiac angiography (arterial phase): Black arrows indicate the circular distribution of arteries surrounding a round tumor.

c: Celiac angiography (venous phase): Tumor contour is clearly demonstrated with moderate accumulation of the contrast material.
films. In malignant lymphoma, tumor vessels were observed diffusely distributed in the tumor with the fine granular appearance. The density of the accumulation of the contrast material in malignant lymphoma was highest in all kind of submucosal tumor we encountered. A precapillary phase of the celiac angiogram in a patient with inoperable malignant lymphoma of the stomach is shown in Fig. 9. Multiple huge tumors in the stomach on the barium study were seen clearly on the celiac angiogram.

Aberrant pancreas

Two patients with aberrant pancreas located at the greater curvature in the antral portion of the stomach were evaluated. Light homogenous accumulation of the contrast material in the tumor and arterial irregularity were characteristic angiographic findings (Fig. 10). No tumor vessels, abrupt termination of arteries and early venous return were seen. The aberrant pancreatic tumor mainly receives the blood supply from the pancreaticoduodenal arterial arcades having no connection with the location in the gastric wall. So, in one case, the diagnosis of cancer
Fig. 5. A 64-year-old woman with leiomyosarcoma.

a: Roentgenogram of the barium study: A large round tumor contour is observed at the fundic portion of the stomach.
b: Celiac angiography (arterial phase): At the region supplied with the branches from the left gastric artery and the short gastric artery, many tumor vessels, abrupt termination of arteries, arterial invasion and irregularity of the arterial course are seen.
c: Celiac angiography (venous phase): Moderate accumulation of the contrast material within the tumor is observed.

of pancreatic head was made preoperatively on the basis of findings such as the arterial irregularity, increased number of arteries and the accumulation of the contrast material.

**Neurinoma**

The celiac angiogram of gastric neurinoma is shown in Fig. 11. Despite all diagnostic efforts including barium study, gastric endoscopy, peritoneoscopy, echogram and angiography, the correct diagnosis was not made preoperatively in this case (Kumagai et al. 1971). Retrospectively the main supplying artery for this tumor was the right gastric artery (RGA) and its branches. As shown by black arrows, many tumor vessels, irregular arteries and abrupt termination of arteries were seen in the light accumulation of the contrast material. So, the tumor is originated from the stomach may be clarified without much difficulties.

**DISCUSSION**

In our clinic, submucosal tumor of the stomach is classified according to the growing form into 4 types; 1, endogastric; 2, exogastric; 3, intramural; and 4, mixed type (Masuda et al. 1967). In leiomyoma, the frequency of each type in this country is as follows: endogastric type 67.5%, exogastric type 32.5%, intramural type estimated as probably endogastric type 2.3% and mixed type 0% (Masuda et al. 1967). As to the symptoms, roughly a manifest gastro-intestinal bleeding
Fig. 6. A 51-year-old man with leiomyosarcoma.

a: Celiac angiography (arterial phase): Tumor vessels, abrupt termination of arteries, arterial invasion and marked irregularity of arterial course are observed at the region shown by black arrows.

b: Celiac angiography (venous phase): Large black arrows show a huge exogastric tumor contour, and small black arrows show the collateral ways of the draining veins for the obstruction of the splenic vein.

In the endogastric type and a palpable abdominal mass in the exogastric type is most frequent. Other symptoms are abdominal distension, epigastralgia, upper abdominal dullness, abdominal discomfort, vomiting, etc. (Masuda et al. 1967). Even if these various symptoms are present, the diagnosis of the exogastric type is generally difficult and the preoperative histological diagnosis is far more difficult.

In 1969, the authors have reported the evaluation of the selective celiac angiography as a diagnostic method for submucosal tumors of the stomach (Yamagata et al. 1969). It was emphasized that the angiographic method was considered to be indispensable for making a diagnosis of the gastric submucosal tumor, especially of the exogastric type. It was also mentioned that of the
Fig. 7. A 43-year-old woman with leiomyosarcoma.

a: Roentgenogram of the barium study: Black arrows show a round large tumor growing from the anterior wall of the stomach invaginated to the duodenum.

b: Celiac angiography (arterial phase): At the region shown by black arrows, the branches from the right gastric (1) and the right gastroepiploic artery (2) are extremely displaced to the curious direction, and irregular tumor vessels and abrupt termination of arteries are demonstrated.

c: Celiac angiography (post-capillary phase): At the region shown by black arrows, light accumulation of the contrast material is observed and multiple tumor vessels and abrupt termination of arteries are demonstrated.

myogenic tumor, the circular distribution of the tumor vessels surrounding the tumor and arterial invasion, irregularity and abrupt termination of small arteries were important findings to differentiate leiomyoma from leiomyosarcoma.

Reuter et al. (1970) stated that 2 of 5 patients with leiomyoma had no abnormal angiographic findings and other 3 had moderate number of tumor vessels and infiltration of gastric arteries. They stressed that there was poor vascularity in leiomyoma of the stomach as compared with that of small bowel. On the other hand, Shibata and Iwasaki (1970) reported that leiomyoma of the stomach was the most vascular tumor, in which many irregular vessels were seen and the
Fig. 8. A 46-year-old man with malignant lymphoma.

a: Roentgenogram of the barium study: A tumor contour is observed in the lesser curvature on the middle portion of the body of the stomach.
b: Celiac angiography (arterial phase): As shown by white arrows, at the region supplied with the branches from the short gastric artery and the left gastric artery, tumor vessels, arterial irregularity and abrupt termination of arteries are seen.
c: Celiac angiography (venous phase): As shown by white arrows, the unusual dense accumulation of the contrast material is observed.

Fig. 9. A 55-year-old man with malignant lymphoma.

a: Roentgenogram of the barium study: Multiple rugged tumor contours are observed centering around the body of the stomach.
b: Celiac angiography (pre-capillary phase): Multiple tumor contours similar to the barium study are demonstrated with abundant tumor vessels.
Fig. 10. A 37-year-old man with aberrant pancreas.
a: Roentgenogram of the barium study: A round filling defect is observed at the prepyloric portion of the stomach.
b: Celiac angiography (arterial phase): As shown by black arrows, arterial irregularity is observed.
c: Celiac angiography (venous phase): As shown by black arrows, light homogenous accumulation of the contrast material within the tumor is observed.

Fig. 11. A 38-year-old man with neurinoma.
Celiac angiography (arterial phase): As shown by black arrows, tumor vessels, irregular arteries and abrupt termination of arteries are seen in light accumulation of the contrast material. The main supplying artery for this tumor is the right gastric artery (RGA).
accumulation of the contrast medium was dense.

In 5 cases of leiomyoma in the present series, moderate accumulation of the contrast material within the tumor and circular distribution of arteries surrounding the tumor were the most significant findings. Beranbaum and Beranbaum. (1966) reported that at first the circular distribution of the intramural arteries was seen as the characteristic for leiomyoma of the gastro-intestinal tract. In our 7 patients with leiomyosarcoma, many tumor vessels, marked irregularity and abrupt termination of arteries, and arterial invasion were seen as the characteristic angiographic findings in all cases. Light accumulation of the contrast material within the tumor was seen in 4 out of 7 patients with this lesion. The main symptom of these cases entering the hospital was a palpable abdominal mass except one. So, a large advanced tumor was often misleading to the disease of the surrounding organs including pancreas, spleen, liver, omentum and various retroperitoneal organs and vice versa. For example, in Fig. 6 the main splenic arterial wall was slightly irregular and ramifications from this artery were seen as supplying arteries for the tumor, and the obstruction of the main splenic vein and the collateral ways furthermore suggested the pancreatic tumor. In fact, the diagnosis of pancreatic cancer had been made before the angiographic examination could reach a correct diagnosis. In 3 cases with malignant lymphoma of reticulum cell type, tumor vessels, arterial invasion and irregularity of arterial course and abrupt termination of arteries were common findings, but the most characteristic finding was the unusual dense accumulation of the contrast material within the tumor continuing until later phase in serial films. Tumor vessels in this lesion were seen as fine granular, dense and diffuse appearance compared with another ones. McAlister et al. (1962) in microangiographic study of the surgical specimen of the gastro-intestinal disease reported lymphoma exhibited finer vessels than carcinoma without areas of laking. Aberrant pancreatic tumors locating at the greater curvature of the antral portion of the stomach were supplied with the branches from the pancreaticoduodenal arterial arcades and also no tumor vessels, arterial invasion and abrupt termination of arteries were seen in this disease. Irregularity of arterial course and light accumulation of the contrast material were observed. In spite of the poor vascularization of the normal pancreatic organ on the conventional angiogram, the aberrant pancreatic tumor indicated light accumulation of the contrast material diffusely within the tumor. The reason of this gap could not be explained. In a case of neurinoma, the tumor showed a quiet exogastric growth, so all diagnostic efforts were exhausted and even the diagnosis of the gastric tumor could not be made. An abdominal tumor of unknown origin is sometimes encountered. In such an occasion, it is emphasized that the angiographic method in addition to the routine conventional examinations is quite an important diagnostic procedure.

References


