Diagnosis of Submucosal Tumors by Injecting a Water Soluble Contrast Medium: Basic Research and Imaging of Tumors

SHIGERU ASAKI, SHIGEAKI HATORI, SHUICHI IWAI, TOSHIAKI NISHIMURA, AKIRA SATO and YOSHIO GOTO

The Third Department of Internal Medicine, Tohoku University School of Medicine, Sendai 980

Asaki, S., Hatori, S., Iwai, S., Nishimura, T., Sato, A. and Goto, Y. Diagnosis of Submucosal Tumors by Injecting a Water Soluble Contrast Medium: Basic Research and Imaging of Tumors. Tohoku J. exp. Med., 1982, 138 (2), 121–130. —— With the aim of adequately distinguishing gastric submucosal tumors from other lesions such as gastric polyps, gastritis, and protuberances due to extragastric pressure, a new method was developed. A water soluble contrast medium is endoscopically injected into a submucosal lesion followed immediately by the application of roentgenography, thereby obtaining X-ray pictures of the lesion through frontal and lateral projections. Since the contrast substance is water soluble, the method can visualize submucosal microchanges. Highly diffusible, the substance usually has a fading time of about 40 min, the present method is convincingly free of danger. This paper provides the results of basic research performed using adult mongrel dogs together with some comments on the applicability of the method in clinical use. —— submucosography; submucosal tumor; contrast medium; X-ray diagnosis; imaging of tumors

Recent advances in techniques for gastric examination including endoscopic scrutinization have made possible the early diagnosis of asymptomatic, small submucosal tumors. Yet there remain a few cases in which the identification is difficult, such as those of epithelial polyps and other tumescent lesions caused by extragastric compression, both being confusingly similar in appearance. With the aim to minimize this confusion, we have developed the following method: A water soluble contrast medium is injected into the mass in question in the gastric submucosa from its oral-side and anal-side tips, followed immediately by the application of roentgenography, and we can obtain its frontal and lateral views (termed “contrasted X-ray imaging”). Investigations were performed on the usefulness of this method mainly for examining the size and the surface nature of a mass. Finally the method was applied to differentiate gastric submucosal tumors from other lesions of similar appearance including protuberant changes due to extragastric compression.

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This paper is Report I on gastric submucosography from our department.
MATERIALS AND METHODS

Materials

Prior to clinical application of submucosography, 3 adult mongrel dogs weighing about 15 kg were injected with contrast medium into the gastric submucosa and examined roentgenographically. We tried to find out by these experiments the most suitable contrast medium, and its concentration and dosage for our purpose.

In order to choose suitable contrast medium, we tentatively used lipiodol, titanium powder, and water soluble substances. The comparative studies revealed that lipiodol is highly viscous, poorly diffusible and unfavorable for quick injection. It stagnated for a long time around the injection site. Its oily property precluded dilution with tissue fluid and made it remain as tiny drops. Therefore, lipiodol was apparently inadequate for the examination of delicate microchanges of the submucosa. Metal material, titanium powder, was difficult to be introduced into tissue through the topical injection needle.

By contrast, the water soluble contrast substance, low in viscosity, was easily introduced through a needle of 0.5 mm in inner diameter into the submucosa. Its diffusibility helped us to detect fine submucosal changes. The injected contrast substance became rapidly diluted and widely diffused, and eventually undetectable by X-ray in about 45 min. No adverse reactions were introduced by an injection of the water soluble contrast medium in the patient; locally induced inflammatory changes were not significant, hence the procedure was safe. Recognizing these advantages, we finally decided to adopt water soluble substances as the contrast medium for our purpose.

Using adult mongrel dogs, the optimum concentration and dosage of the contrast medium for clear visualization by roentgenography were tested. As the results, 3.0 ml of the contrast medium visualized the object, but it became hazy and unavailable for scanning in about 45 min after injection. The fading time was slightly prolonged with larger amounts of the contrast medium. Dilution of the contrast medium with distilled water to 50% or 25% caused no noticeable difference in imaging, though a lower concentration tended to shorten the fading time. When applied to a gastric submucosal tumor, 1-3 ml of a water soluble medium was sufficient to produce a clear X-ray image. As for marking the esophago-gastric juncture clear, 0.2 ml was sufficient to visualize the juncture in a lateral view of the contrasted barium-filled X-ray image of the esophagus.

Fig. 1. Injector and its tip portion.
Local changes due to the injection of contrast medium

The injection of a contrast medium caused edema at the site of injection, but it disappeared in a few days. Although mechanical vascular injury by the injection needle sometimes induced a slight bleeding. Four days after injection, there remained only slight edematous traces at the injection site and inflammatory cellular infiltration was insignificant.

Then, we applied our method to a total of 100 patients who had been diagnosed by fiber-gastroscope biopsy as gastritis. These patients showed endoscopic features suggestive of either submucosal tumor or other tumescent lesion. Among these 100, 18 submucosal tumor cases underwent gastrectomy and 7 others underwent endoscopic polypectomy. In these cases, a correlative study of contrasted X-ray images and resected specimens was carried out.

Because the water soluble contrast medium contains iodine, patients with oversensitivity to iodine were excluded beforehand. Furthermore, taking into consideration a potential danger of the local spreading of malignancy, patients with malignancy were also excluded from the present study.

Methods

With the use of a usual fiberscope for biopsy, a water soluble contrast medium, 60 w/v% meglumine iotalamate solution, or 64.9 w/v% ioddide solution, was injected using a usual fiberscope for biopsy equipped with a local injection needle, 0.5 mm in inner diameter (Fig. 1), and a specially designed injector (Fig. 2) into the oral-side and anal-side tips of each submucosal mass of the patient (Fig. 3). Plain roentgenograms were immediately taken.
to visualize the mass in frontal and lateral views. In order to obtain good pictures, the stomach was inflated by an appropriate amount of air and gastric peristalsis was suppressed by administering an antispasmodic. Also, it brought about better results to take the X-ray pictures within 5 min after injection. The addition of several drops of appropriate pigment, such as 5% Patent-Blue V solution, to the contrast medium helped us to scrutinize the movement of the contrast medium injection.

**Results**

*Diffuse pattern of contrasted X-ray images*

The normal submucoosa. X-ray pictures taken immediately after the endoscopical injection of a water soluble contrast medium, 1 ml, into the normal

![Image](https://via.placeholder.com/150)

**Fig. 4 (upper).** Submucosography of normal gastric mucosa. Left: Frontal view. Right: Lateral view.

**Fig. 5 (lower).** Submucosography of extragastric compression caused by calcified lymphnode.
gastric submucosa are shown in Fig. 4, presenting the frontal view on the left and the lateral view on the right. The contrast medium spread homogeneously showing a diffuse pattern. Even submucosal blood vessels were depicted.

*Epithelial gastric polyps.* The injected contrast medium spread homogeneously in a diffuse pattern. But in some cases in which fiber hyperplasia of the submucosa was intense, the contrasted X-ray image by a frontal projection was vague or faintly translucent; and by a lateral projection, the image showed a filling defect in the mucosa in the direction to the gastric cavity, suggesting that the lesions were epithelial polyps.

*Submucosal tumescences caused by extragastric pressure.* A contrasted X-ray image obtained for a submucosal tumescent lesion caused by pressure of a calcified lymphnode is shown in Fig. 5. The left picture shows the frontal view and the right picture the lateral view, both representing a diffuse pattern. Likewise, gastric submucosal tumescent changes caused by either hepatoma, splenic cancer, pancreatic cancer or intrabowel gases all presented images of the diffuse pattern.

**Defect patterns of contrasted X-ray images**

All of the submucosal tumors revealed contrasted X-ray images of the defect pattern.

*Case No. 1.* A 40 year-old male. The endoscopic image of the submucosal mass is shown in Fig. 6. The mass covered by a normal mucosa was endoscopically diagnosed as a gastric submucosal tumor. Fig. 7 shows the contrasted X-ray image of this tumor obtained prior to operation. The left picture shows the frontal view and the right picture the lateral view. The tumor is represented by a filling defect. As shown in Fig. 8, the lesion was histopathologically confirmed as a leiomyoma that grew from the gastric propria muscularis extending toward the mucosa, showing an intragastric pattern of development.

*Case No. 2.* A 75 year-old female. Fig. 9 shows her gastric submucosal mass.

![Endoscopic picture of intraluminal growth of leiomyoma.](image)
Fig. 7. Submucoscopicgraphy of Fig. 6. Left: Frontal view. Right: Lateral view.

Fig. 8. Histological specimen showing intraluminal type growth of tumor. The propria muscularis is partially absent artificially.

Fig. 9. Endoscopic picture of extragastric growth of leiomyoma.
endoscopically photographed. The surface was covered with a normal mucous membrane, showing bridging folds, and the mass was endoscopically diagnosed as a gastric submucosal tumor. Fig. 10 shows its contrasted X-ray image, presenting the frontal view on the left and the lateral view on the right. The tumor was shown as a filling defect, and the lateral projection manifested specific spikes like rose thorns. As shown in Fig. 11, the tumor was histopathologically diagnosed as a leiomyoma that grew in the gastric propria muscularis and extended outward showing an extragastric development pattern.

Proposal of the MM line and the PM line

The contrast medium injected into the gastric submucosa mainly spread within the layer, but in part it could diffuse to the muscularis mucosae and the propria muscularis. On the X-ray lateral image of the object in the submucosa, we could observe two border lines (Fig. 12), one represented by the muscularis mucosae (the MM line), and the other represented by the propria muscularis (the PM line). One of the aim of submucosography is to decide the growth mode of submucosal tumor with relation to the MM and the PM line.

Application to marking

A contrast medium of 0.2 ml endoscopically injected into tissue could well be traced by barium-used X-ray examination. Fig. 13 illustrates a barium-filled X-ray image of the esophagus obtained just after 0.2 ml of 60 w/v% meglumine
iotalamate solution was injected into the mucosa at the esophago-gastric junction. As indicated by the arrow, the junction was visualized well.

**Fig. 11.** Histological specimen showing an extragastric growth of tumor.

**Fig. 12.** Schema of MM line and PM line. MM, muscularis mucosae; PM, muscularis propria.

**Fig. 13.** Esophagogastric junction marking. Marking point is arrowed.

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**DISCUSSION**

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However, in clinic conventionalities, the term has been used in a wider sense, involving various tumescent lesions, such as aberrant pancreas, carcinoid, eosinophilic granuloma, varices, and other inflammatory protuberances. Malignant lymphomas, pervasive or reactive, are, however, usually excluded and treated separately. In Western countries, gastric submucosal tumors are usually expressed with a pathohistologically distinctive adjective, “benign” or “malignant,” as, for instance, “benign submucosal tumor” by Schindler et al. (1942), and “benign intramural tumor” by Palmer (1951). In the present paper, masses in or below the gastric submucosa were generally treated as gastric submucosal tumors without the histological or pathohistological distinction between “benign” and “malignant.”

The recent striking progress in technique of gastric examination with X-ray and/or endoscopical scrutiny and the wide-spread mass examinations of the stomach have together contributed to the possible diagnosis of asymptomatic, small submucosal tumors. Yet there are a few instances of gastric polyps and tumescent changes due to extragastric pressure that might cause confusions.

Diagnoses of submucosal tumors by means of X-ray or endoscopical scanning have been reported by various authors including Moore (1924), Rigler (1930), and Schindler et al. (1942). But our new method of endoscopically injecting a water soluble contrast medium into the object lesion and immediately obtaining its X-ray image may be worthy of note in that it can work favorably to distinguish between gastric submucosal tumors and other changes similar in appearance but different in substance, such as gastric polyps and protuberances due to extragastric pressure. In addition, the device can lead us to determine the development pattern of an individual tumor and further to discern submucosal blood vessels. It can also be applied to an X-ray marking method, distinctively visualizing the contrasted image of the object. As a prerequisite step, we carried out an iodine test in order to exclude patients oversensitive to iodine from the subjects in this series. In its clinical application unaccompanied by adverse reactions, our method may well be warranted as a safe and effective way of tumor identification before instituting any treatment.

The injection of oleaginous suspension of lipiodol or popiodol as a contrast medium has so far been tried to ascertain clinically whether cancer has metastasized or not to the regional lymphnodes (Herman et al. 1966). Use of an oleaginous substance as a contrast medium has also been attempted in microangiography to study the mode of deep infiltration of gastric cancer (Sato et al. 1973). However, oil-blended substances usually become drops soon after injection, and eventually impeded against spreading and are liable to stay as foreign material close to the site of injection. Moreover, as the injection is usually made directly into malignant lesions, this technique is likely to potentiate cancer invasion, and undoubtedly may cause problems in clinical use. By contrast, our device, using a water soluble contrast medium, can allow the contrast material to pervade soon after injection, serving to reveal in detail microchanges of the object instead of staying locally as a foreign substance, hence minimizing the risk of infection (Asaki et al. 1976).
Owing to the recent remarkable progress in technique of endoscopy, it has become possible to remove epithelial polyps endoscopically. Also, case reports of endoscopical lumpectomies for gastric submucosal tumors have come to be published (Classen et al. 1973; Asaki 1976). But as endoscopical removal of a gastric submucosal tumor is feared to induce fatal bleeding or perforation, it is indispensable for the physician in charge to grasp beforehand the actual condition of tumor’s intramural occupancy. In this respect, our method may well be recommended as a favorable means for substantiating diagnosis and treatment of submucosal tumors.

References