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Evaluation of endoscopic ultrasonography for the diagnosis of submucosal tumors of the esophagus

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Summary. Endoscopic ultrasonography was carried out on 55 patients whose X-ray films or endoscopic examinations indicated the presence of a submucosal tumor. Endoscopic ultrasonography revealed 8 cases of extraluminal compression and 48 cases of submucosal tumors. Histological studies were performed on 29 cases with submucosal tumors. In 28 of the 29 cases (97%) the location of the tumor in the esophageal wall was correctly estimated ultrasonographically, and appropriate treatment was selected. Tumors ranging from 3 to 50 mm in diameter could be measured accurately. This method may be helpful in follow-up studies. Endoscopic ultrasonographic findings, such as characteristics of the tumor border and internal echoes, were studied to predict the histological diagnosis of the tumor. Leiomyoma, cyst, granular cell tumor, lipoma, and intraluminal metastasis of esophageal cancer were all found to have specific ultrasonographic findings indicating the histological nature of the tumor.

Key words: Endoscopic ultrasonography – Submucosal tumors of the esophagus – Esophageal tumors – Ultrasonographic diagnosis of esophageal tumors.

Diagnosis of submucosal tumors of the esophagus has been based on endoscopic examination and X-ray films, i.e., irregularity of the esophageal wall due to tumor compression or changes in the esophageal mucosa. There are still some difficulties in estimating the size and site of the tumor in the esophageal wall and in evaluating the histological type of the tumor. We employed endoscopic ultrasonography (EUS) for the detection and evaluation of submucosal tumors of the esophagus. This method has some advantages in diagnosing these tumors.

Methods and materials

The endoscopes employed were the GF-UM1 and GF-UM2 (Olympus Optical, Tokyo), both of which are designed for endoscopic ultrasonography. The ultrasonic scanning units used were the EU-M1 and EU-M2 (Olympus). A 7.5-MHz or 10-MHz radial scanner was mounted on the tip of the fiberscope. Before examination, the patients were premedicated with an anticholinergic agent and small doses of a minor tranquilizer, after which 4% lidocaine [Xylocaine] was sprayed on the surface of the pharyngeal mucosa.

Table 1. Discrimination of submucosal tumors from extraluminal compression by endoscopic ultrasonography (EUS) (1983–September 1987). Final diagnosis of submucosal tumor was made by histological examination of: resected tumor (26), biopsy specimens (3). Final diagnosis of extraluminal compression was made by: histological examination of resected tumors (3), of biopsy specimen (1); computed tomography (4)

EUS evaluation	Final diagnosis	
	Submucosal tumor	Extraluminal compression
Submucosal tumor	29	1[a]
Extraluminal compression		
Abnormal artery		3
Mediastinal tumor		2
Lung cancer		2
Total	29/29 (100%)	7/8 (88%)
Overall accuracy	36/37 = 97%	

[a] Lung cancer

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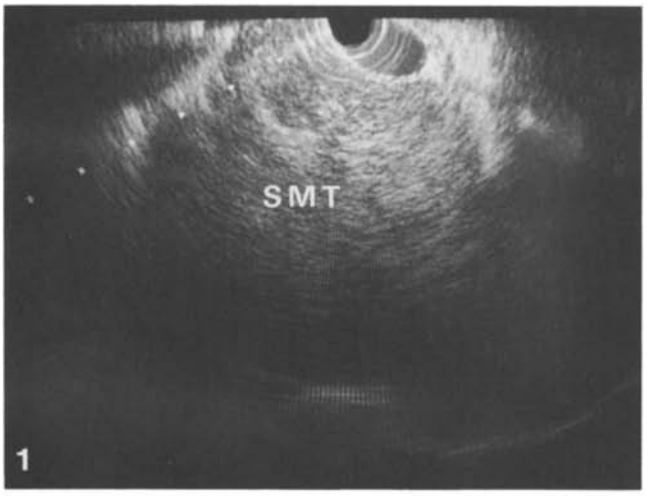
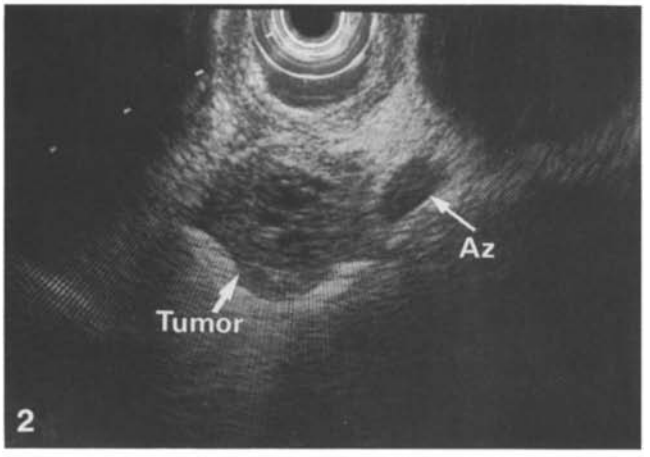
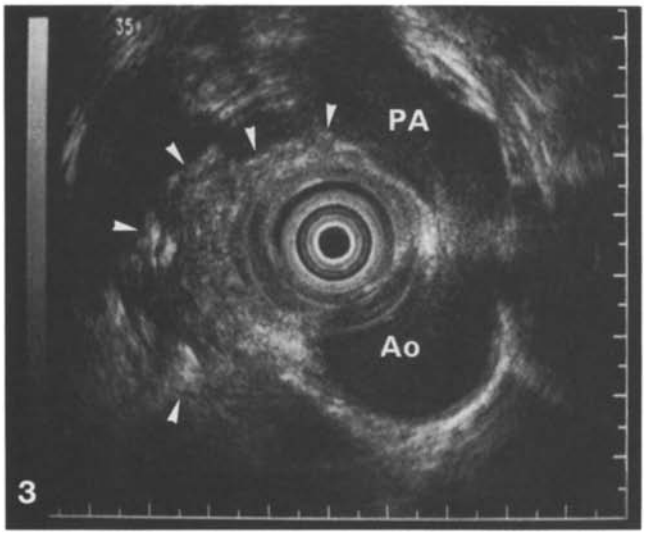
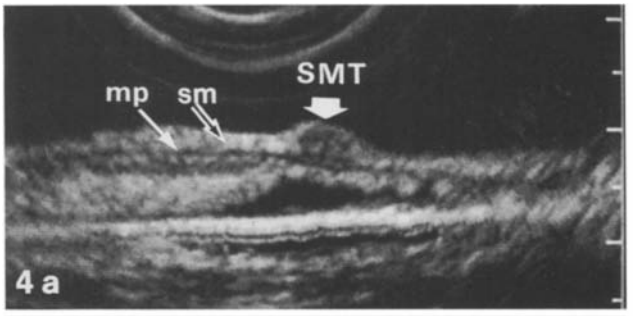
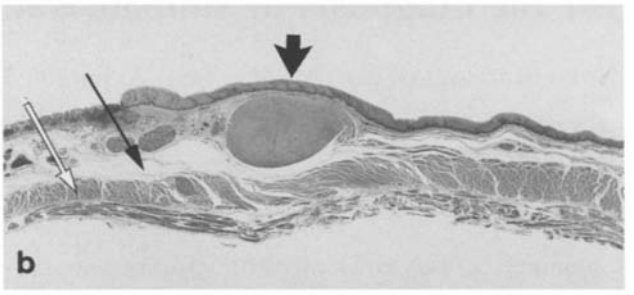
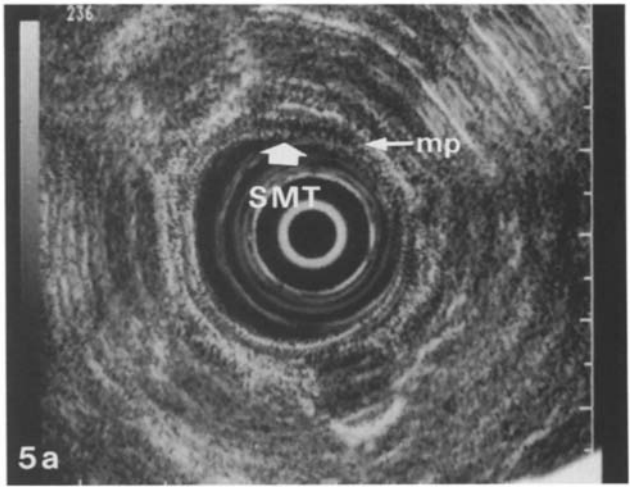












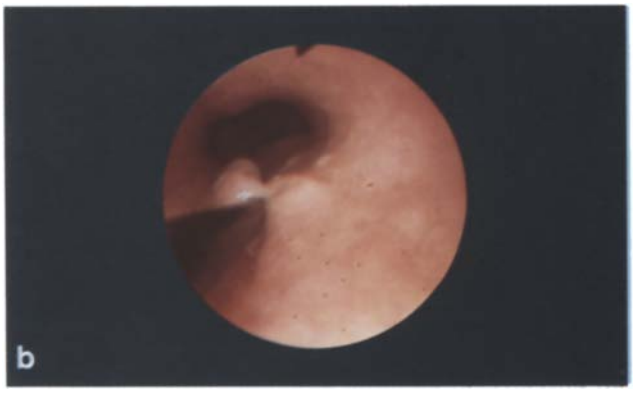


Fig. 1. Lung cancer invading the esophageal wall, which was depicted as a submucosal tumor

Fig. 2. Mediastinal tumor. The *tumor* is located close to the posterior esophageal adventitia and the azygos vein (*Az*)

Fig. 3. Lung cancer invading the esophagus. The *arrows* show the areas of cancer invasion; *PA* pulmonary artery, *A* descending aorta

Fig. 4. **a** Resected esophageal specimen in the water tub. *mp* Muscularis propria, *sm* submucosal layer, *SMT* submucosal tumor (leiomyoma). **b** The *thin black arrow* indicates the submucosal layer; the *white arrow* indicates the muscularis propria. The *large black arrow* shows the leiomyoma

Fig. 5. **a** Leiomyoma (*SMT*) located in the submucosal layer. The fourth layer (*mp*) can be seen under the tumor. **b** It was removed by endoscopic polypectomy

With patients lying on their left side, the fiberscope is introduced perorally into the esophagus and is usually passed further into the stomach. If a patient has a marked stenosis of the esophagus or cardia, the fiberscope must be manipulated carefully to keep the tip immediately proximal to the stricture. A small balloon at the tip of the fiberscope should be inflated with deaerated water (8–10 ml) to provide good contact with the esophageal wall. The fiberscope is then slowly withdrawn under observation. Endoscopic ultrasonography was performed on 55 patients suspected of having a submucosal tumor in the esophagus following roentgenographic or endoscopic examinations. Histological diagnosis could be made in 33 cases (29 resected specimens and 4 biopsy specimens). The other 22 cases were followed up by EUS.

Results

Among 55 patients suspected of having a submucosal tumor of the esophagus, EUS disclosed 7 cases of extraluminal compression and 48 submucosal tumors. A final, definitive diagnosis of the submucosal tumors was made by histological studies of the tumors in 29 cases. Extraluminal compression was established by histological studies of the tumors in 4 cases and by computed tomography in 4 cases (Table 1). In one case in which EUS indicated a submucosal tumor, it was later revealed that the tumor was lung cancer invading the esophagus (Fig. 1). One hundred percent (29/29) of the resected submucosal tumors were correctly evaluated by EUS. Seven out of 8 cases (88%) with esophageal deformity due to extraluminal compression and findings suggestive of a submucosal tumor were correctly evaluated by EUS (Figs. 2, 3).

In the normal esophageal wall, five layers can be differentiated by EUS. In vitro studies of the resected esophagus have revealed that the third layer (hyperechoic) corresponds with the submucosal layer and the fourth (hypoechoic) with the muscularis propria (Fig. 4a, b) [8]. Analyzing the relationship between components of the esophageal wall and the tumor mass by EUS revealed the site of the tumor in the wall. If the tumor mass was in the third layer without invading the fourth layer, the tumor could be in the submucosal layer (Fig. 5). If the tumor continued into the fourth layer, invasion of the muscularis propria was possible (Fig. 6). The estimation of the tumor location in the esophageal wall by EUS was histologically verified in 29 submucosal tumors, which were surgically resected or removed by endoscopic polypectomy (Table 2). They were correctly evaluated by EUS in 28 cases (97%): 100% of those were in the submucosal layer and 94% in the muscularis propria.

Tumors as small as 5 mm in size could be detected regularly by EUS; the smallest tumor detected was 3 mm. The correct evaluation of the greatest dimension of esophageal submucosal tumors estimated by EUS was verified in 21 cases, in which the tumors were surgically resected or removed by endoscopic polypatomy (Fig. 7). The mean error was $0.01 + 0.22$ cm.

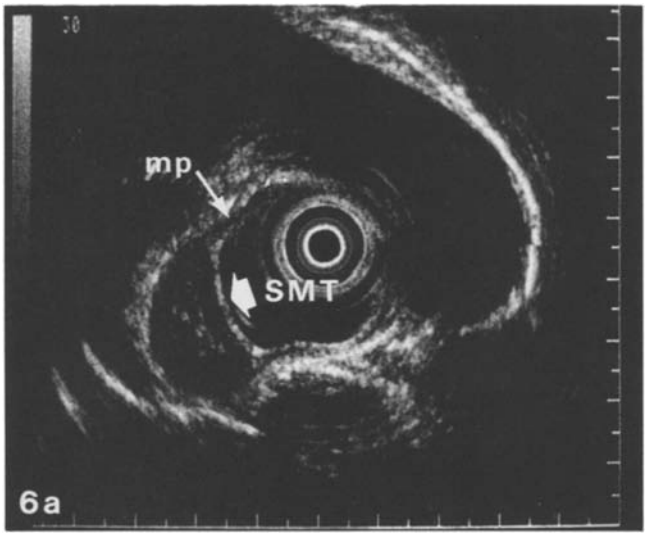
Histological studies on 29 submucosal tumors of the esophagus revealed 14 leiomyomas, 1 lipoma, 4 cysts, 1 granular cell tumor and 9 intramural metastases of esophageal cancers. Differential diagnosis of those tumors was attempted on the basis of the EUS findings on the tumor border, internal echo, and tumor invasion of specific esophageal wall layers (Table 3). Five histologically different tumors could be characterized by EUS findings.

Table 2. Accuracy of estimations of the depth of tumor invasion made according to endoscopic ultrasonography (EUS) findings (1983–September 1987). sm, Submucosal layer; mp, muscularis propria

EUS diagnosis	Histology		
	sm	mp	sm-mp
sm	10	1	
mp		17	
sm-mp			1
	10/10 (100%)	17/18 (94%)	1/1 (100%)
Overall accuracy 28/29 = 97%			

Table 3. Relationship between ultrasonic findings and histological diagnosis (1983–September 1987). Lei, Leiomyoma; Lip, lipoma; GCT, granular cell tumor; Int. met., intramural metastasis of esophageal cancer

	Histological diagnosis				
	Lei (14)	GCT (1)	Cyst (5)	Lip (1)	Int. met. (9)
Margin					
distinct	14	1	5	1	4
indistinct	0	0	0	0	5
Echo pattern					
homogeneous	13	1	5	1	1
heterogeneous	1	0	0	0	8
Echo level					
low	12	0	5	0	1
middle	2	1	0	0	8
high	0	0	0	1	0
Extending to muscularis propria	8	0	0	0	2
Strong reinforcement of posterior interfaces	0	0	5	0	0



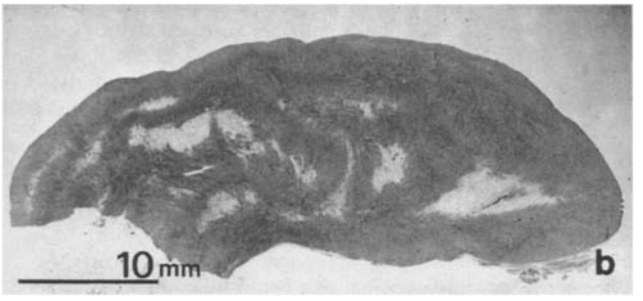


Fig. 6. **a** Leiomyoma (*SMT*) located in the muscularis propria. The tumor invaded the fourth layer (*mp*). **b** Surgically enucleated specimen

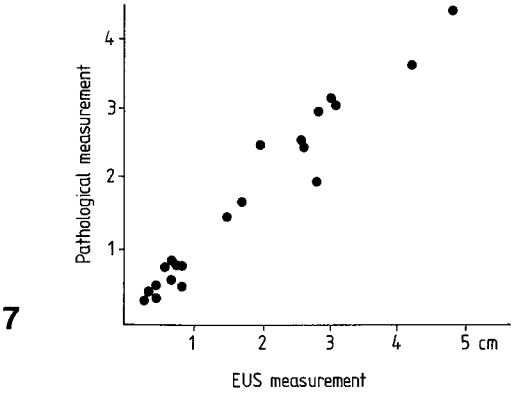


Fig. 7. Relationship between measurement of size by endoscopic ultrasonography (EUS) and by histological measurement (1983 – September 1987)

The EUS image characteristics of each tumor were as follows:

1. Leiomyoma: the echo level of the tumor was as low as that of the muscularis propria. Usually, they contained fine echoes scattered evenly with occasional strong echoes. The border of the tumor was clear and smooth (Figs. 5, 6).

2. Granular cell tumor: the echo level of the tumor was slightly higher than that of the leiomyoma. It arose in the submucosal layer or the lamina propria (Fig. 8) [2].

3. Lipoma: this tumor could be detected as a hyperechoic mass with a smooth and well-defined border in the esophageal wall (Fig. 9a–c).

4. Cyst: a cyst in the esophageal wall had a sonotransparent image with strong reinforcement of posterior interfaces. It had a smooth and well-defined border and was easy to compress by pressure from a balloon (Fig. 10). However, if cysts contained mucous material secreted by epithelium, they could have scattered internal echoes.

5. Intramural metastasis of esophageal cancer: EUS findings resembled those of leiomyoma, but they could be distinguished by a higher echo level of the tumor mass and heterogenous internal echoes. The tumor borders were irregular and ill-defined (Fig. 11).

Case reports

Case 1

A 56-year-old man was examined by EUS for a tumor in the thoracic esophagus. Two tumor components were detected by EUS. The deeper component was continuous to the muscularis propria, and the internal echoes of the tumor resembled those of leiomyoma. The shallow component had a higher echo level and irregular distribution (Fig. 12a). The biopsy specimen from the shallow component of the tumor showed squamous cell carcinoma. Preoperative studies of the tumor suggested superficial esophageal cancer concomitant with leiomyoma of the esophagus. This was confirmed by histological studies of the resected specimen (Fig. 12b).

Case 2

A 33-year-old woman had a tumor in the middle portion of the thoracic esophagus. Endoscopic ultrasonography findings showed a mass 3.2 cm × 2.3 cm in size with homogenous internal echoes and a strong reinforcement of posterior interfaces (Fig. 13). These findings suggested a cyst containing mucin, possibly a bronchogenic cyst.

Discussion

The clinical evaluation of esophageal submucosal tumors has heretofore been achieved by endoscopic [4] or roentgenographic studies [11], through analysis of their configuration, the characteristics of their borders, and an estimation of their mobility. Sometimes however, it is difficult

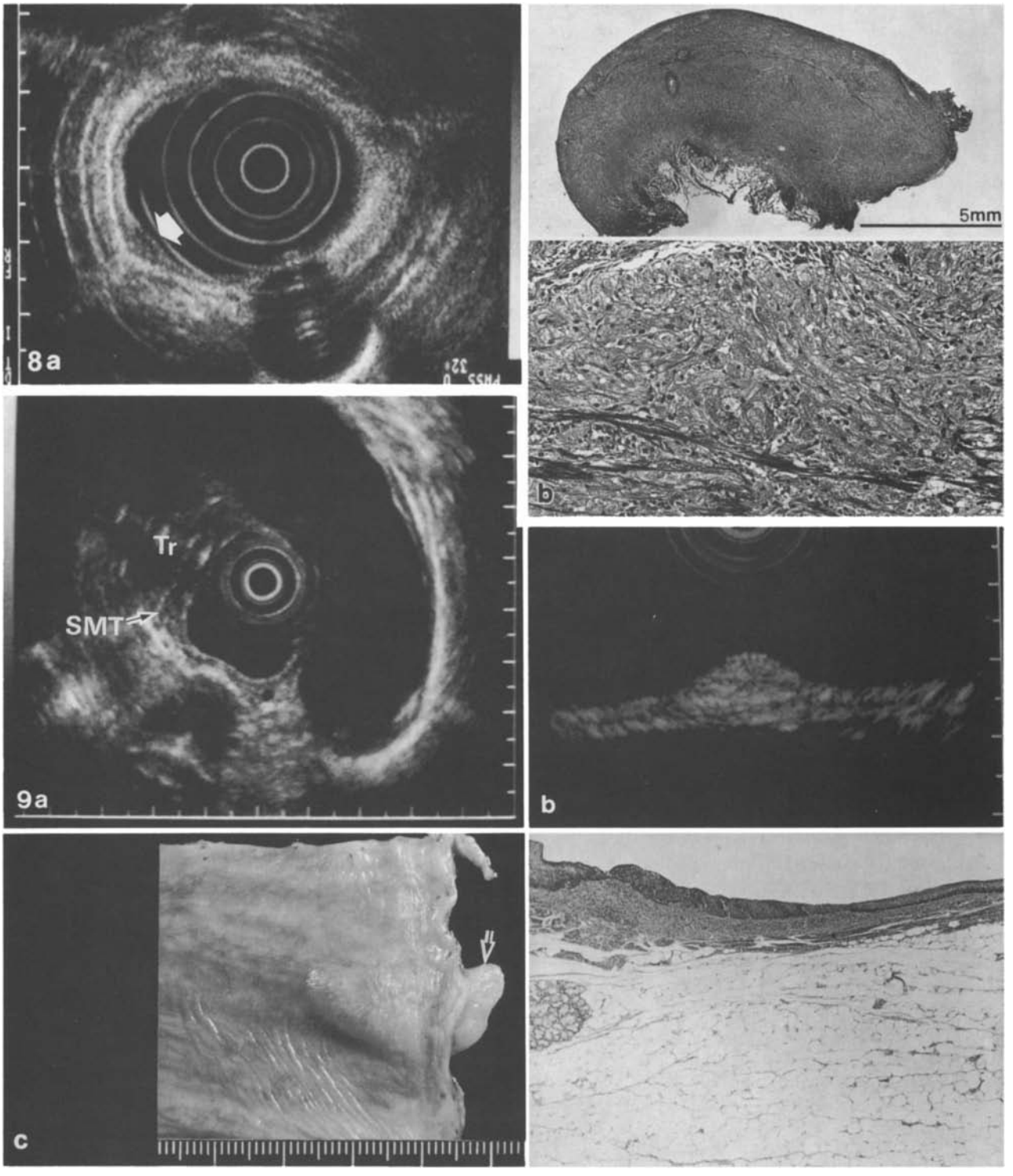
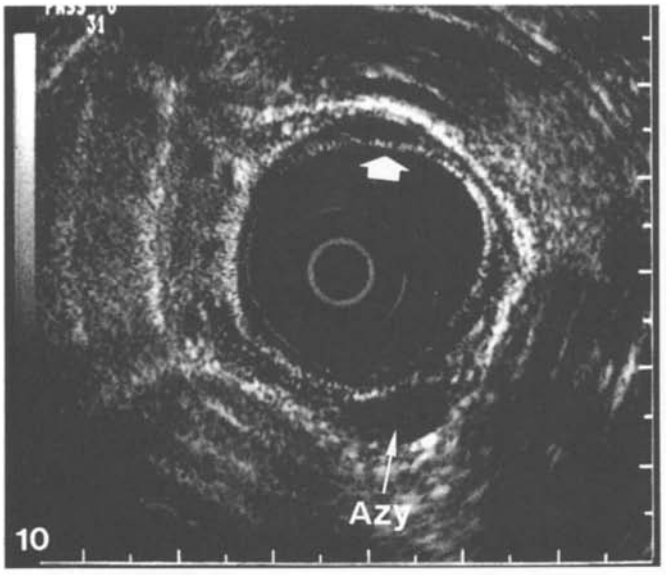
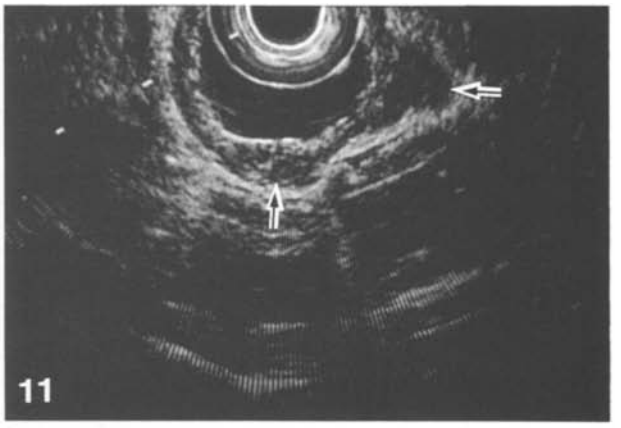
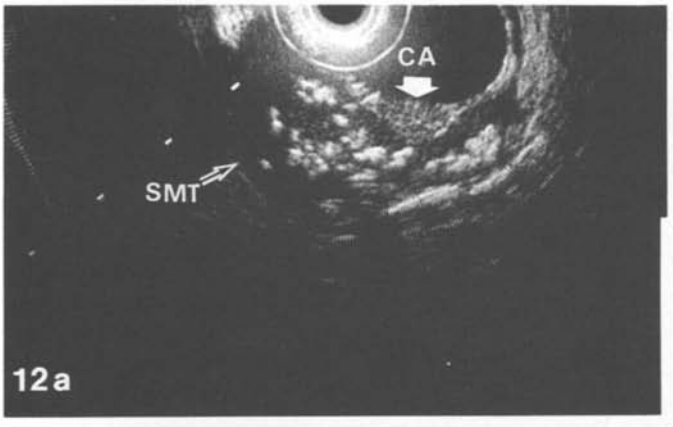


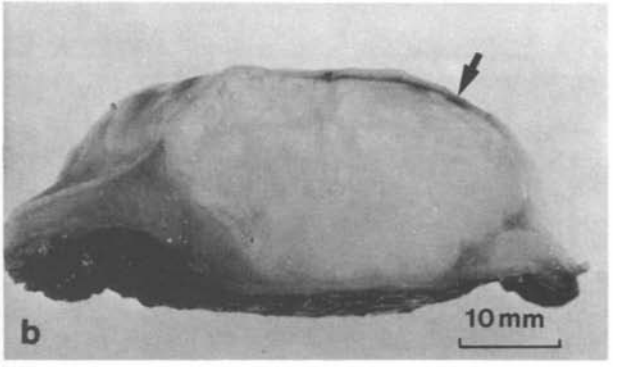
Fig. 8. a Granular cell tumor (*arrow*). It was removed by endoscopic polypectomy. **b** Histological findings

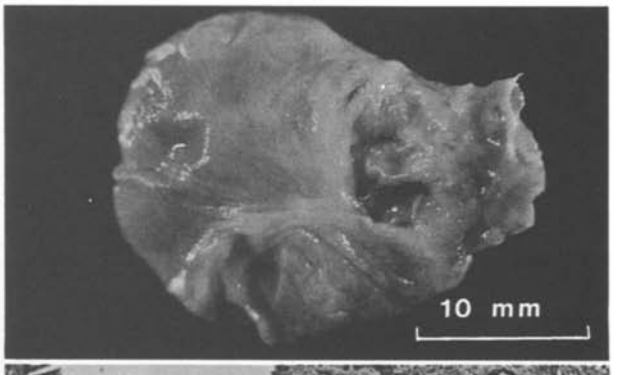
Fig. 9. a Lipoma of the esophagus (*SMT*). **b** Endoscopic ultrasonographic findings of the resected specimen in the water tub. **c** Histological findings

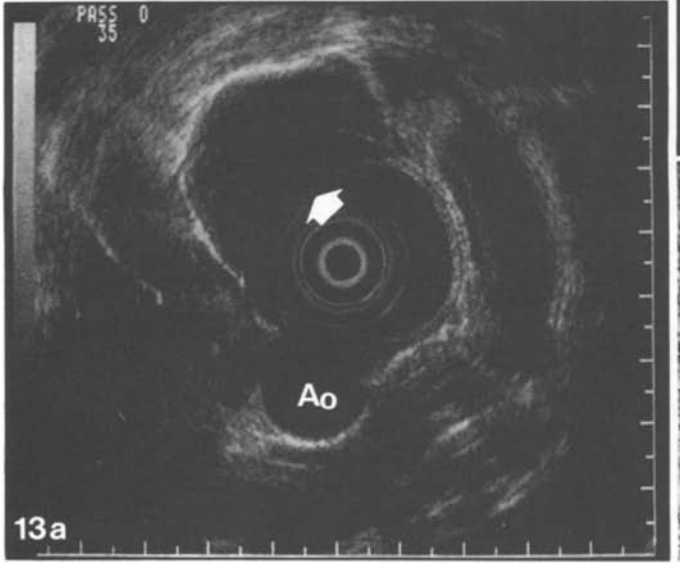












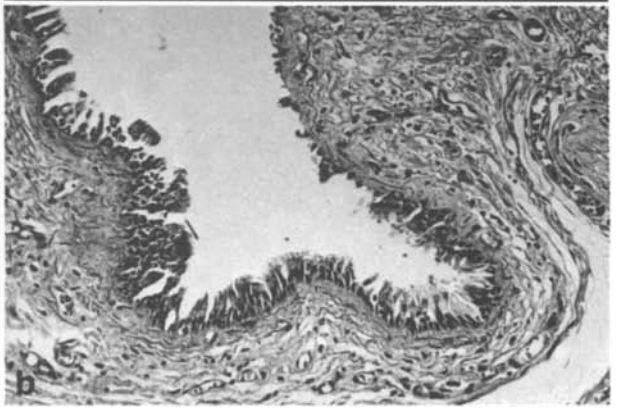


Fig. 10. Endoscopic ultrasonographic findings of a cyst (*arrow*) of the esophagus

Fig. 11. Intramural metastases of an esophageal cancer (*arrows*)

Fig. 12. **a** Esophageal submucosal cancer concomitant with leiomyoma. *SMT* Leiomyoma, *CA* cancer. **b** Resected specimen. The *arrow* indicates the esophageal cancer

Fig. 13. **a** Tracheobronchial cyst (*arrow*) in the esophagus. *Ao* Aorta. **b** *Upper part:* resected specimen, *lower part:* histological findings

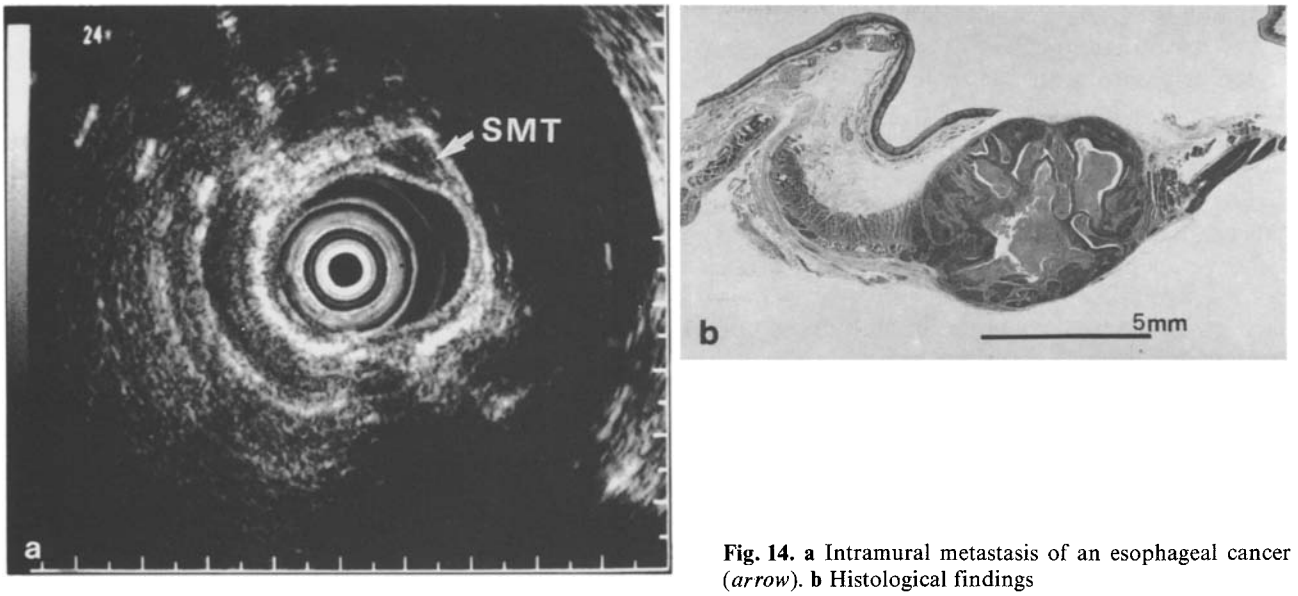


Fig. 14. **a** Intramural metastasis of an esophageal cancer (*arrow*). **b** Histological findings

to distinguish an intramural tumor from an extraesophageal compression caused by adjacent structures. There are various causes of compression of the esophageal wall or protruding lesions, which resemble esophageal submucosal tumors. These include congenital abnormalities in arteries or veins, aneurysms, mediastinal tumors, and malignant tumors of the lung that invade the esophagus. They must be correctly evaluated and differentiated. Palchick et al. [10] employed computed tomography or radionuclide angiography as noninvasive measures for the differential diagnosis of esophageal compression.

Recent advances in EUS have made detailed evaluation of submucosal tumors of the esophagus possible. Five layers in the normal esophageal wall can be demonstrated by EUS. The position of the tumor can be estimated by detecting tumor invasion of the individual layers of the esophageal wall. This method has already achieved excellent results in estimation of the depth of esophageal cancer [8].

We were able to identify tumors from 3 mm to 50 mm in diameter. These results coincided with those of Yasuda et al. [18], who visualized tumors from 5 mm to 65 mm in diameter by EUS. Tumor sizes measured by EUS were proved to be close to the real tumor sizes. Endoscopie ultrasonography therefore, provides a reliable clinical follow-up of submucosal tumors of the esophagus.

Differential diagnosis of submucosal tumors of the esophagus is still difficult, even with computed tomography or an magnetic resonance imaging [12]. Recently, ultrasonography has achieved some success in the differential diagnosis of breast cancer [16]. Certain types of submucosal tumors of the esophagus could be identified by EUS. Leiomyomas were demonstrated as tumor masses with well-defined margins, an echo level as low as that of the muscle, and fine, evenly scattered internal echoes. They frequently extend to the muscularis mucosa or the muscularis propria. Our results coincided with the report Yasuda et al. on the EUS findings of leiomyomas [8]. Occasionally a leiomyoma has strong internal echoes. We had two such cases (7%). Histological studies of the resected specimen revealed calcifications in the leiomyoma, which may have been responsible for the strong echoes. Calcifications have been found in 1.8% of leiomyoma in the esophagus [13].

Differentiation of leiomyosarcoma from leiomyoma of the esophagus is still difficult. Many histological studies have revealed two types in leiomyosarcoma of the esophagus: the tumorous type and the infiltrating type [3, 5]. The tumorous type was found in 69% of reported Japanese cases of leiomyosarcoma of the esophagus [14]. According to Misunaga [7], leiomyosarcoma could be distinguished from leiomyoma according to characteristics of the border and tumor size. Appelman and Helwig reported that most leiomyosarcomas are larger than 5 cm in diameter and have infiltrating margins [1]. However, some leiomyosarcomas are less than 2 cm in diameter [9]. In such cases, only follow-up studies demonstrating an increase in size and changes in the internal echoes indicate malignancy [6].

One case of esophageal lipoma was demonstrated as a hyperechoic mass in the submucosa by EUS. This resembled the cases reported by

Mitsunaga [7] and Yasuda et al. [18]. Esophageal cysts may be congenital or acquired. Congenital cysts originate from an esophageal gland or a tracheobronchial gland. The acquired retention cysts can develop as a result of obstruction of esophageal gland excretory ducts [17]. One esophageal retention cyst was demonstrated as an echo-free mass in the esophageal wall, but in three other presumably congenital esophageal cysts (one originating from an esophageal gland and two cases from a tracheobronchial gland), internal echoes were fine and homogenously scattered like those of leiomyoma, and in all of them strong reinforcement was recognized. Pathological studies of those three cysts showed mucin within the tumor. It was believed that mucinous material caused the fine, scattered echoes. Thus, only strong reinforcement at the bottom of the mass suggested a cyst.

We had eight cases of intramural metastasis of esophageal cancer. They were demonstrated by EUS as submucosal masses with irregular echoes. In seven of the eight cases, those EUS findings were considered to be indicative of a malignant process. One case with a small intramural metastasis of an esophageal cancer of less than 5 mm in diameter was hard to evaluate accurately by EUS alone because it had a well-defined border and no heterogenous internal echoes (Fig. 14a, b).

These results enabled suitable treatment of the esophageal submucosal tumors to be selected. A submucosal tumor of the esophagus limited to the lamina propria or the submucosa could be removed by endoscopic polypectomy, provided its largest dimension was less than 2 cm [19]. Endoscopic ultrasonography could also demonstrate large nutrient arteries, enabling us to avoid massive bleeding following polypectomy by additionally performing a hemostatic procedure before removal of the tumor [15].

In the surgical treatment of submucosal tumors of the esophagus if a tumor invades the mucosal layer, local excision or resection should be performed. If a tumor is present below the submucosal layer, enucleation could be performed according to EUS findings [13].

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References

1. Appelman HD, Helwig BE (1976) Gastricepitheliod leiomyoma and leiomyosarcoma (leiomyoblastoma). Cancer 38: 708–728
2. Bayerdorffer E, Ottenjann R (1986) Granular cell tumor in upper GI-tract endoscopy: five cases of esophageal location. Endoscopy 18: 97–100
3. Choh JH, Khazei AH, Ihm HJ (1986) Leiomyosarcoma of the esophagus: report of a case and review of the literature. J Surg Oncol 32: 223–226
4. Endo M (1983) Endoscopic examination in the esophagus. In: Kusama S, Wada T, Saigusa M (eds) Geka Mook 33. Kanehara shupan, Tokyo Ohsaka Hukuoka, pp 25–32
5. Franklin GO, Antler AS, Thelmo WL, Rosenthal WS (1982) Esophageal leiomyosarcoma. NY State J Med: 1100–1103
6. Mahendra Ranchod MB CHB, Kempson RJ (1977) Smooth muscle tumors of the gastrointestinal tract and retroperitoneum. A pathologic analysis of 100 cases. Cancer 39: 255–262
7. Misunaga A (1987) Diagnosis of submucosal tumors of the upper gastrointestinal tract by endoscopic ultrasonography. Gastroenterol Endosc 28: 3–15
8. Murata Y, Muroi M, Yoshida M, Ide H, Hanyu F (1987) Endoscopic ultrasonography in the diagnosis of esophageal carcinoma. Surg Endosc 1: 11–16
9. Nauert TC, Zornoza J, Ordonez N (1982) Gastric leiosarcomas. AJR 139: 291–297
10. Palchick BA, Alpert MA, Holmes RA, Tully RJ, Wilson RC (1983) Esophageal hemangioma. Diagnosis with computed tomography and radionuclide angiography. South Med J 76: 1582–1584
11. Plachta A, Montrose NY (1962) Benign tumor of the esophagus: review of literature and report of 99 cases. Am J Gastroenterol 38: 639–652
12. Schulthess GK, Mcmurdo K, Tscholakoff D, Geer G, Gamsu G, Higgins CB (1986) Mediastinal masses: MR image. Radiology 158: 289–296
13. Seremetis MG, Lyons WS, Deguzman VC, Peabody JW (1976) Leiomyoma of the esophagus. An analysis of 838 cases. Cancer 38: 2166–2177
14. Shimazu H, Kobori O, Danno M, Yokohata T, Sito H, Morioka Y (1983) Leiomyoma and leiomyosarcoma of the esophagus: report of 9 cases and review of the Japanese literature. J Jpn Surg Soc 84: 355–368
15. Tio TL, Tytgat GNJ (1986) Endoscopic ultrasonography of an arteriovenous malformation in a gastric polyp. Endoscopy 18: 156–158
16. Ueno E, Ito K, Saito K, Wkasugi H, Morioka Y (1981) The ultrasonic tissue characterization of breast diseases. Jpn J Med Ultrasound 8: 123–132
17. Vantrappen G, Pringot J (1974) Tumors of the esophagus, benign tumors, and cysts of the esophagus. In: Vantrappen G, Hellemans J (eds) Diseases of the esophagus. Springer, Berlin Heidelberg New York, pp 431–446
18. Yasuda K, Nakajima M, Kawai K (1986) Endoscopic ultrasonography in the diagnosis of submucosal tumor of the upper digestive tract. Scand J Gastroenterol [Suppl 123] 21: 59–67
19. Yoshida M, Hayashi T, Yoshida K, Ide H, Suzuki S, Yamada A, Endo M (1978) Endoscopic polypectomy in the benign esophageal tumors. Gastroenterol Endosc 20: 217–221