

Diagnosis of Pancreatic Diseases using Endoscopic Ultrasonography (EUS) – Emphasizing the significance of Elastography –

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For the development of EUS, it is essential to incorporate the recent remarkable advances in ultrasonography. Now that both Convex/Linear and radial type electronic scanning EUS techniques have come to be used in clinical settings, the time has come to integrate the advanced techniques of ultrasonography into EUS. The use of contrast-enhanced agents is another important point, and EUS technology should catch up with the current level of ultrasonography to make use of these agents. Reconstructed 3D images may not only make the interpretation of the diseases much easier, but also open the way to the standardization of EUS procedure. Furthermore, it has also become possible to use EUS with Elastography, which enables real-time visualization of the degree of hardness of tissue in patients with various diseases. Elastography is a new method of tissue characterization that is expected to be further developed and applied more extensively in the future. The diagnostic methods mentioned in this report may be useful in the diagnosis of pancreatic diseases.

Key Words: Electronic Scanning EUS, Tissue Harmonic Imaging, Contrast-Enhanced EUS, Three-Dimensional Images, Pancreatic Diseases, Elastography

1. Introduction

The transabdominal ultrasonography (US) is recognized as a useful tool for the diagnosis of pancreatic diseases¹⁾, it is also true that its essential weakness of “not being able to see through air” becomes a considerable handicap when observing the pancreas, which is for the most part located behind the gastrointestinal organs.

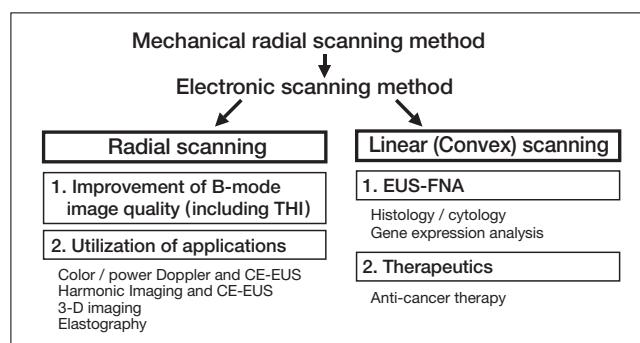
Endoscopic ultrasonography (EUS) was developed to minimize the effect of air or residue by enabling observation from inside the gastrointestinal tract. Because EUS enables observation from inside the intestinal tract, it has the advantages of attenuating the abovementioned artifacts while enabling observation by high frequency ultrasonography because the target disease can be observed from the proximal region.

EUS is a form of endoscopy but it is essentially ultrasonography. Obviously, taking into consideration the huge developments that have recently been made in ultrasonography, it would be difficult for EUS to survive as a diagnostic method with only its present advantages.

This situation has spurred the introduction of new EUS

systems. The evolution of EUS in recent years is shown in Table 1. At first, only mechanical radial scanning type EUS was available but electronic scanning Convex/Linear type EUS is now applied clinically. Color Doppler, Power Doppler and FFT analysis are applicable with this method, and it has become possible to make diagnoses of diseases that require evaluation of blood flow. Other huge clinical benefits of EUS include EUS guided fine needle aspiration (EUS-FNA) of the target disease.

Table 1 : Progress of EUS



However, the range of observation with this method was narrow and it was not necessarily easy to interpret clinical anatomy, particularly in cases of biliary/pancreatic disease. Electronic radial scanning EUS was developed in October 2000 upon request by clinicians for radial EUS which also shows the hemodynamics of diseases²⁻⁴.

The usefulness of electronic scanning EUS (electronic convex/electronic radial) for the diagnosis of pancreatic disease is described in this report.

2. Electronic Convex scanning EUS

Since 1992, we have mainly used Pentax EUS machines and HITACHI ultrasound machines to evaluate blood flow and perform EUS-FNA biopsies in patients with pancreatic diseases, and have reported their usefulness⁵⁻¹⁰.

Fig. 1 shows the system we used. It is considered that the key to collecting a sufficient amount of specimen is to avoid the same aspiration route as best as possible by using an endoscope forceps elevator at the time of actual aspiration, and to assure the aspiration needle takes different routes in the target tumor under negative pressure^{5,6}. Favorable results were achieved at our department using EUS-FNA with a rate of accurate diagnosis of pancreatic disease of 94%.

However, since we also experienced several cases of peritoneal metastasis considered attributable to EUS-FNA¹¹, EUS-FNA should be used carefully when it is applied to extramural diseases of the gastrointestinal tract.



Fig. 1 : EUS system
Pentax FG-3670UTK, entire system and head of probe

3. Electronic radial EUS

As stated above, we have had the opportunity to use electronic radial type EUS machines since October 2000 with the cooperation of Pentax and HITACHI. After initial animal experiments, clinical application was started in February 2001²⁻⁴. Fig. 2 shows the EG-3670URK electronic radial EUS. The EG-3670URK is a direct view type endoscope equipped with an electronic radial probe with a 360° angle of view at the tip.

EUS is basically used to obtain B-mode images. It is difficult to use it as a new modality for clinical applications when the image quality is inferior to that obtained with mechanical radial EUS.

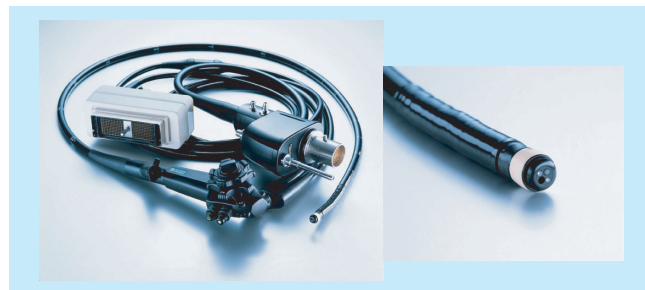


Fig. 2 : EUS system
Pentax EG-3670URK, entire system and head of probe

Fig. 3 shows a case of intraductal papillary mucinous neoplasm of the pancreas. The inner structure is more clearly shown by electronic radial EUS than with mechanical radial EUS due to fewer artifacts. Observation using Tissue Harmonic Imaging is also possible with electronic radial EUS.

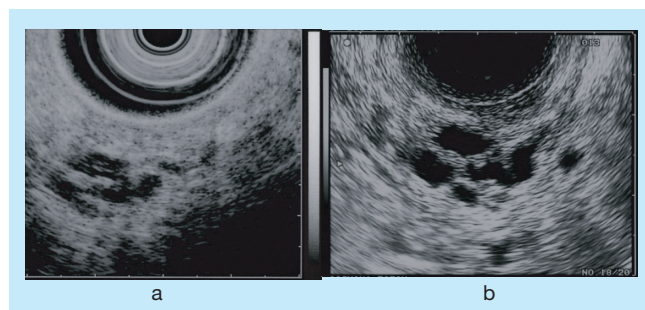


Fig. 3 : Intraductal papillary mucinous neoplasm (IPMN): branch type
a : Image obtained with mechanical radial EUS (7.5 MHz). Sufficient observation inside the neoplasm was difficult due to artifacts.
b : Image obtained with an electronic radial EUS (7.5 MHz). With attenuation of artifacts, the septum and mural nodule were clearly shown inside the neoplasm.

Fig. 4 shows another case of intraductal papillary mucinous neoplasm of the pancreas. The image is clearer compared with that obtained with electronic radial EUS using fundamental imaging³.

Tissue Harmonic Imaging may be considered a matter of course when using electronic scanning EUS and it is not fair to compare the images obtained with Tissue Harmonic Imaging with those obtained with mechanical radial EUS. Since the B-mode images of electronic scanning EUS were superior to those of mechanical radial EUS, and Tissue Harmonic Imaging with electronic scanning EUS was more superior still, the reason for the transition from mechanical radial-type EUS to electronic scanning-type EUS is obvious. As shown in Table 1, diagnostic ability

drastically improved with the possible use of various applications. This report focuses on our experiences with EUS-EG (EUS-Elastography) for various applications.

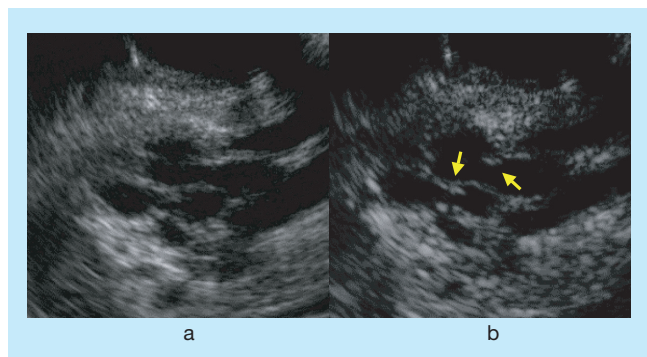


Fig. 4 : Intraductal papillary mucinous neoplasm (IPMN): branch type

a : Image obtained with electronic radial EUS. A multilocular cystic tumor was clearly shown.

b : When observation was made using Tissue Harmonic Imaging, artifacts were further attenuated and contrast resolution was improved to enable more detailed observation.

4. Elastography

The clinical usefulness of Elastography (EG), which visualizes elastic information of tissue using transabdominal ultrasonography (US) has been reported, mainly concerning the diagnosis of disorders superficial organs such as the thyroid and breast.

Elastography is a technology that visualizes the difference in distortion between hard tissue and soft tissue in real-time. With the cooperation of HITACHI and Pentax, the clinical use of EUS-Elastography (EUS-EG) became possible.

We investigated the usefulness of EUS-EG in the diagnosis of pancreatic diseases.

5. Methods

In this system, both B-mode and EUS-EG images are represented on a dual screen at the same time, so we can precisely compare both images of the same scan plane. In EUS-EG, tissue elasticity in the ROI is expressed as different colors, that is, from hard to soft tissue, it is displayed as colors ranging from blue through to red. We compared EUS-EG images with B-mode images of pancreatic diseases.

The EUB-8500 and HI VISION 900 (HITACHI) as ultrasound diagnostic machines and the EG-3630UR and EG-3670URK (Pentax) as endosonoscopes were used in this study.

6. Results

The characteristic images of EUS-EG were thought to be as follows from our preliminary results:

6.1 Solid tumors

(1) Pancreatic ductal carcinoma

Elastography images were obtained in all cases. Tumorous areas were depicted as areas of hard elasticity. The size of tumors in EG-mode images was revealed to be the same or slightly wider in range than in B-mode images, and parts of the delineation of color signals in EG-mode images were ambiguous.

(2) Chronic pancreatitis

The pancreas parenchyma was depicted as an image of various colors indicating tissue ranging from hard to soft. In one case of pseudo-tumorous pancreatitis, EUS-Elastography could distinguish benignancy from malignancy.

(3) Endocrine tumors

The delineation was blurred because the hardness was represented as the same as that of the surrounding pancreatic parenchyma.

6.2 Cystic lesion

In most cases (IPMN: intraductal papillary mucinous neoplasm, SPT: solid pseudo-papillary tumor, and so on.), there were no color signals in the cystic area, whereas septa or the surrounding area appeared as various colors. At this point, the meaning of the colors remains unknown.

6.3 Representative cases

Fig. 5 shows an EUS-EG image of normal pancreatic parenchyma. The normal pancreas in the ROI is depicted as a uniformly green color tone.

Fig. 6 demonstrates the typical EUS-EG image of pancreatic ductal carcinoma. EUS-EG shows an elevation of

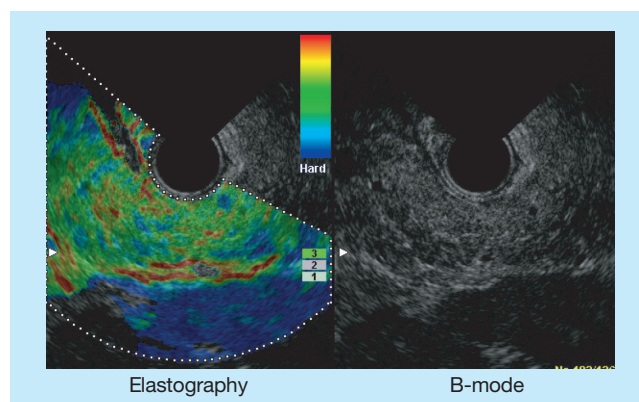


Fig. 5 : Normal pancreatic parenchyma (pancreatic body to tail.) This shows an EUS-Elastography image of normal pancreatic parenchyma. The normal pancreas in the ROI is depicted as a uniformly green color tone.

tumor elasticity in accordance with a hypoechoic area in a B-mode image. The border of the tumor was rather distinct and a soft area was depicted as an irregular area inside the tumor.

Fig. 7 is the image of a pancreatic endocrine tumor. In this case, the tumor was revealed as rather soft compared with the surrounding pancreatic parenchyma in accordance with a hypoechoic area in a B-mode image. The rea-

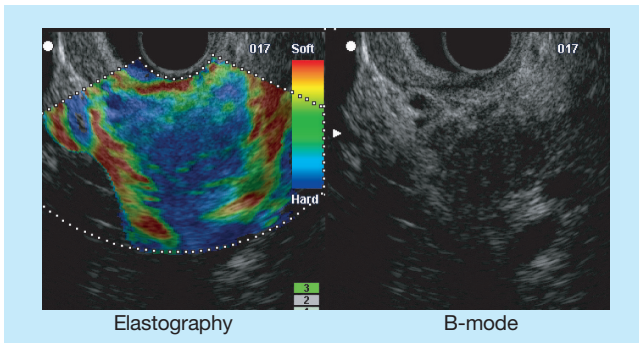


Fig. 6 : Pancreatic ductal carcinoma

EUS-Elastography showed an elevation of tumor elasticity in accordance with a hypoechoic area in a B-mode image. The border of the tumor was rather distinct and a soft area was depicted as an irregular area inside the tumor.

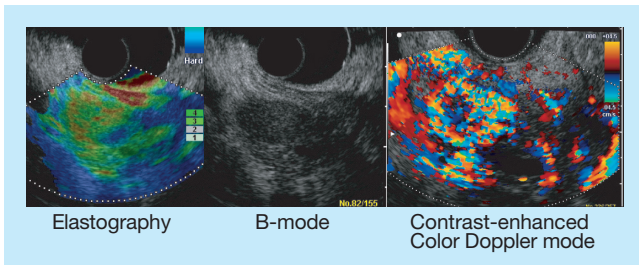


Fig. 7 : Pancreatic endocrine tumor

In this case, the tumor was revealed as rather soft compared with the surrounding pancreatic parenchyma in accordance with a hypoechoic area in a B-mode image. The reason for the softness may be explained by a vascular rich structure as indicated by numerous color signals within the tumor on enhanced Color Doppler EUS.

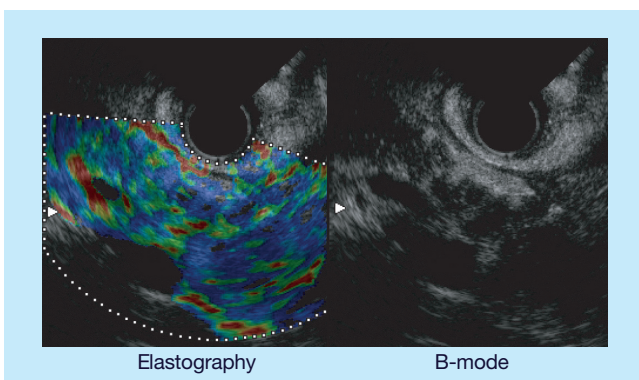


Fig. 8 : Chronic pancreatitis

The parenchyma of chronic pancreatitis was depicted as an image of various colors indicating elasticity ranging from hard to soft. It is clearly different from the color pattern of elasticity in normal pancreas.

son for the softness may be explained by a vascular rich structure as indicated by numerous color signals within the tumor on enhanced color Doppler EUS.

Fig. 8 shows a case of chronic pancreatitis. The parenchyma of chronic pancreatitis was depicted as an image of various colors indicating elasticity ranging from hard to soft. It is clearly different from the color pattern of elasticity in normal pancreas.

EUS-Elastography adds new information for the diagnosis of pancreatic diseases, and it may be a promising diagnostic modality in the near future.

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