〈Case Report〉

Two cases of colonic stricture of Crohn's disease: challenges analyzed by Shear Wave Elastography against different stricture types

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ABSTRACT Crohn's disease (CD) is an inflammatory bowel disease that occasionally presents with strictures. Intestinal strictures have two main types; benign inflammatory/fibrosis and malignant/cancer strictures. However, diagnosing CD strictures can be very difficult, because of the inability to perform endoscopy or inadequate biopsy. In these case reports, we describe the difference in shear wave speed (SWS) assessment between fibrosis and cancer using shear wave elastography (SWE). SWE examination showed differences between benign and malignant stenosis in CD patients. doi：10.11482/KMJ-E202450073 *(Accepted on October 9, 2024)*
Key words：Ultrasound, Shear Wave Elastography, Stricture, Tissue stiffness, Crohn's disease

INTRODUCTION

Crohn's disease (CD) is a transmural disease in which progressive inflammation leads to thickening of the intestinal wall and fibrous processes. Furthermore, this inflammation and healing process can lead to intestinal strictures. Structuring CD is a significant clinical issue in the development of obstruction. Intestinal strictures are histologically characterized by a mixture of inflammatory and mesenchymal cells, with the deposition of excess extracellular matrix (ECM), resulting in different degrees of fibrosis[1)]. According to population-based studies using the Montreal classification, the probability of progression to CD strictures is approximately 15% and 21.6% at 10 and 20 years of age, respectively[2-4)]. Therefore, analyzing the types of intestinal strictures, degree of stenosis, and stiffness is important to select treatments against intestinal strictures, such as anti-inflammatory drugs, endoscopic balloon dilation, and surgical resection.

Moreover, colorectal cancer (CRC) could be a very important complication of CD, sometimes leading to colonic strictures. Therefore, the surveillance of intestinal cancer in patients with CD is important. Most international guidelines recommend beginning

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surveillance with colonoscopy 8-10 years after the onset of the disease or symptoms[5, 6].

Colonic strictures are an important high-risk factor for dysplasia and CRC in patients with CD. [New Zealand Guidelines [Ministry of Health NA; 2011. pp1-54] In a retrospective study involving 293 patients with inflammatory bowel disease and colorectal strictures, dysplasia and malignancy were found in 1.4% and 0.8% of the patients, respectively[7]. In a large cohort of patients with CD, those with colonic stenosis had a higher risk of CRC over time than those without stenosis (hazard ratio (HR) 18.8, 95% confidence interval (CI) 3.45-102.7), with a probability of developing CRC 5 and 10 years after diagnosis, respectively [8]. Therefore, surveillance endoscopic biopsies of accessible strictures should be performed to obtain a histopathological diagnosis. However, strictures that cannot be passed or are inadequately biopsied, should be considered for surgery[7, 9].

Differentiating between benign and malignant strictures is a major challenge in medical imaging. Diagnosis is challenging because an endoscopic biopsy of an accessible stricture should be performed to obtain a histopathological diagnosis, however, some strictures cannot be passed. Tissue samples are usually necessary for a reliable diagnosis, of CD stricture lesions; however, they may be difficult to obtain.

Intestinal strictures are clinically evaluated using cross-sectional images, such as intestinal ultrasound (IUS), computed tomography (CT), and magnetic resonance imaging (MRI) examinations because they allow sophisticated assessment of the entire intestinal wall[10, 11]. In particular, IUS is a noninvasive, non-radiating, broadly available, and accurate diagnostic tool for evaluating disease activity and complications, monitoring disease progression, and assessing therapeutic response in patients with CD[12, 13]. Point-of-care IUS has a sensitivity of 80-90% and a specificity of 94%-98% in properly discriminating between inflammatory and noninflammatory diseases in patients with abdominal symptoms, leading to the modification of treatment strategies in > 60% of patients with CD[14, 15]. The treat-to-target strategy for inflammatory bowel diseases shifts the goal of treatment to long-term prevention of complications and proposes close monitoring of disease activity [16]. Ultrasound elastography is a promising, noninvasive technique, for assessing tissue stiffness. Elastography has two major types: shear wave elastography (SWE) and strain elastography (SE). Some reports on US elastography examination as a useful tool for evaluating bowel wall thickness, and stricture lesions in CD have been published. It is unclear whether US elastography shows a difference between benign and malignant stricture lesions in CD.

Here, we showed two types of colonic stricture lesions in patients with CD assessed using SWE.

CASE REPORTS

This study was approved by the Institutional Review Board of Kawasaki Medical School (IRB No. 3749) and conducted according to the Declaration of Helsinki. The patient provided written informed consent for publication.

IUS was performed using the US system Aplio i 900 (Cannon Medical system, Japan) with a 7 MHz linear transducer (3-11 MHz, PLI-705BX) in the most affected bowel segment, mainly ileocecal lesions in CD. All patients underwent IUS in the supine position after at least 6 h of fasting. These procedures were performed by a single gastroenterologist (J.H.) with > 35 years of experience in IUS examination. The disease site was defined as the pathological wall thickness based on a bowel wall thickness (BWT) > 3 mm for the ileum and > 4 mm for the colon and ileocecal area[13, 17].

Elasticity was quantified using SWE by measuring the scissoring speed induced by the acoustic

radiation force impulse using the same US system[18]. During the shear wave speed (SWS) measurement, SWE was performed without unnecessary transducer compression to prevent technical errors from increasing the SWS. Regarding full bowel wall elasticity in stenotic lesions, at least five regions of interest (ROI) of the stenotic bowel segment were measured. The ROIs were placed at the position of full thickness of the bowel wall without the surrounding tissues and luminal content. The SWS in each ROI was measured more than five times, and the mean value in each ROI was calculated, excluding the maximum and minimum values. Furthermore, data on inadequate ROIs were excluded. An adequate ROI was defined as follows: the rectangle surrounded by a red line indicates that the standard deviation (SD) was <10% of the mean SWS value and in the propagation map, the waveform of the measurement point was not distorted.

Case 1

Case 1 was a 51-year-old man with descending colon CD stricture. The patient had CD for 33 years and was treated with infliximab for 10 years (Table 1). Furthermore, the patient had autosomal dominant polycystic kidney disease. This year, the patient sometimes experienced abdominal pain causing colonic obstruction. Blood tumor markers were gradually evaluated; CEA was 5.5 ng/mL (reference range, 0.1-5.0 ng/mL), and CA19-9 was 76.7 U/mL (reference value, less than 37 U/mL). Abdominal CT revealed luminal narrowing of the intestinal stricture and wall thickness (Fig. 1A). Radiographic examination with a liquid contrast agent revealed deformation of the descending colon (Fig. 1B). Colonoscopy also revealed descending colonic stenosis, and the colonoscope did not pass through the stricture site (Fig. 1C). A random biopsy of the stricture was performed, and showed inflammation, but not malignant cells. SWE showed a median SWS value of 1.91 m/s (Fig. 1D,1E) (Table 1). Despite the absence of malignant cells in the biopsy, surgical resection of the stricture was performed because we could not completely rule out malignancy. Histopathological examination revealed benign stenosis due to inflammation and fibrosis (Fig. 1F, 1G, 1H). The maximum thickness of the stenosis and fibrosis was 12 and the 7 mm, respectively.

Table 1. Clinicopathological characters of 2 cases

	Case 1	Case 2
Age	51	45
gender	M	F
disease duration (yrs)	33	25
IFX period (yrs)	10	7
Harvey-Bradshaw index	4	2
stenosis		
type	fibromuscular	cancer
site	descending colon	ileo-cecal junction
luminal diameter (mm)	1.85	1.93
wall thickness (mm)	7.5	8.5
BUSS score*	5.62	6.37
shear wave elastography (m/s)	1.91	5.33
SES-CD**	13	12

*Bowel ultrasound score (BUSS); Allocca M, *et al.* Clin Gastroenterol Hepatol 2021
**Simple Endoscopic Score Crohn's disease (SES-CD)

Case 2

Case 2 was a 45-year-old woman with an ileocecal CD stricture. The patient had 25 years of CD, and was treated with infliximab for 7 years (Table 1). However, the patient experienced abdominal pain in the previous year due to intestinal obstruction. Endoscopic assessment of disease activity revealed no disease control, and the patient developed CD-associated chronic inflammation in the cecum, including the appendix. Abdominal CT revealed luminal narrowing of the intestinal stricture and wall thickness (Fig. 2A). Radiographic examination revealed deformation of the ileocecal area (Fig. 2B). During colonoscopy, the colonoscope did not pass through the ileocecal stricture (Fig 2C). A random biopsy of the stricture was performed, and the

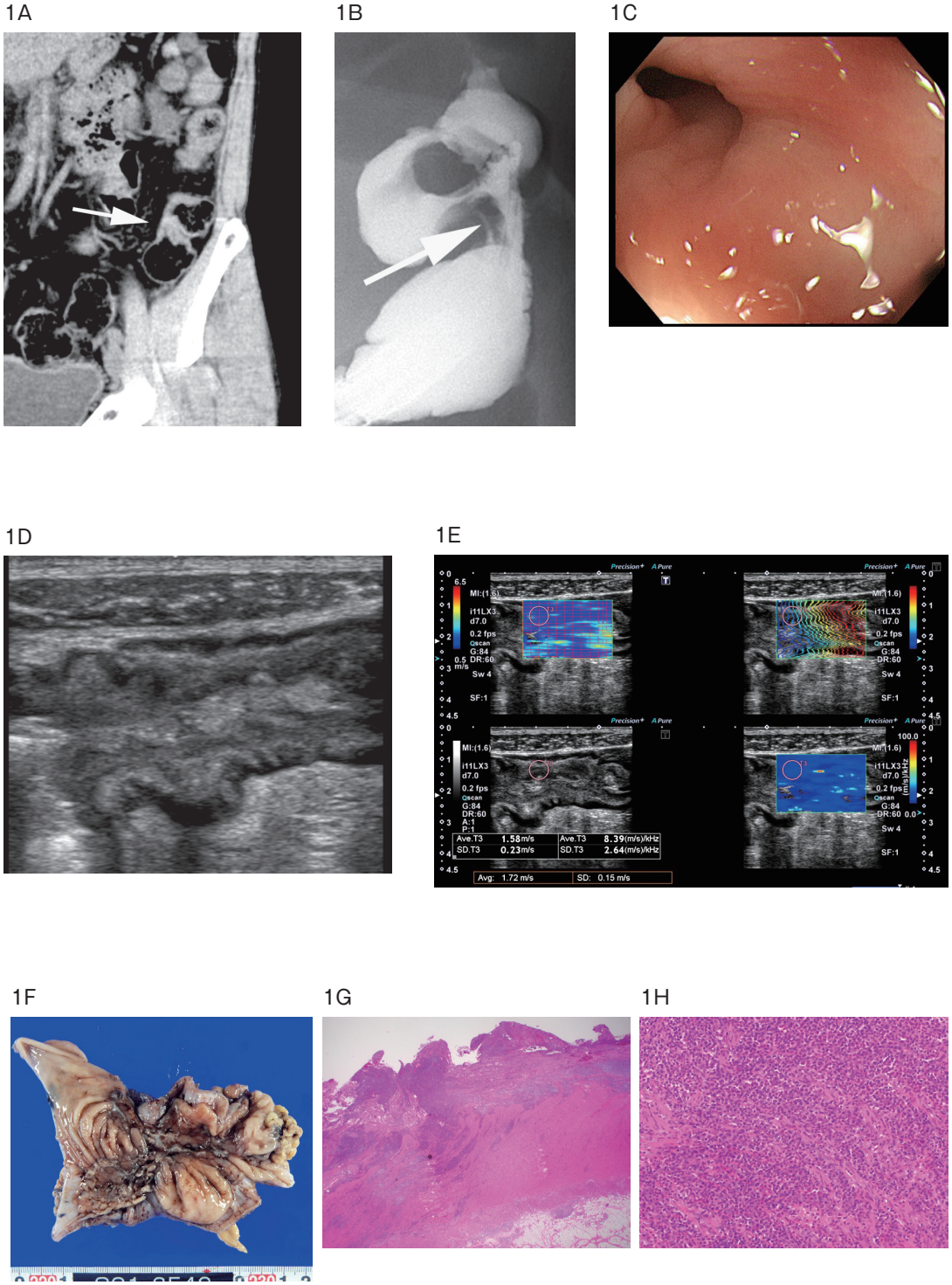

Fig. 1 . Case 1 (A) CT (B) X-ray (C) Colonoscopy (D) US (E) SWE (F-H) Histological exam
(A)CT. (B) X-ray showing the stenosis and deformation of the descending colon. (C) The colonoscopy (PCF PQ260, dimer 10.8 mm, Olympus, JAPAN) could not pass through the stricture. (D) US showing bowel wall thickness. (E) Ultrasound SWE showed a median SWS, of 1.91 (m/s). (F) Resected specimen (G) Low magnification of the section (H) High magnification.

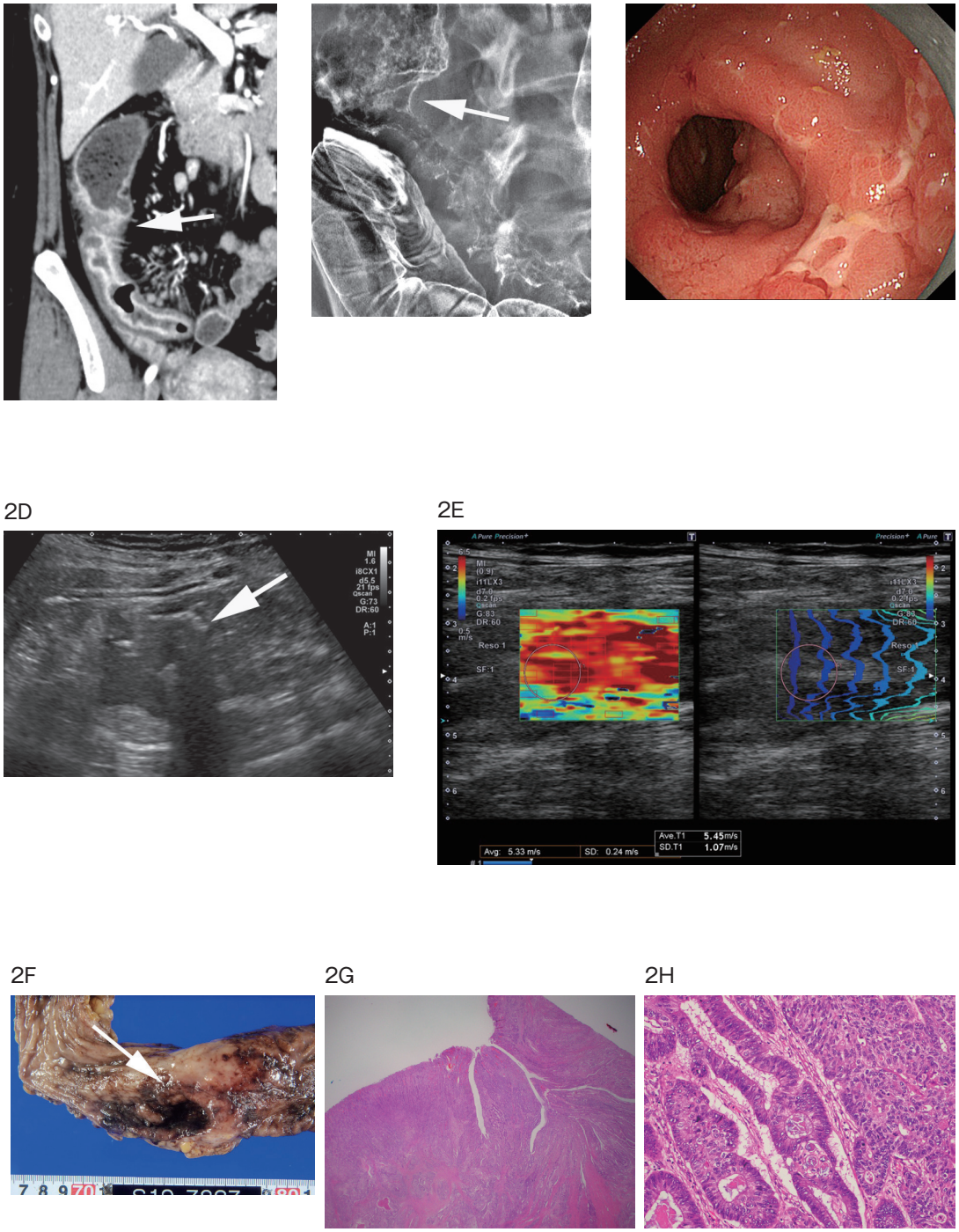

Fig. 2. Case 2 (A) CT (B) X-ray (C) Colonoscopy (D) US (E) SWE (F-H) Histological exam
(A)CT. (B) X-ray showing the stenosis and deformation of descending colon. (C) The colonoscopy (PCF PQ260, dimer 10.8 mm, Olympus, JAPAN) could not pass through the stricture. (D) US showing bowel wall thickness. (E) Ultrasound SWE showing a median SWS, 1.91 (m/s). (F) Resected specimen (G) Low magnification of section (H) High magnification.

histopathological examination revealed malignant cells. SWE showed a median SWS value of 5.33 m/s (Fig. 2D, 2E) (Table 1). Surgical resection of the stricture was performed. Histopathological analysis revealed malignant stenosis due to appendiceal cancer (T3, tubular adenocarcinoma, and poorly differentiated adenocarcinoma) associated with CD (Fig. 2F, 2G, 2H). The thickness of the tumor area was 35 mm, and the maximum diameter of the tumor was 25 mm. Fibrosis and an inflammatory cell infiltrate consisting primarily of neutrophils were observed around the tumor.

DISCUSSION

To the best of our knowledge, this is the first case report in which SWE showed different SWS values on two colonic stricture lesions in patients with CD. We showed two cases of different types of stricture lesions; the benign stricture showed low SWS, whereas the malignant stricture showed high SWS.

Bowel US has been recognized as a useful tool for detecting stenosis in patients with CD. More recently, US elastography has been proposed as a promising tool for evaluating fibrosis and inflammation in the bowel walls of CD strictures[19–21]. In the SWE method, an initial US push pulse that induces a shear wave perpendicular to the US beam is applied to the tissue. SWE measures the scissoring speed of a shear wave induced by an acoustic radiation force impulse, whereas SE assessment is a derivative of the comparison between targeted and surrounding tissues after external pressure induced by an operator and is presented as a color-coded elastogram. The interpretation of SE is more subjective because of the diagnostic method itself, and the advantage of SWE is that the measurements are objective and do not depend on the surrounding tissues. Thus, SWE is more reliable and reproducible than SE. Furthermore, SWE has been useful for differentiating benign and malignant lesions in the breast, prostate, and thyroid[22–27]. Harvre *et al* attempted to discriminate CD-related strictures from malignant and benign tumors using SE[28]. No significant differences were observed in any of the SE parameters between these lesions, although both CD strictures and tumors displayed a higher density than the surrounding tissues. Information on the gastrointestinal area is limited and malignant tumors associated with CD have been reported.

Some reports have shown that US elastography is useful for analyzing bowel wall thickness and strictures in patients with CD[21]. Ding *et al*. evaluated the diagnostic performance of SE and SWE for intestinal stenosis in CD indicating that SWE performs better for evaluating and differentiating intestinal stenosis in CD[29]. They reported that an SWS value of 2.7 m/s SWS is the cutoff value for differentiating between inflammatory and fibro stenotic strictures. In Case 1 of this report, the SWS was lower than the cutoff value. In contrast, in Case 2, the SWS was higher than the cutoff value. In these cases, we showed that SWE showed completely different SWS values for different stricture types. The reason why this SWS difference exists was not clarified; however, it could be speculated. At first, the maximum diameter of the tumor in Case 2 was 25 mm, which was larger than the fibrosis of 7 mm in Case 1, and the possibility that this affected the SWS cannot be denied.

Second, malignant stenosis might lead to high SWS values. It has been reported that tumors increase in hardness as they progress[30]. Thus, we surmised that a stiffer and larger lesion may have altered the SWS. The stiffness difference between benign and malignant lesions in the intestine, particularly between CD epithelial and cancer cells, and the effect of lesion size remain unknown. In the future, we must collect more cases and evaluate them.

In conclusion, we experienced two patients with CD with different types of stenotic lesions; we

found differences in SWS values between benign and malignant stenosis. Because SWS reflects tissue stiffness and it may be used to differentiate between benign and malignant stenotic lesions.

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