Case Report

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Ultrasonographic evaluation of changes over time in one defecation cycle in adults with functional constipation: A report of two cases

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Summary **We described fecal retention during the defecation cycles of adults with functional constipation *via* ultrasonography (US) of the large intestine. US was performed continuously after the last defecation until the next defecation. We defined the fecal finding level on US as follows: weak fecal retention, a marginally high echo in the colonic lumen; or strong fecal retention, a strongly echoic colon lumen with showing a crescent-shaped acoustic shadow on transverse images and haustrations on longitudinal images. The findings confirmed weak fecal retention in the colon throughout the defecation cycle and a pattern of strong fecal retention in the descending and sigmoid colon and over the colon, including the transverse colon and ascending colon, in patients with functional constipation.**

Keywords: Ultrasonography, functional constipation, slow transit, fecal retention, adults

1. Introduction

Ultrasonography (US) can be used to observe the position of fecal storage and the state of the feces, and is therefore considered useful for the evaluation of constipation. Previously, objective constipation evaluations have confirmed the time of colon transit as a measure of defecation function (*1,2*). However, although these evaluations demonstrated the areas of fecal stagnation, they could not provide real-time information about where and what type of feces were stored in the colon. Therefore, we demonstrated through a comparison with computed tomography findings that fecal properties, such as the existence of haustration and crescent-shaped, highly echoic area with acoustic shadows, could be evaluated on US images (*3*). In addition, we demonstrated that US could be used to assess fecal retention patterns that did and did not involve the rectum in patients with chronic constipation (*4*). Functional constipation types can be classified as normal transit, slow transit, and anorectal dysfunction (AD) (*5-7*), and we demonstrated the ability to evaluate the latter type by confirming fecal retention in the rectum using US.

However, the previous study was a cross-sectional investigation, and no study has investigated changes in the fecal retention state over time in the large intestine up to the point of fecal discharge. To clarify the characteristics of colonic fecal retention patterns in elderly patients with constipation, it is first necessary to investigate the colonic fecal retention patterns in adult patients with constipation. In this case report, we observed the fecal retention status and subjectively

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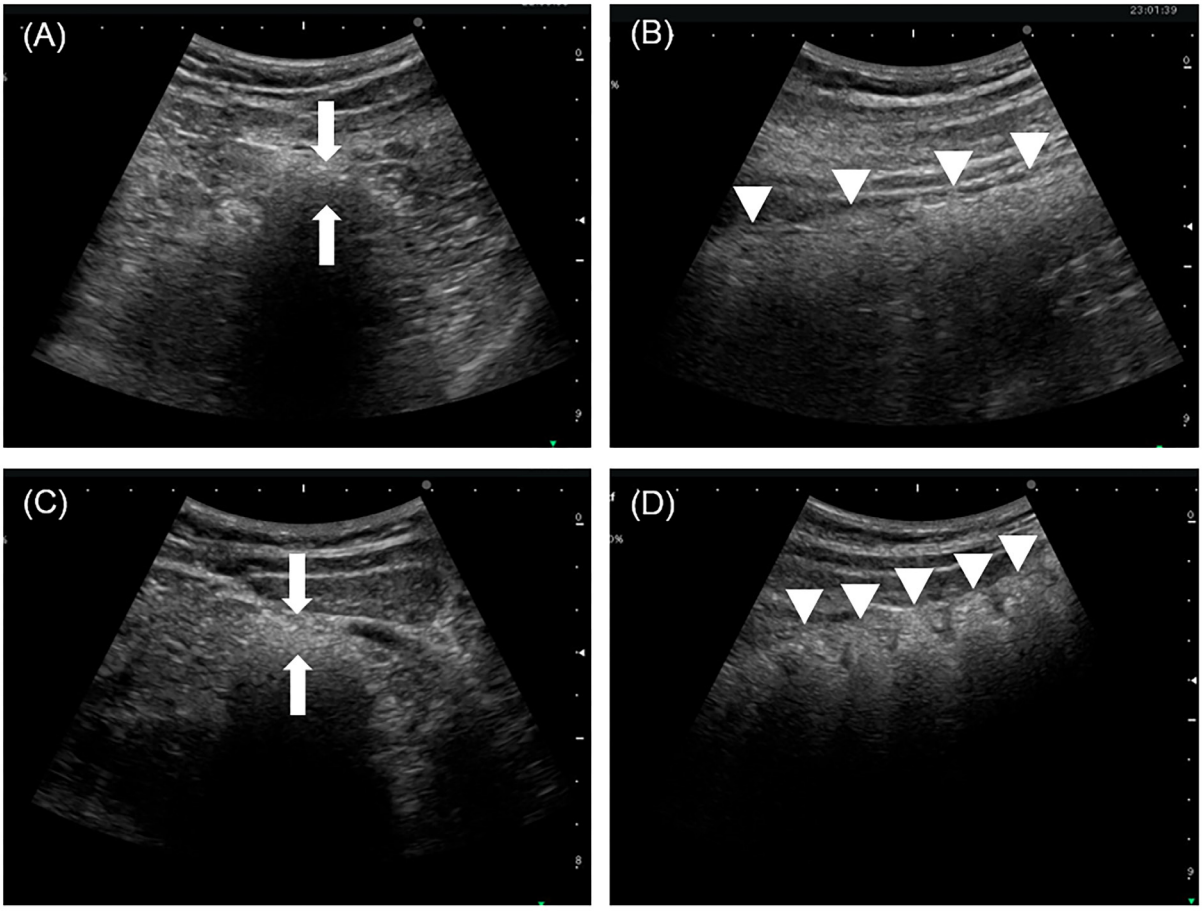

Figure 1. Standards for ultrasonographic imaging evaluations. (A, B) Ultrasonography (US) images of weak fecal retention in a 32-year-old male patient. **(A)** A transverse US image showing a marginally highly echoic colonic lumen (arrows) and posterior echo behind the descending colon. **(B)** A longitudinal US image showing a flattened outer boundary wall and highly echoic descending colon wall (arrowheads). **(C, D)** US images of strong fecal retention in a 25-year-old male patient. **(C)** A transverse US image showing a strongly echoic colonic lumen (arrows) and a strong acoustic shadow behind the descending colon (arrowheads). **(D)** A longitudinal US image showing a crescent-shaped acoustic shadow with haustrations and strong echoes on the descending colon wall (arrowheads).

evaluated one defecation cycle using US with a longitudinal view in adult patients with functional constipation, and compared the findings with those from a case of non-constipation.

2. Case Report

2.1. *Ultrasound technique*

All subjects were adults without disease during treatment and without morphological abnormalities of the large intestine. US of the ascending, transverse, descending and sigmoid colon and rectum was performed continuously from after the most recent defecation until after the subsequent defecation in our laboratory, using an US system (FUJIFILM FC1-X, FUJIFILM SonoSite, Bothell, WA, USA) with a curved-array probe (2-5 MHz). The resulting images were supplemented by transverse and longitudinal sonographic scans. According to a previous study (*3*), we defined the US levels of fecal finding as follows: a weak fecal retention finding was indicated by a marginally highly echoic colonic lumen and posterior echo behind the colon on transverse images, and a flattened outer boundary wall and highly echoic colon wall on longitudinal images; a strong fecal retention finding was indicated by a strongly echoic colonic lumen and strong acoustic shadow behind the colon on transverse image, and a crescent-shaped acoustic shadow with haustrations and a strongly echoic colon wall on longitudinal images (Figure 1). US was performed by a trained researcher. Static images were interpreted by a certified sonographer with 30 years of experience.

The Rome IV criteria were used to determine the presence or absence of functional constipation (*3*). Two items were selected from the Constipation Assessment Scales and used to evaluate subjective discomfort due to constipation (*8*). Fecal properties were evaluated using the Bristol stool form scale (*9,10*), and fecal amounts were evaluated using King's stool chart (*11-13*). This study was approved by the Ethical Committee of the Graduate School of Medicine, The University of Tokyo, Japan (No. 11521).

Table 1. Ultrasonographic findings and subjective evaluation during observation period

	Evaluation	Site/item	Immidiately after last defecation	After 8 hours	After 16 hours	After 24 hours	After defecation
Non-constipation	Ultrasonographic evaluation	Ascending colon	+	+	+	+	+
		Transverse colon	–	+	+	+	+
		Descending colon	–	+	+	+	–
		Sigmoid colon	–	–	+	++	+
		Rectum	–	–	–	–	–
	Subjective evaluation	Abdominal distention or bloating	0	0	1	1	0
		Sensation of rectal pressure or fullness	0	0	0	0	0
				After 1 day	After 2 days	After 3 days	After defecation
Case1	Ultrasonographic evaluation	Ascending colon		–	+	++	+
		Transverse colon		++	++	++	++
		Descending colon		++	++	++	+
		Sigmoid colon		++	++	++	++
		Rectum		–	–	–	–
	Subjective evaluation	Abdominal distention or bloating		1	1	1	0
		Sensation of rectal pressure or fullness		0	0	0	0
Case2	Ultrasonographic evaluation	Ascending colon		+	+	+	+
		Transverse colon		+	+	+	+
		Descending colon		+	++	++	++
		Sigmoid colon		+	++	++	++
		Rectum		–	–	–	–
	Subjective evaluation	Abdominal distention or bloating		0	0	1	0
		Sensation of rectal pressure or fullness		0	0	0	0

After 1 day indicates the day after the last defecation day. +: Weak fecal loading (+), ++: Strong fecal loading (++), –: No fecal loading findings. Number: the score of subjective evaluation: 0, none; 1, some; 2, severe.

2.2. *Non-constipation*

A 32-year-old healthy man with a history of daily defecation was followed up. US follow-up was performed for 8 hours from the last defecation until the next defecation during a 2-day period. The US findings and subjective evaluations during the observation period are shown in Table 1. Weak fecal retention was observed only in the ascending colon at baseline, whereas strong fecal retention was also confirmed in the distal intestine over time. Findings indicative of strong fecal retention were observed in the sigmoid colon after 24 hours (Figure 2). The strong fecal retention in the sigmoid colon and 'abdominal distention or bloating' were resolved after defecation. The defecated stools were assigned a 4-point score (normal stool) on the Bristol stool form scale and a F-type score (> 200 g) on King's stool chart.

2.3. *Functional constipation*

2.3.1. *Case 1*

A 25-year-old man with a defecation cycle of 3-4 days was followed up. His diet comprised regular meals. US follow-up was performed for approximately 24 hours from the last defecation until the next defecation over a 4-day period. The US findings and subjective evaluations during the observation period are shown in Table 1. Fecal retention was almost always observed in the colon, excepting the rectum. After 3 days, fecal retention was found in the ascending colon, as well as the transverse, descending and sigmoid colon. Strong fecal retention finding was observed in the transverse and sigmoid colon throughout the observation period. As shown in Figure 2, findings of strong fecal retention finding were observed in the transverse and sigmoid colon, despite defecation. The patient received a score of 1 point for 'abdominal distention or bloating' after 1-3 days, which decreased to 0 points after defecation. During the observation period, the 'sensation of rectal pressure or fullness' was 0-point. The defecated stools were classified as 2 points (hard stool) on the Bristol stool form scale and as B-type (100-200 g) on King's stool chart.

2.3.2. *Case 2*

A 28-year-old female with a defecation cycle of 3-4 days was followed up. Her diet comprised regular meals. The US follow-up was performed for approximately 24 hours from the last defecation to the

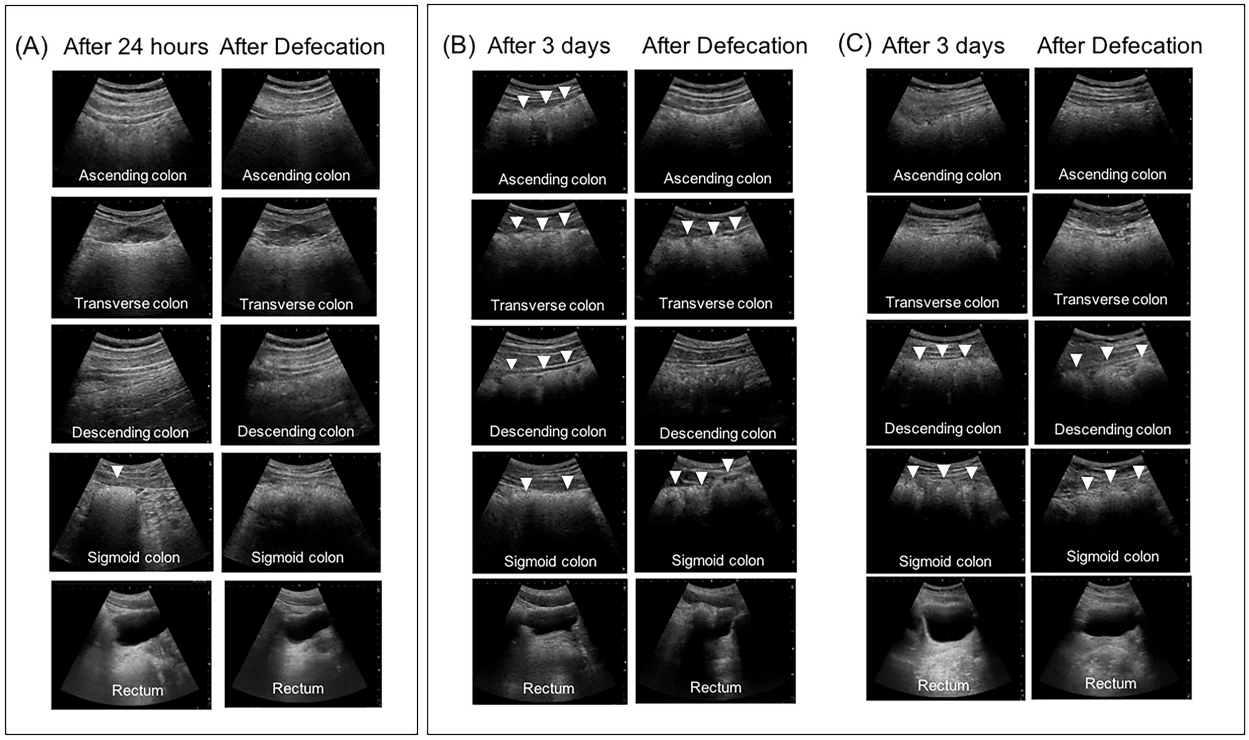

Figure 2. Fecal retention observed by ultrasonography in cases of non-constipation and functional constipation. (A) A post-defecation longitudinal ultrasonography (US) image of a 28-year-old female subject with no constipation after 24 hours. **(B)** A post-defecation longitudinal US image of a 25-year-old male patient with functional constipation after 3 days. **(C)** A post-defecation longitudinal US image of a 28-year-old female patient with functional constipation after 3 days. Arrowheads indicate fecal retention, as depicted by a crescent-shaped acoustic shadow with haustrations and strong echoes on the longitudinal US image.

next defecation over a 4-day period. The US findings and subjective evaluations during the observation period are shown in Table 1. Fecal retention was always observed in the colon, except for the rectum, although findings of strong fecal retention were only observed in the descending and sigmoid colon throughout the observation period. In addition, as shown in Figure 2, these findings of strong fecal retention in the descending and sigmoid colon persisted despite defecation. The score of 'abdominal distention or bloating' was only 1 point after 3 days, but decreased to 0 points after defecation. During the observation period, the 'sensation of rectal pressure or fullness' score remained at 0 points. The defecated stools were classified as 2 points (hard stool) on the Bristol stool form scale, and as A-type (< 100 g) on King's stool chart.

3. Discussion

In this study, we observed the fecal retention status on longitudinal US images and subjective evaluations during one bowel movement cycle in adult patients with functional constipation; additionally, we compared these findings with those from a non-constipated subject for the first time. This study targeted adults with a perception of normal bowel movements, which may explain the lack of fecal retention in the rectum. Therefore, the two cases of functional constipation in this study appear to meet the criteria of the slow transit type.

Our evaluation of functional constipation revealed that feces are always stored in the colon (excluding the rectum) throughout the defecation cycle. By contrast, the subject without constipation did not exhibit fecal storage in the colon after defecation, and the feces had gradually moved to the distal colon. We note that the post-defecation US findings from the non-constipation case may not have coincided with the findings observed after the previous defecation because of variations in the time of US examination. As defecation occurred 24 hours after the last defecation, we considered that fecal retention findings were observed in the transverse and sigmoid colon after defecation because stool moved distally from the proximal colon.

This study demonstrates the ability of US to evaluate two types of slow transit in patients with functional constipation. Previous studies based on colon scintigraphy have reported that slow transit type is characterised by a pattern exhibiting a transport delay throughout the colon, as well as a pattern of transport delay in the descending and sigmoid colon (*2*). In our study, the evaluation of fecal retention findings at two levels also revealed two slow transit patterns associated with functional constipation; the first exhibited persistent strong fecal retention, especially in the descending and sigmoid colon, whereas the second exhibited persistent strong fecal retention in

descending and sigmoid colon, as well as the ascending and transverse colon. The results of US were consistent with those of colon scintigraphy. Our findings indicate that US is more useful than previous bowel function tests for the non-invasive evaluation of constipation (*1,2*), as this tool can evaluate not only the site of fecal retention, but also the properties of feces.

In conclusion, adults with functional constipation always exhibit fecal accumulation in the colon (excluding the rectum) throughout the defecation cycle. Moreover, US could be used to confirm a pattern of fecal retention findings characterised by strong echoes and acoustic shadows in the descending and sigmoid colon, as well as a pattern of echogenic findings throughout the colon (including the transverse and ascending colon) in adults with functional constipation.

Conflict of interest

This was a joint research program with FUJIFILM Corporation, and the study was conducted under the sponsorship of this organization. Masaru Matsumoto, Koichi Yabunaka, and Mikako Yoshida belong to a social collaboration department which receives funding from FUJIFILM Corporation.

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