

Can irritable bowel syndrome be detected by ultrasound?

Yohei Okawa*

Department of Nursing, Kochi University School of Medicine, Japan.

SUMMARY Functional gastrointestinal disease is one in which gastrointestinal symptoms persist chronically or recurrently. This disease is challenging because it does not have an organic cause that can be detected in routine laboratory tests. Among them, the symptoms of irritable bowel syndrome (IBS), which is a type of functional gastrointestinal tract disease, include abnormal bowel movements associated with abdominal pain. However, no specific test has been established to definitively diagnose these diseases, including IBS. The traditional Rome IV diagnostic criteria are used to diagnose IBS by assessing subjective symptoms. However, it has been suggested that IBS is difficult to diagnose using the Rome IV criteria among unconscious or cognitively impaired patients. It is recommended that abdominal ultrasonography be used to assess IBS with diarrhea and constipation. Previously, constipation among elderly people who ingested food orally was objectively assessed by ultrasound, and colonic fecal distribution patterns were classified in constipated patients and healthy people. Objective visualization of the large intestine was used to assess constipation. Therefore, fecal retention among adults and elderly individuals was reported using ultrasonography. It was suggested that stool retention could be confirmed by observing the hyperechoic region of the rectum. Strong hyperechoic regions with acoustic shadows in the rectum indicate the presence of hard stools, thus enabling medical workers to identify constipation. In the future, ultrasonography may be useful for diagnosing IBS in unconscious patients or those with cognitive decline.

Keywords functional gastrointestinal disease, gastrointestinal symptoms, constipation

1. Introduction

Functional gastrointestinal disease is a disease in which gastrointestinal symptoms persist chronically or recurrently. There are no organic lesions on clinical examination, and the symptoms are due to functional abnormalities (1). Types of functional gastrointestinal disorders include irritable bowel syndrome (IBS), functional abdominal distension, functional constipation, functional diarrhea, and unspecified functional bowel disease (1-3). Symptoms of IBS, which is a typical functional gastrointestinal disorder, include abdominal pain, abdominal discomfort, and associated bowel abnormalities (3). However, objective examination that can make a definitive diagnosis has not been established for these disease groups, including IBS. Therefore, we suggest that a novel, objective method for diagnosing IBS should be developed based on various views of articles.

2. Diagnosis of IBS

Recently, Rome IV diagnostic criteria have been used

as diagnostic criteria for IBS by assessing subjective symptoms (1-4). The Rome IV diagnostic criteria can distinguish functional bowel disease with chronic symptoms from transient gastrointestinal symptoms. The criteria include abdominal pain and defecation disorders occurring more than 6 months before diagnosis and for more than 3 days in the last 3 months (3,4). Defecation disorder subtypes can be classified into IBS with diarrhea (IBS-D) and IBS with constipation (IBS-C); these subtypes are considered useful in clinical practice. Stool shapes range from watery to hard stools, and it has been suggested that transit time through the gastrointestinal tract is reflected by stool shape (5,6). On the other hand, it has also been reported that the defecation frequency and transit time of IBS patients are often the same as those of healthy subjects (7,8). This classification method includes that in addition to diarrhea type and constipation type, there are patients who are judged as having mixed IBS (IBS-M) with both characteristics and those with unsubtyped IBS (IBS-U), which does not include all criteria (2-4). However, this diagnosis is limited to those patients who have a clear awareness. Rome IV criteria are evaluated based on

the patient's subjective symptoms, which are based on abdominal pain (4). This fact suggests that it is difficult to use the Rome IV criteria to diagnose IBS in patients that are unconscious or have cognitive decline.

A previous study suggested that it is difficult to completely exclude organic diseases by diagnosing symptoms using only the Rome criteria (9). On the other hand, the study also suggested that the Rome criteria can be used to exclude unnecessary examinations and that other diseases can be significantly narrowed down (9). However, many physicians do not remember the diagnostic criteria for IBS; it has been reported that physicians use diagnostic criteria in only 4% of clinical practice. In addition, there is not enough evidence that the Rome criteria can be used to diagnose unconscious patients or those with cognitive decline because the Rome criteria evaluate only subjective symptoms. Additionally, many epidemiological studies have indicated that the Rome IV criteria are not sufficient. However, several epidemiological studies have used the Rome II criteria, which are effective for diagnosing IBS. Additionally, the Rome III criteria were developed in statistical studies of epidemiological data based on the Rome II criteria. Furthermore, a number of studies have suggested that the home environment, psychosocial factors, gastrointestinal motility abnormalities, visceral hypersensitivity, intestinal bacteria, and brain-intestinal correlations have been thoroughly examined (4,10). However, the Rome criteria are based only on the patient's subjective symptoms, such as abdominal pain or defecation. Therefore, there is not enough evidence that the Rome criteria can be used to diagnose unconscious patients or those with cognitive decline.

3. Subjective symptoms can be evaluated by questionnaires

The diagnosis of IBS is made by Rome IV diagnostic criteria (4) and other questionnaires. However, there are various factors related to the onset of IBS, so several questionnaires are used to evaluate the relationship between daily living conditions, quality of life (QOL), psychological conditions and abdominal symptoms (11-14). The evaluation of QOL using the SF-36 is clinically useful because it can be compared with that of patients with other diseases. In addition, the IBS-QOL, which is an IBS-specific QOL survey, is effective in assessing the effects of treatment (15). SCL-90-R, HDRS (16), EPQ, and DSSI (11) are also available. The symptoms of IBS patients can be evaluated by using a combination of these questionnaires. In particular, these questionnaires might reveal mental problems, such as anxiety and depression.

4. Effects of colonoscopy and colonography as objective methods of evaluation

The diagnosis of IBS is based on the Rome IV

diagnostic criteria (2,4) and other questionnaires (17,18). However, it is difficult to subjectively evaluate patients who are unconscious or have reduced cognitive function. Therefore, it is important to use objective evaluation methods. There are few epidemiological studies on the effectiveness of colonoscopy and colonography in the diagnosis of IBS. A previous study suggested that pain during colonoscopy was significantly more severe in IBS patients than in non-IBS patients (19). Furthermore, another previous study of colorectal angiography also suggested that IBS patients showed significant spasm compared with those without abdominal symptoms (20). Although the use of routine colonoscopy and colon radiography in the current diagnosis of IBS is not required, evidence-based objective methods of evaluation may be necessary for exclusion diagnosis, especially for patients with signs of IBS.

5. Abdominal ultrasound may be used to objectively and noninvasively evaluate IBS

Although there are few epidemiological studies on the usefulness of endoscopic imaging examinations on anything other than the large intestine in the diagnosis of IBS, there are articles on ultrasound examination and upper gastrointestinal endoscopy (21). In a previous study on ultrasound, it was reported that the contractile movement of the gallbladder was higher in the IBS group than in the control group in both the fasted state and after diet loading (22,23). It has been suggested that IBS is associated with cholecystectomy, but the small number of cases and its direct association with IBS symptoms are unknown. In addition, a previous study in Japan evaluated colonic motility by abdominal ultrasonography and reported that colonic contraction in the IBS group was enhanced by observing the sigmoid colon on an empty stomach. In the postmeal observation of the sigmoid colon, 9 IBS cases diagnosed by Rome II criteria and 4 controls were compared. In IBS-C, segmental movement was enhanced. On the other hand, in IBS-D, enhanced transport of intestinal contents to the anus was observed (24). Based on these reports, ultrasonic examination can be considered a noninvasive examination and is expected to be useful for the evaluation of intestinal motility. However, since there are few research reports, future verification is expected.

Furthermore, very few reports have diagnosed IBS using ultrasound. Among them, some previous studies have confirmed the characteristic changes in the gastrointestinal tract of IBS by using ultrasound. In a previous study, ultrasound was used to investigate the gastric emptying rate (GER) and antral motility of 76 IBS children who met the Rome III diagnostic criteria. The GER was significantly reduced in the IBS group exposed to stressful events. This result indicates that in IBS patients, stress causes more damage to the

GER and antral motility than in healthy individuals. In this ultrasound study, the GER and pyloric motility slowed gastric emptying and impaired pyloric sinus motility in all four IBS subtype children. However, a clear relationship between gastrointestinal motility abnormalities and symptoms has not been shown (25). In addition, a previous study investigating whether transvaginal ultrasound was useful in diagnosing IBS reported that the intestinal wall of the sigmoid colon was thickened in approximately 27 patients with a history of IBS (26). However, transvaginal ultrasound is a test for women only, and it is a difficult method for people living a general healthy social life.

Thus, studies on IBS diagnosis using ultrasound have not been sufficiently conducted. Several transvaginal and transrectal research methods have been reported (25-28), all of which are painful for patients and difficult to use in home care and medical facilities.

In recent years, it has become possible to easily and noninvasively inspect constipation by applying a small ultrasonic wave percutaneously to the abdominal wall (29). In particular, elderly people with impaired cognitive motor function cannot complain of subjective symptoms, so it is an important advance to easily test for constipation and diarrhea with such a small ultrasound procedure.

6. Is it possible for nurses to objectively evaluate IBS by using ultrasound?

Ultrasound can visualize information in the body in real time by simply applying a probe to the abdomen. In addition, unlike X-ray abdominal radiography, there is no exposure, and it can be repeated (Table 1). Furthermore, in recent years, the development of pocket-sized ultrasound devices has rapidly advanced (29), and it is becoming possible to use ultrasound not only in the examination room but also at home or at the bedside (30,31).

In a previous study, constipation among elderly people who ingested food orally was evaluated objectively by ultrasound, and the fecal distribution pattern of the large intestine was classified in patients with constipation (29,30). Objective visualization of the large intestine was used to evaluate constipation. For this reason, fecal retention was reported using ultrasonography in adults and elderly individuals, and Japanese nurses used ultrasound as a physical assessment tool to assess constipation (31). It has been

suggested that stool retention can be confirmed by observing the hyperechoic region of the rectum.

Furthermore, it has been reported that a hyperechoic region is also found in the rectum of patients with functional constipation (30-32). The strong hyperechoic region with acoustic shadow in the rectum indicates the presence of hard stool and has been suggested to be able to identify IBS.

However, previous studies evaluated only constipation patients and did not adequately examine diarrhea in enterally fed elderly people with impaired cognitive motor function. In addition, ultrasound has been used to diagnose enteritis in the digestive tract. In the case of infectious enteritis and ischemic colitis, specific echo findings are recognized, and ultrasound can be used to diagnose the disease. Thus, while the effectiveness of ultrasound has been shown for specific diseases, it has not been verified for diarrhea in elderly individuals.

In Japan, the 2016 medical fee revision (33) established a new "urination independence guidance fee", which includes "remaining urine measurement" using ultrasound and "urination diary" as requirements. Ultrasound has become a new assessment method for which general nurses should learn and develop educational programs for nurses (34-39). From the above, if it becomes possible for a nurse to predict diarrhea by using ultrasound, they can change the content of meals according to the individuality of the elderly patient and provide excretory supplies (incontinence pants, diapers, pads, etc.). Drug administration will make the daily life of patients safer and easier. Therefore, future research should examine these subjects.

7. Limitation

Rome IV diagnostic criteria based on subjective symptoms are used to diagnose IBS. This approach is limited to those who can communicate and complain on their own. On the other hand, ultrasonic waves can be a tool for diagnosing IBS by an objective index. To date, it has been reported by several previous studies that constipation and normal stool can be confirmed percutaneously easily and noninvasively. However, it is difficult to evaluate abdominal pain, which is essential for IBS diagnosis, by ultrasound. In the future, further visualization of defecation disorders and indicators that can objectively evaluate abdominal symptoms, such as abdominal pain, should be verified.

Table 1. Examination of intestinal colon

Examination	Evaluate contents	Real time	Invasion
Abdominal X-ray	Distribution of stool (volume)	No	Radiation exposure
	Colonic transit time (movement)		
CT imaging	Distribution of stool (volume and quality)	No	Radiation exposure
MRI scan	Distribution of stool (volume and quality)	No	Take up too much time; Noise exposure
Ultrasound imaging (US)	Distribution of stool (volume, quality and movement)	Yes	Non-invasive

8. Conclusion

The traditional Rome IV diagnostic criteria are used to diagnose IBS by assessing subjective symptoms. The Rome IV diagnostic criteria can distinguish between functional bowel disease with chronic symptoms and transient gastrointestinal symptoms. The Rome IV criteria assess whether abdominal pain and defecation disorders occurred more than 6 months before diagnosis and whether these symptoms persisted for more than 3 days in the last 3 months. The defecation disorder subtypes can be divided into IBS-D and IBS-C, but this diagnosis is used only in patients with clear awareness. The Rome IV criteria are used to assess subjective symptoms in patients who have abdominal pain or bowel movements, suggesting that diagnosing IBS using the Rome IV criteria among unconscious patients or cognitively impaired patients is difficult.

It is recommended that abdominal ultrasonography be used to assess IBS. In a previous study, constipation among elderly people who ingested food orally was objectively assessed by ultrasound, and the pattern of fecal distribution in the large intestine was classified in patients with constipation. Objective visualization of the large intestine was used to assess constipation. Therefore, fecal retention among adults and elderly individuals was reported using ultrasonography. Thus, it was suggested that stool retention could be confirmed by observing the hyperechoic region of the rectum. Furthermore, hyperechoic regions have also been reported in the rectum of patients with functional constipation. Furthermore, strong hyperechoic regions with acoustic shadows in the rectum indicate the presence of hard stools, thus enabling medical workers to identify constipation. In the future, ultrasonography may be useful for diagnosing IBS in unconscious patients or those with cognitive decline.

Acknowledgements

We would like to express our sincere gratitude to the reviewers for providing valuable information in the process of developing this article.

Ethics approval and consent to participate: This study was conducted as part of a pilot study.

Funding: None

Conflict of Interest: The author has no conflict of interest to disclose.

References

1. Longstreth GF, Thompson WG, Chey WD, Houghton LA, Mearin F, Spiller RC. Functional bowel disorders. *Gastroenterology*. 2006; 130:1480-1491.
2. Drossman DA. Functional gastrointestinal disorders: History, pathophysiology, clinical features and Rome IV. *Gastroenterology*. 2016; S0016-5085(16)00223-7.
3. Drossman DA. The functional gastrointestinal disorders and the Rome III process. *Gastroenterology*. 2006; 130:1377-1390.
4. Drossman DA, Hasler WL. Rome IV-functional GI disorders: Disorders of gut-brain interaction. *Gastroenterology*. 2016; 150:1257-1261.
5. Degen LP, Phillips SF. How well does stool form reflect colonic transit? *Gut*. 1996; 39:109-113.
6. Törnblom H, Van Oudenhove L, Sadik R, Abrahamsson H, Tack J, Simrén M. Colonic transit time and IBS symptoms: What's the link? *Am J Gastroenterol*. 2012; 107:754-760.
7. Ragnarsson G, Bodemar G. Division of the irritable bowel syndrome into subgroups on the basis of daily recorded symptoms in two outpatient samples. *Scand J Gastroenterol*. 1999; 34:993-1000.
8. Saad RJ, Rao SS, Koch KL, Kuo B, Parkman HP, McCallum RW, Sitrin MD, Wilding GE, Semler JR, Chey WD. Do stool form and frequency correlate with whole-gut and colonic transit? Results from a multicenter study in constipated individuals and healthy controls. *Am J Gastroenterol*. 2010; 105:403-411.
9. Jellema P, van der Windt DA, Schellevis FG, van der Horst HE. Systematic review: Accuracy of symptom-based criteria for diagnosis of irritable bowel syndrome in primary care. *Aliment Pharmacol Ther*. 2009; 30:695-706.
10. Mayer EA, Savidge T, Shulman RJ. Brain-gut microbiome interactions and functional bowel disorders. *Gastroenterology*. 2014; 146:1500-1512.
11. Boyce PM, Koloski NA, Talley NJ. Irritable bowel syndrome according to varying diagnostic criteria: Are the new Rome II criteria unnecessarily restrictive for research and practice? *Am J Gastroenterol*. 2000; 95:3176-3183.
12. Walter SA, Kjellström L, Talley NJ, Andreasson AN, Nyhlin H, Agréus L. Prospective diary evaluation of unexplained abdominal pain and bowel dysfunction: A population-based colonoscopy study. *Dig Dis Sci*. 2011; 56:1444-1451.
13. Robinson A, Lee V, Kennedy A, Middleton L, Rogers A, Thompson DG, Reeves D. A randomised controlled trial of self-help interventions in patients with a primary care diagnosis of irritable bowel syndrome. *Gut*. 2006; 55:643-648.
14. Andrae DA, Patrick DL, Drossman DA, Covington PS. Evaluation of the irritable bowel syndrome quality of life (IBS-QOL) questionnaire in diarrheal-predominant irritable bowel syndrome patients. *Health Qual Life Outcomes*. 2013; 11:208.
15. Heitkemper MM, Jarrett ME, Levy RL, Cain KC, Burr RL, Feld A, Barney P, Weisman P. Self-management for women with irritable bowel syndrome. *Clin Gastroenterol Hepatol*. 2004; 2:585-596.
16. Guthrie E, Creed F, Fernandes L, Ratcliffe J, Van Der Jagt J, Martin J, Howlett S, Read N, Barlow J, Thompson D, Tomenson B. Cluster analysis of symptoms and health seeking behaviour differentiates subgroups of patients with severe irritable bowel syndrome. *Gut*. 2003; 52:1616-1622.
17. Ghoshal UC, Gwee KA, Chen M, *et al*. Development, translation and validation of enhanced Asian Rome III questionnaires for diagnosis of functional bowel diseases in major asian languages: A Rome Foundation-Asian neurogastroenterology and motility association working

- team report. *J Neurogastroenterol Motil.* 2015; 21:83-92.
18. Kanazawa M, Nakajima S, Oshima T, Whitehead WE, Sperber AD, Palsson OS, Drossman DA, Miwa H, Fukudo S. Validity and reliability of the Japanese version of the Rome III diagnostic questionnaire for irritable bowel syndrome and functional dyspepsia. *J Neurogastroenterol Motil.* 2015; 21:537-544.
 19. Kim ES, Cheon JH, Park JJ, Moon CM, Hong SP, Kim TI, Kim WH. Colonoscopy as an adjunctive method for the diagnosis of irritable bowel syndrome: Focus on pain perception. *J Gastroenterol Hepatol.* 2010; 25:1232-1238.
 20. Lanng C, Mortensen D, Friis M, Wallin L, Kay L, Boesby S, Jørgensen T. Gastrointestinal dysfunction in a community sample of subjects with symptoms of irritable bowel syndrome. *Digestion.* 2003; 67:14-19.
 21. Zhao Y, Zou D, Wang R, *et al.* Dyspepsia and irritable bowel syndrome in China: A population-based endoscopy study of prevalence and impact. *Aliment Pharmacol Ther.* 2010; 32:562-572.
 22. Guliter S, Yilmaz S, Yakaryilmaz F, Keles H. Evaluation of gallbladder motility in patients with irritable bowel syndrome. *Swiss Med Wkly.* 2005; 135:407-411.
 23. Güçlü M, Pourbagher A, Serin E, Kul K, Ozer B, Cosar A, İçer MO, Gür G, Boyacıoğlu S. Ultrasonographic evaluation of gallbladder functions in patients with irritable bowel syndrome. *J Gastroenterol Hepatol.* 2006; 21:1309-1312.
 24. Kusunoki H, Kamada T, Sato M, Haruma K, Hata J. Ultrasonographic assessment of sigmoid colon in patients with irritable bowel syndrome. *Nihon Rinsho.* 2006; 64:1461-1466.
 25. Devanarayana NM, Rajindrajith S, Bandara C, Shashiprabha G, Benninga MA. Ultrasonographic assessment of liquid gastric emptying and antral motility according to the subtypes of irritable bowel syndrome in children. *J Pediatr Gastroenterol Nutr.* 2013; 56:443-448.
 26. Crade M, Pham V. Ultrasound examination of the sigmoid colon: Possible new diagnostic tool for irritable bowel syndrome. *Ultrasound Obstet Gynecol.* 2006; 27:206-209.
 27. Awad RA, Martin J, Cal y Major M, Noguera JL, Ramos R, Amezcua C, Camacho S, Santiago R, Ramirez JL, Castro J. Transrectal ultrasonography: Relationship with anorectal manometry, electromyography and sensitivity tests in irritable bowel syndrome. *Int J Colorectal Dis.* 1998; 13:82-87.
 28. O'Connor OJ, McSweeney SE, McWilliams S, O'Neill S, Shanahan F, Quigley EM, Maher MM. Role of radiologic imaging in irritable bowel syndrome: Evidence-based review. *Radiology.* 2012; 262:485-494.
 29. Yabunaka K, Matsumoto M, Yoshida M, Tanaka S, Miura Y, Tsutaoka T, Handa M, Nakagami G, Sugama J, Okada S, Sanada H. Assessment of rectal feces storage condition by a point-of-care pocket-size ultrasound device for healthy adult subjects: A preliminary study. *Drug Discov Ther.* 2018; 12:42-46.
 30. Tanaka S, Yabunaka K, Matsumoto M, Tamai N, Noguchi H, Yoshida M, Nakagami G, Sugama J, Sanada H. Fecal distribution changes using colorectal ultrasonography in older people with physical and cognitive impairment living in long-term care facilities: A longitudinal observational study. *Healthcare (Basel).* 2018; 6:55.
 31. Matsumoto M, Tanaka S, Yabunaka K, Yoshida M, Miura Y, Tsutaoka T, Handa M, Nakagami G, Sugama J, Okada S, Sanada H. Ultrasonographic evaluation of changes over time in one defecation cycle in adults with functional constipation: A report of two cases. *Drug Discov Ther.* 2018; 12:304-308.
 32. Yabunaka K, Nakagami G, Tabata K, Sugama J, Matsumoto M, Kido Y, Iuchi T, Sanada H. Constipation in the elderly in a Japanese long-term medical facility: An ultrasonographic investigation. *Drug Discov Ther.* 2018; 12:233-238.
 33. Ministry of Health, Labor and Welfare Insurance Bureau. Outline of Medical Fee Revision in 2016. Japanese Version. (in Japanese)
 34. Yamada T, Minami T, Soni NJ, Hiraoka E, Takahashi H, Okubo T, Sato J. Skills acquisition for novice learners after a point-of-care ultrasound course: Does clinical rank matter? *BMC Med Educ.* 2018; 18:202.
 35. Selim AA, Ramadan FH, El-Gueneidy MM, Gaafer MM. Using Objective Structured Clinical Examination (OSCE) in undergraduate psychiatric nursing education: Is it reliable and valid? *Nurse Educ Today.* 2012; 32:283-288.
 36. Smith V, Muldoon K, Biesty L. The Objective Structured Clinical Examination (OSCE) as a strategy for assessing clinical competence in midwifery education in Ireland: A critical review. *Nurse Educ Pract.* 2012; 12:242-247.
 37. Cawthorn TR, Nickel C, O'Reilly M, Kafka H, Tam JW, Jackson LC, Sanfilippo AJ, Johri AM. Development and evaluation of methodologies for teaching focused cardiac ultrasound skills to medical students. *J Am Soc Echocardiogr.* 2014; 27:302-309.
 38. Duff B, Massey D, Gooch R, Wallis M. The impact of a multimodal education strategy (the DeTER program) on nurses' recognition and response to deteriorating patients. *Nurse Educ Pract.* 2018; 31:130-135.
 39. Wanjiku GW, Bell G, Wachira B. Assessing a novel point-of-care ultrasound training program for rural healthcare providers in Kenya. *BMC Health Serv Res.* 2018; 18:607.
- Received September 5, 2020; Revised September 28, 2020; Accepted October 24, 2020.
- *Address correspondence to:*
Yohei Okawa, Department of Nursing, Kochi University School of Medicine, Kohasu, oko-cho, Kochi 783-8505, Japan
E-mail: okawayohei98@gmail.com
- Released online in J-STAGE as advance publication October 29, 2020.