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MV-Flow™ Vascularity Index for Intestinal Ultrasound in Ulcerative Colitis

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Introduction

Background

Intestinal ultrasound (IUS) is a noninvasive imaging modality used for the diagnosis and longitudinal monitoring of inflammatory bowel disease (IBD). In ulcerative colitis (UC), objective monitoring aligned with the Treat-to-Target strategy is required. IUS can be performed repeatedly at the bedside and allows assessment of inflammatory activity by integrating multiple parameters, including bowel wall structure, vascularity, and (when needed) tissue stiffness.[1]

This white paper outlines the concept of multiparametric IUS for treatment monitoring in UC, with a focus on practical implementation points centered on microvascular flow imaging (MV-Flow™):

- Assessment of bowel wall structure: bowel wall thickness (BWT), wall layer stratification, and the presence of edema/fatty change (with the expectation of future AI-assisted measurement support)
- Assessment of bowel wall vascularity: improved visualization beyond color Doppler using microvascular flow imaging (MV-Flow™), and semi-quantitative evaluation (e.g., Vascularity Index)
- Assessment of bowel wall stiffness: adjunctive use of elastography (shear-wave elastography SWE) to provide clues for chronic change and differential interpretation

System and probe selection

A B

Figure 1. Ultrasound system used for data acquisition: (A) Samsung ultrasound diagnostic system V8 and (B) For colonic evaluation, a high-frequency linear probe is used as the primary transducer, and low-to-mid frequency convex probes are added for deeper assessment. (During data acquisition: LA2-14A and LA2-9S for the colon; CA1-7S for deeper evaluation.)

For UC monitoring, key requirements include: (1) spatial resolution for bowel wall assessment using high-frequency linear probes; (2) high-sensitivity Doppler/microvascular flow modes; (3) reproducibility of acquisition conditions (standardization of presets, gain, PRF, low-velocity filters, etc.); and (4) robust image storage and reporting workflows using system (Figure 1). In addition, local education and quality control (imaging protocols,

segment definitions, and assurance of inter-rater agreement) are critical for successful clinical implementation.

Case Study

Assessment of bowel wall structure

Basic approach

In UC, inflammatory activity is assessed by systematically scanning colonic segments—rectum to sigmoid colon, descending colon, transverse colon, and ascending colon—according to disease extent, and integrating findings from BWT, wall layer stratification, and signs such as edema and vascular dilatation. Because BWT is influenced by anatomical location, patient position, and compression, respiration and compression conditions should be standardized, and follow-up examinations should be performed under the same conditions at the same site whenever possible. For BWT measurement, it is recommended to measure at two points in both the longitudinal and transverse planes, separated by ≥1 cm or by ≥90° (Figure 2).

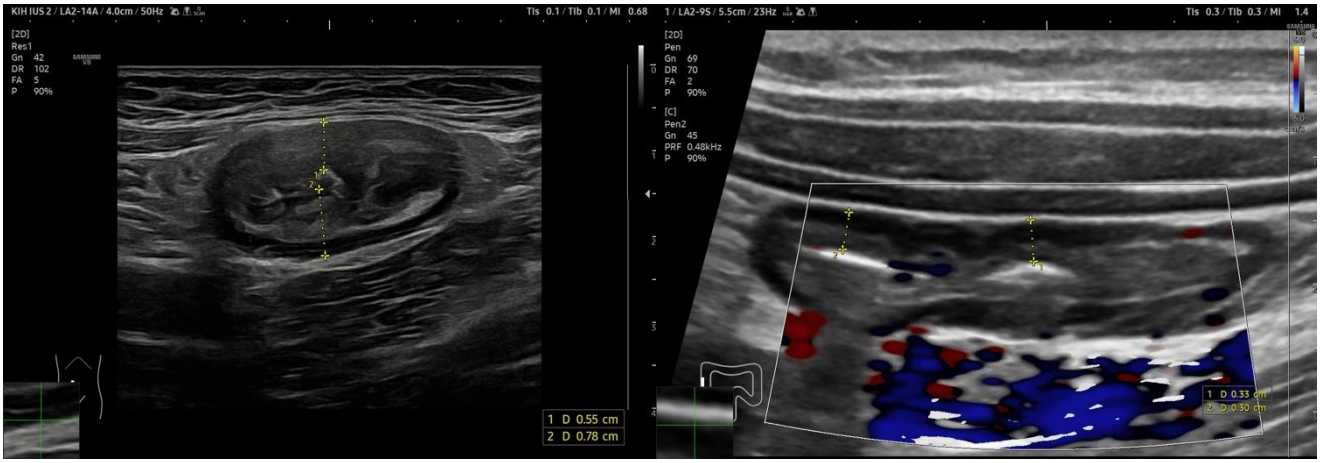

Figure 2. Conceptual framework for assessing BWT and wall layer stratification. Use both transverse and longitudinal views to achieve reproducible measurements.

AI-assisted BWT measurement

Because BWT measurement is operator-dependent and influenced by experience, future AI-based automatic segmentation and measurement assistance may improve reproducibility and shorten workflows. Clinical implementation requires standardized acquisition conditions and validation of AI outputs (agreement with manual measurements and external validity). With the anticipated integration of AI into Samsung ultrasound systems, further studies—especially regarding external validity among novice users—are expected.

Assessment of bowel wall vascularity

Color Doppler and MV-Flow™

While color Doppler is useful for assessing inflammatory activity in UC, it has limitations in detecting microvascular flow within the bowel wall. Vascularity is commonly evaluated semi-quantitatively using a color

Doppler signal (CDS) score. For example, in the modified Limberg score (IBUS-SAS CDS subscore), vascularity is graded on a 4-point scale[2]:

0: Absent
1: Short signals
2: Long signals inside bowel
3: Long signals inside & outside bowel

To capture low-velocity flow, optimization of settings is essential—for example, lowering PRF/velocity scale (e.g., to a few cm/s) and adjusting gain to just below the noise threshold. In recent years, microvascular flow imaging (MVFI) has been used to visualize fine, low-velocity flow signals, aiding pattern-based diagnosis and detection of mild inflammation.[3] MV-Flow™, a type of MVFI, is expected to enhance sensitivity for microvascular flow detection and improve visualization of intramural bowel wall flow. Vascularity findings should be interpreted together with structural findings such as BWT, and changes before and after treatment should be tracked under identical acquisition conditions. In UC clinical cases, MV-Flow™ can provide more detailed depiction of vascularity (Figure 3).

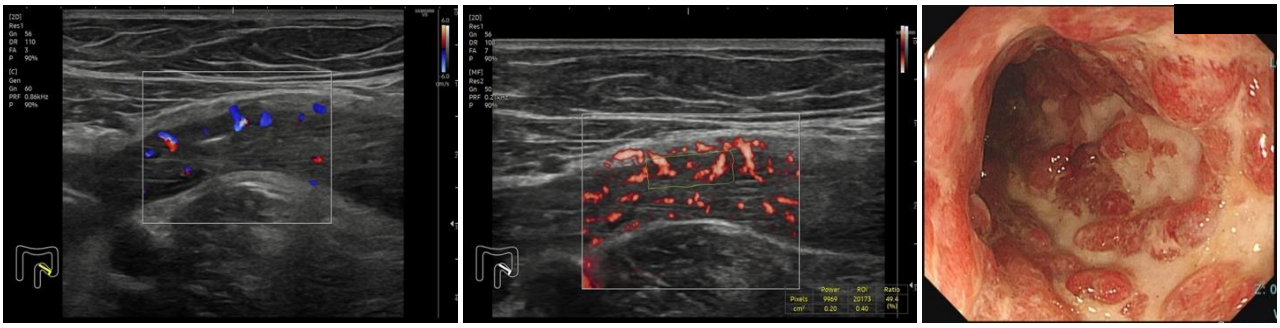

Figure 3. Comparison of intramural bowel wall flow visualization using color Doppler vs MV-Flow™. MV-Flow™ supports visualization of microvascular flow. CDS subscore was 3, and the MV-Flow™ Vascularity Index was 49.4%. Endoscopy showed map-like ulcers at the same site, with a Mayo endoscopic score of 3 (most severe).

Even in colonic segments affected by UC, MV-Flow™ may provide clearer depiction of intramural flow that can be difficult to detect with color Doppler (Figure 4). When using quantitative indices (e.g., Vascularity Index), it is mandatory to standardize ROI placement and acquisition settings, and to establish site-specific operational rules. In our practice, to ensure reproducibility when using Vascularity Index clinically, we measure over a 1-cm length including the entire thickness of the anterior wall of the target bowel segment.

Figure 4. Comparison of intramural bowel wall flow visualization using color Doppler vs MV-Flow™. MV-Flow™ supports visualization of microvascular flow. CDS subscore was 0, but the MV-Flow™ Vascularity Index was 14.7%. Endoscopy showed reduced vascular pattern visibility at the same site, with a Mayo endoscopic score of 1 (mild).

Assessment of bowel wall stiffness

Assessment of bowel wall stiffness (elastography) may provide clues regarding chronic changes and differential interpretation (whether inflammation predominates or whether fibrosis contributes). However, in UC, the role of fibrosis assessment is not as established as it is in Crohn's disease (CD), and at present it is most practical to treat this as an adjunctive parameter.

Shearwave Elastography (SWE)

SWE quantifies tissue stiffness using parameters such as shear-wave speed and may provide real-time, reproducible information. In IBD, research has primarily focused on evaluating CD strictures, but SWE may also have potential as an adjunct in UC for assessing chronic change and associated lesions.
SWE includes point measurement (Point-SWE) and two-dimensional SWE (2D-SWE), both of which are affected by ROI placement, compression, respiration, depth, and other factors. For clinical implementation, standardization of measurement procedures and evaluation of reproducibility (intra- and inter-operator) are essential (Figure 5).
Note: The use of elastography for the bowel was performed with review and approval by the ethics committee of Kitasato University Hospital.

Figure 5. Example (schematic) of stiffness assessment using SWE. Quantitative values depend on the device and acquisition conditions; interpretation requires caution.

Conclusion

For treatment monitoring in UC, IUS is useful as a noninvasive and repeatable assessment tool. Integrating vascularity information with bowel wall structure (BWT and wall layer stratification) can improve the accuracy of assessing inflammatory activity and treatment response. MV-Flow™ may support visualization of microvascular flow; therefore, with standardized acquisition conditions and well-defined operational rules, MV-Flow™ could be incorporated into routine clinical monitoring workflows.
Note: This white paper is intended as an overview of clinical implementation. Detailed data are planned to be reported separately in an academic manuscript.

References

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[2] Tokushima K, Jimbo K, Suzuki M, et al. Differentiation of Active Ulcerative Colitis vs Non inflammatory Bowel Disease Proctitis by Transperineal Superb Microvascular Imaging. *Inflammatory Bowel Diseases* 2023. 30 (7): 1103-1111

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