Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Title:
Artificial intelligence-based diagnostic imaging system with virtual enteroscopy and virtual unfolded views to evaluate small bowel lesions in Crohn's disease

Authors:
Kazuhiro Furukawa, Masahiro Oda, Osamu Watanabe, Masanao Nakamura, Takeshi Yamamura, Keiko Maeda, Kensaku Mori, Hiroki Kawashima

DOI: 10.17235/reed.2024.10405/2024
Link: PubMed (Epub ahead of print)

Please cite this article as:
Furukawa Kazuhiro, Oda Masahiro, Watanabe Osamu, Nakamura Masanao, Yamamura Takeshi, Maeda Keiko, Mori Kensaku, Kawashima Hiroki. Artificial intelligence-based diagnostic imaging system with virtual enteroscopy and virtual unfolded views to evaluate small bowel lesions in Crohn's disease. Rev Esp Enferm Dig 2024. doi: 10.17235/reed.2024.10405/2024.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Artificial intelligence-based diagnostic imaging system with virtual enteroscopy and virtual unfolded views to evaluate small bowel lesions in Crohn's disease

Kazuhiro Furukawa [1)], Masahiro Oda [2)3)], Osamu Watanabe [1)], Masanao Nakamura [4)], Takeshi Yamamura [1)], Keiko Maeda [1)], Kensaku Mori [3)2)5)], Hiroki Kawashima [1)]

1) Department of Gastroenterology and Hepatology, Nagoya University Graduate School of Medicine, Nagoya, Japan
2) Information Technology Center, Nagoya University, Nagoya, Japan
3) Graduate School of Informatics, Nagoya University, Nagoya, Japan
4) Department of Endoscopy, Nagoya University Hospital, Nagoya, Japan
5) Research Center for Medical Bigdata, National Institute of Informatics, Tokyo, Japan

Corresponding author

Kazuhiro Furukawa, M.D., Ph.D.

Department of Gastroenterology and Hepatology, Nagoya University Graduate School of Medicine, Nagoya, Japan

65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan

E-mail: kazufuru@med.nagoya-u.ac.jp

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Keywords : Artificial intelligence. Crohn's disease. Diagnostic imaging system. Small bowel lesion. Virtual enteroscopy. Virtual unfolded view.

Abbreviation's list: small bowel lesion (SBL), Crohn's disease (CD)

Abstract:

Since even subtle mucosal changes may be depicted using virtual endoscopy created by the three-dimensional reconstruction of MDCT images, we developed a novel diagnostic imaging system that integrates and displays virtual enteroscopy, curved planar reconstruction, and a virtual unfolded view, the width of which changes with increases/decreases in the inner luminal diameter. The system is also equipped with artificial intelligence that superimposes and displays depressed areas, generates an automatic small bowel centerline that connects fragmented small bowel regions, and performs electronic cleansing. We retrospectively evaluated the diagnostic performance of this system for small bowel lesions in Crohn's disease, which were divided into two groups: endoscopically-observable and endoscopically-unobservable. Lesion detection rates for stenoses, longitudinal ulcers with a cobblestone appearance, and scars were excellent in both groups. This system, when used in combination with endoscopy, shows slight mucosal changes in areas in which an endoscope cannot reach due to strictures, thereby extending the range of observation of the small bowel. This system is a useful diagnostic modality that has the capacity to assess mucosal healing and provide extraluminal information.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Dear Editor,

The detailed examination of small bowel lesions (SBLs) in Crohn's disease (CD) includes cross-sectional imaging, such as CT and MR enterography, and endoscopy, including balloon-assisted and capsule endoscopies. Although cross-sectional imaging facilitates the identification of disease activity and its extent as well as complications, mucosal visualization is inferior to endoscopy (1,2). However, capsule endoscopy is associated with a risk of retention and balloon-assisted endoscopy with bleeding and perforation (3,4). Subtle mucosal changes may be depicted using virtual endoscopy created by the three-dimensional reconstruction of MDCT images (5). We created a novel diagnostic imaging system that integrates and displays virtual enteroscopy, curved planar reconstruction, and a virtual unfolded view, the width of which changes with increases/decreases in the inner luminal diameter. This system is also equipped with artificial intelligence that superimposes and displays depressed areas, automatically generates the small bowel centerline that connects fragmented small bowel regions, and performs electronic cleansing (Fig. 1).

We retrospectively evaluated the diagnostic performance of this system for SBLs in CD. Subjects comprised 37 patients (30 males and 7 females; median age, 39 years) with established CD: 15 with ileitis and 22 with ileocolitis. The median disease duration was 11 years, and 23 patients had a previous history of surgical treatment. MDCT was performed on all patients immediately after endoscopy (32 double-balloon endoscopies, 3 colonoscopies, and 2 esophagogastroduodenoscopies) because air or

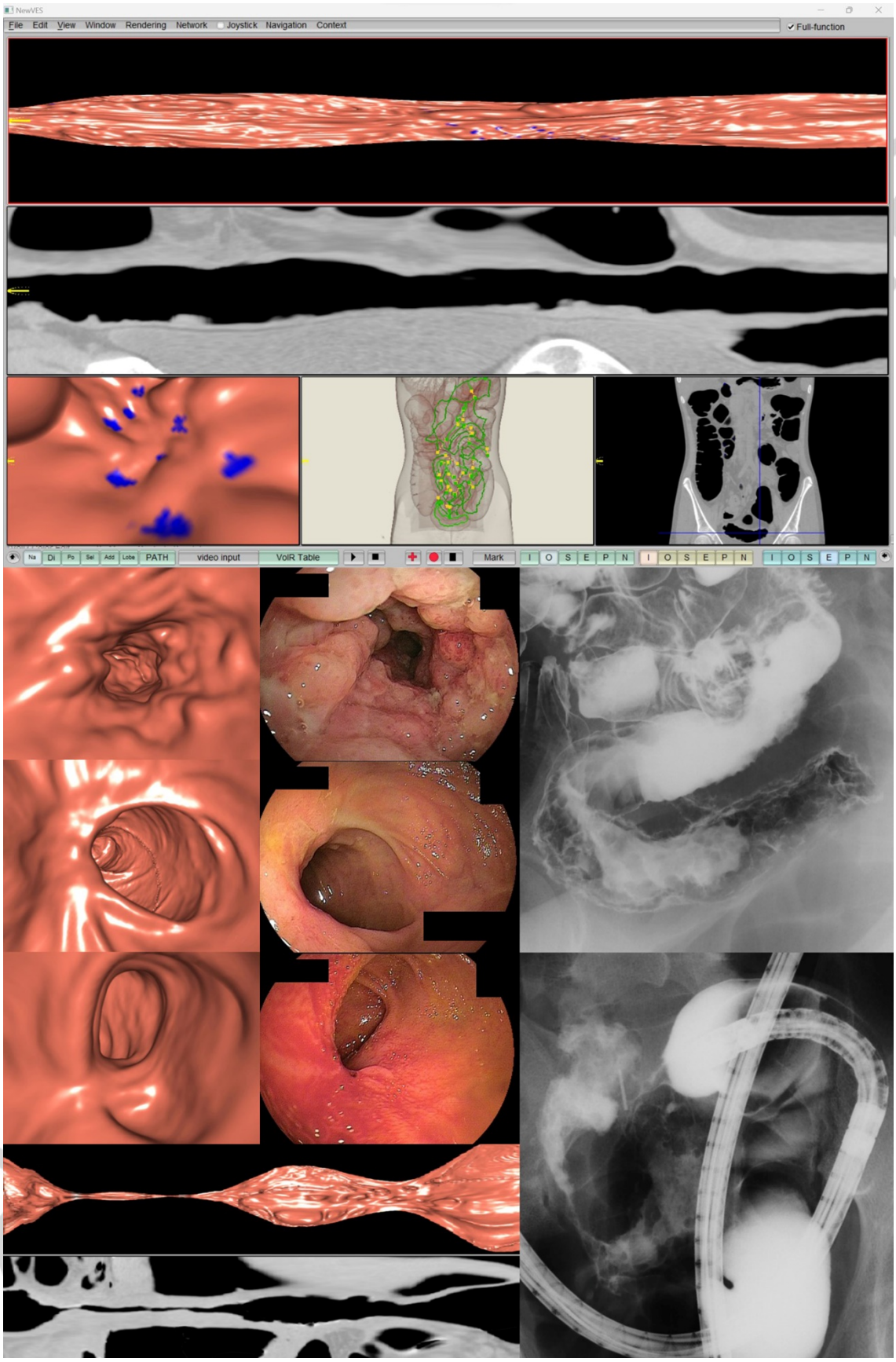
carbon dioxide was used as the negative contrast agent. SBLs were classified as endoscopically-observable and endoscopically-unobservable. In the latter group, lesions were not observable endoscopically due to strictures or other reasons, but were detected in a small bowel follow-through during or after the examination. The endoscopically-observable group included 19 stenoses, 3 longitudinal ulcers with a cobblestone appearance, 18 irregular ulcers or aphthae, and 7 scars, with detection rates of 89.5% (17/19), 100% (3/3), 22.2% (4/18), and 71.4% (5/7), respectively. The endoscopically-unobservable group included 25 stenoses, 6 longitudinal ulcers with a cobblestone appearance, and 1 scar, with detection rates of 92.0% (23/25), 100% (6/6), and 100% (1/1), respectively. Excellent lesion detection rates, except for irregular ulcers or aphthae, were achieved. This system, when used in combination with endoscopy, detects slight mucosal changes in areas in which an endoscope cannot reach due to strictures, thereby extending the range of observation of the small bowel. This system is a useful diagnostic modality that may assess mucosal healing and provide extraluminal information.

References

1. Guglielmo FF, Anupindi SA, Fletcher JG, et al. Small Bowel Crohn Disease at CT and MR Enterography: Imaging Atlas and Glossary of Terms. Radiographics 2020;40:354-375.
2. Elsayes KM, Al-Hawary MM, Jagdish J, et al. CT enterography: principles, trends, and interpretation of findings. Radiographics 2010;30:1955-70.

3. Pasha SF, Pennazio M, Rondonotti E, et al. Capsule Retention in Crohn's Disease: A Meta-analysis. Inflamm Bowel Dis 2020;26:33-42.
4. Xin L, Liao Z, Jiang YP, et al. Indications, detectability, positive findings, total enteroscopy, and complications of diagnostic double-balloon endoscopy: a systematic review of data over the first decade of use. Gastrointest Endosc 2011;74:563-70.
5. Furukawa K, Miyahara R, Itoh A, et al. Diagnosis of the invasion depth of gastric cancer using MDCT with virtual gastroscopy: comparison with staging with endoscopic ultrasound. AJR Am J Roentgenol 2011;197:867-75.

Revista Española
de Enfermedades Digestivas
The Spanish Journal
of Gastroenterology



Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Figure legend

Novel artificial intelligence-based diagnostic imaging system (a). The upper row is a virtual unfolded view, the middle row is a curved planar reconstruction view, and the lower row, from left to right, is virtual enteroscopy, external, and multiplanar reconstruction views. The virtual unfolded view shows changes in width with increases/decreases in the inner luminal diameter, which allow the presence of stenoses to be confirmed. Virtual enteroscopy displays a blue overlay of depressed areas that are candidates for ulcerative lesions. The location of a lesion may be detected in the external view. The multiplanar reconstruction view may be switched between the axial, coronal, and sagittal planes.

Virtual enteroscopy (b), double-balloon endoscopy (c), and small bowel follow-through (d) of the cobblestone appearance. Virtual enteroscopy (e) and double-balloon endoscopy (f) of an irregular ulcer. Virtual enteroscopy (g) and double-balloon endoscopy (h) of a scar. A virtual unfolded view (i) and small bowel follow-through (j) of stenoses.