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Lessons from Korean Capsule Endoscopy Multicenter Studies

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Since its development, video capsule endoscopy (VCE) introduced a new area in the study of small bowel disease. We reviewed and discussed current issues from Korean capsule endoscopy multicenter studies. Main results are as follows: First, there was no significant difference in diagnostic yield according to the method of bowel preparation. Second, VCE represents a reliable and influential screening measure in patients with chronic unexplained abdominal pain and this technique could successfully alter the clinical course especially for patients with small bowel tumor. Third, the inter-observer variation in the expert group was lower than that in trainee group. Fourth, studies about the spontaneous capsule passage after retention showed 2.5% of retention rate and the size of lumen was an important factor of spontaneous passage. We need larger scale studies on the effect of bowel preparation methods on the diagnostic yield and further studies about the learning curve or unique capsule endoscopic findings for small intestinal diseases in Korean patients.

Key Words: Capsule endoscopy; Small intestine; Small bowel disease

INTRODUCTION

Video capsule endoscopy (VCE) introduced a new era in the study of small bowel disease. Prior to VCE, visualization of the small intestine required radiographic or endoscopic methods which had significant disadvantages in terms of radiation hazard, patient discomfort as well as in low diagnostic sensitivity and specificity. The video capsule is a 11×26 mm disposable device that weighs 3.7 g and is covered with a bio-compatible plastic containing a metal oxide silicon chip camera, lens, light source, battery, and radio-telemetry transmitter. VCE records stream images at the rate of 2 per second over 7 to 8 hours of image acquisition period, yielding a total of approximately 50,000 images per examination. The image covers 140 degrees with 8-fold magnification and a depth of view of 1 to 30 mm. The primary indications for VCE include occult or overt obscure gastrointestinal (GI) bleeding, suspected Crohn's disease, non-steroidal anti-inflammatory drug (NSAID)-induced small bowel injury, celiac disease, and chronic

diarrhea. VCE examination is now the accepted standard for examination of the small bowel worldwide.¹ A variety of VCE devices are currently under development with the goal of extending the technology to different areas and capabilities. Interpretation of VCE small bowel images is both subjective and time consuming with a significant potential for inter-observer variation in the interpretation of the VCE results. Industry has responded by continuing to develop software programs to assist in interpretation of the captured images.

We discuss current issues from Korean capsule endoscopy multicenter studies and highlights clinical aspects of small intestinal diseases in Korean patients.

RESULTS FROM KOREAN CAPSULE ENDOSCOPY STUDIES

Bowel preparation

Despite the diagnostic accuracy of VCE, the yield can be limited by intestinal contents, food, and air bubbles. For overcoming the limitation, some clinicians have prepared the small bowel using purgative agents, such as simethicone, polyethylene glycol (PEG), and sodium phosphate (NaP).²⁻⁶ However, the bowel preparation methods for capsule endoscopy has not been standardized yet. So we conducted a prospective, randomized, single-blind, multi-center study to evaluate the qualities of visualization and the diagnostic yields of three different methods of bowel preparation.⁷ All evaluations took place

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between October 2004 and September 2007, and nine tertiary academic hospitals participated in the study. A cohort of 134 patients with suspected small bowel disease was randomly assigned to three groups. Patients in group A ($n=44$) fasted for 12 hours before being administered an M2A capsule (Given Imaging, Yoqneam, Israel). Patients in group B ($n=45$) were asked to drink two doses of 45 mL of NaP with water during the afternoon and evening on the day before the procedure and to drink at least 2 L of water thereafter. Patients in group C ($n=45$) drank 2 L of a PEG lavage solution the evening before the procedure. The mean gastric emptying time (GET) was 34.9 minutes for the group A, 47.2 minutes for the group B, and 25.2 minutes for the group C. The mean small intestinal transit time (SITT) was 321.8 minutes for the group A, 313.5 minutes for the group B, and 337.6 minutes for the group C. The capsule reached the cecum in 33 patients in the group A (75%), 33 patients in the group B (73%), and 32 patients in the group C (71%). No significant difference was observed among groups in terms of GET, SITT, or the percentage of patients in whom the capsule reached the cecum. Overall cleansing of the small bowel was adequate in 43% of patients in the group A, 77% of those in the group B, and 56% of those in the group C. In comparison with the other groups, the group B had significantly better image quality than the group A ($p=0.001$). No significant difference in the image quality was observed between the group B and C or between the group A and C. Diagnoses for obscure GI bleeding were established in 9 patients (39%) in the group A, 16 patients (69%) in the group B, and 14 patients (50%) in the group C. No significant difference in diagnostic yield was observed among the groups. In conclusion, the results of our prospective study suggest that bowel preparation with NaP improves the quality of capsule endoscopy images. Nevertheless, no significant difference in diagnostic yield was observed among the groups.⁷ Although there were several limitations, the study has clinical meanings in that it is the first prospective randomized multicenter study comparing the efficacy of each bowel preparation methods.

Unexplained abdominal pain

Most of the studies dealing with VCE have been focused on the evaluation of obscure GI bleeding.⁸⁻¹¹ However, it is increasingly used in other indications associated with small bowel diseases. Chronic abdominal pain is a common problem seen in practice and likely to remain unexplained. In some cases, small bowel disorders can be one of the causes. Even though chronic abdominal pain has been one of the indications of VCE, there are few studies focused on this. Shim et al.¹² and Korean Gut Images Group evaluated retrospectively the helpfulness of VCE in patients with unexplained abdominal pain in a multicenter study. Among the 110 patients with abdomi-

nal pain, 19 cases revealed positive findings of VCE; stricture, significant erosion or ulceration, etc. Weight loss was a significant risk factor for positive finding. The diagnostic yield of VCE in chronic abdominal pain was 17.3%. These data suggest that VCE may be helpful in assessing patients suffering from unexplained abdominal pain, and this study can lead to prospective studies for confirming the exact role of VCE in this indication.¹²

Small bowel tumors

Tumors in the small bowel represent only 3% to 6% of all GI tract tumors and 1% to 3% of all malignant GI tumors.¹³ Because traditional diagnostic modalities are inaccurate and incapable of accessing small bowel, studies for small bowel tumors often fail to diagnose the tumor in the early or locally advanced stages.¹⁴ Although VCE is a promising diagnostic modality for assessing small bowel, data about VCE in the field of small bowel tumor are insufficient.^{15,16} A study by The Korean Gut Images Group evaluated the diagnostic and therapeutic impacts of VCE in the field of small bowel tumors by reviewing all VCE findings and clinical records on a nationwide scale.¹⁷ VCE records consecutively pooled from the beginning of VCE use in Korea, specifically from October 2001 until April 2008, from 14 centers throughout Korea were reviewed. The PillCam SB video capsule endoscope (Given Imaging) was used for all VCE procedures. Clinical information and VCE video images of small bowel tumors were analyzed. A total of 1,332 cases of VCE for all clinical indications were reviewed. Small bowel tumors were diagnosed with VCE in 57 (4.3%) out of the 1,332 patients. The tumors were malignant in 33 cases, including 3 cases of adenocarcinoma, 8 cases of lymphoma, 20 cases of GI stromal tumor, and 2 cases of metastatic cancer. Similar to the previous studies in Western countries, the histological diagnosis of our study showed a predominance of malignant tumors. However, the frequency according to the tumor type in Korea was different from the previous studies.¹⁸⁻²⁰ We suggest genetic, ethnic difference and food style as the causes of difference. The most frequent indications for VCE in malignant tumors were obscure GI bleeding ($n=43$), followed by abdominal pain ($n=8$) and weight loss ($n=2$). The results about indication was consistent with that of our previous report.¹² The common types found with VCE were subepithelial mass without bleeding in 28 cases, epithelial mass with fungating or ulceration in 11 and 6 cases, respectively (Fig. 1). Thirty of 57 tumors were identified exclusively by VCE (diagnostic impact, 30/57, 52.6%), and they were smaller in size (mean, 14.3 mm; range, 2 to 35 mm) compared to the other tumors detected in radiological studies (mean, 48.7 mm; range, 10 to 110 mm). Seven patients underwent surgical resection (therapeutic impact, 7/57, 12.3%). In

our study, VCE displayed an exclusive diagnostic impact of 52.6% (30/57) and led to exclusive therapeutic decisions in 12.3% (7/57) of cases. On the base of the results of this study, we believe that the diagnostic yield of VCE for small bowel tumor is superior to that of other conventional studies and VCE represents a reliable and influential screening measure in patients with indications of small bowel disease. This technique can successfully alter the clinical course of patients.¹⁷

Inter-observer variation

One of the limitations of VCE is inter-observer variation in the interpretation of the results. Several previous studies reported this issue, and the main reason is the differences in the images obtained by VCE and traditional endoscopy.^{10,21-23} We also performed a multi-center study to evaluate the accuracy and inter-observer agreement in expert readers compared to those in trainees based on capsule endoscopy structured terminology (CEST) and to determine the risk factors associated with missing lesions.²⁴

Fifty-six VCE video clips were collected from eight university hospitals in South Korea and were independently re-

viewed by 13 gastroenterology experts and 10 trainees. The expert readers of the VCE results were gastroenterologist specialists (professors) and the trainees, who recently received license in internal medicine, were in their 1st year of specialty training (fellowship) in gastroenterology. All investigators recorded their findings based on CEST. To determine the accuracy of individual viewers, we defined the 'gold standard' as a joint review by four experts. The 56 VCE video clips included five normal cases, 19 cases of protruding lesions, 21 cases of depressed lesions, three cases of flat lesions, one case of abnormal mucosa, six cases with blood in the lumen, and one case of stenotic lumen. The overall mean accuracies in the experts and trainees were $74.3 \pm 22.6\%$ and $61.7 \pm 25.4\%$, respectively. The overall accuracy in the trainee group was significantly lower than that in the expert group ($p < 0.001$), especially in normal, tumor, venous structure, and ulcer cases. The accuracies in the two groups varied with the VCE findings. The accuracies were higher in cases with more prominent intraluminal changes (e.g., active small-bowel bleeding, ulcer, tumor, and stenotic lumen). In contrast, subtle mucosal lesions, such as erosion, angioectasia, and diverticulum,

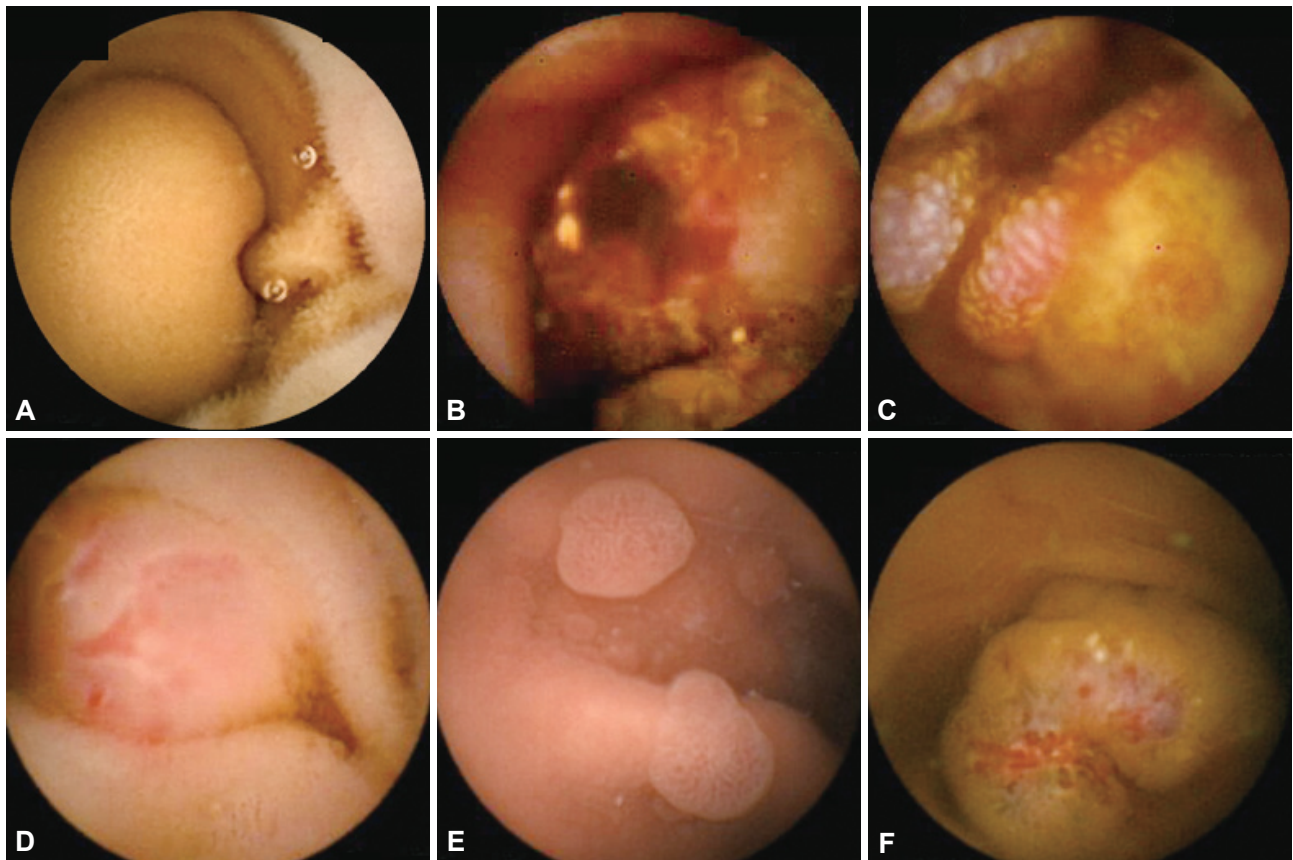


Fig. 1. Variable findings of tumors of small intestine detected by capsule endoscopy. (A) Subepithelial mass with intact covering mucosa and yellowish hue, diagnosed as lipoma. (B) Multiple epithelial mass with fungoid growth, diagnosed histologically as lymphoma. (C) Epithelial lesion with ulceration. (D) Subepithelial mass with superficial ulceration, diagnosed as gastrointestinal stromal tumor. (E) Multiple sessile polyps with fine-coarse surface texture and white hue, diagnosed as adenoma. (F) Protruding mass with superficial vascular and lymphatic dilatation.

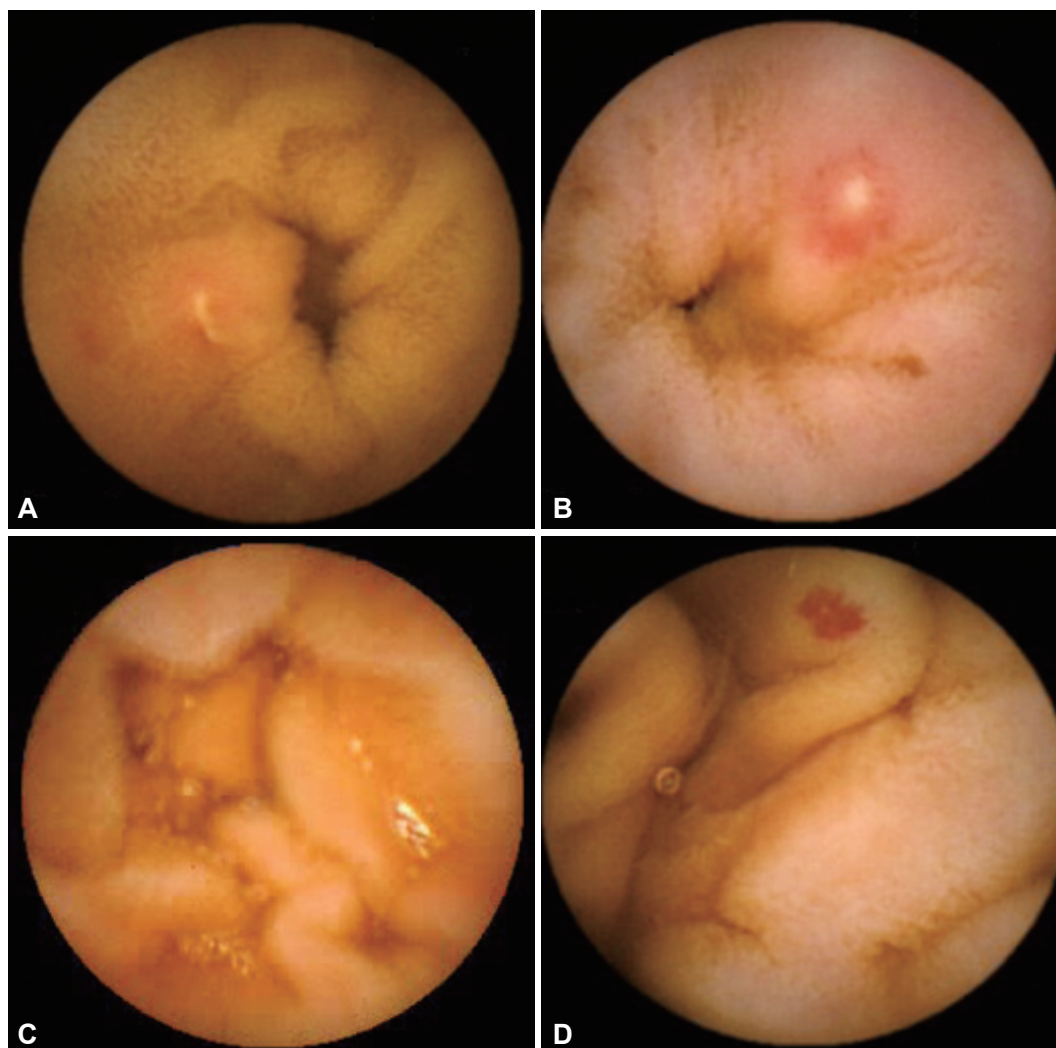


Fig. 2. Flat lesions in the small bowel. (A) Erosions. (B) Aphthous ulcer. (C) Diverticulum. (D) Angiodysplasia.

had lower accuracies (Fig. 2). The mean kappa values for the experts and trainees were 0.61 (range, 0.39 to 0.97) and 0.46 (range, 0.17 to 0.66), respectively. This study is the first systematic study to evaluate the inter-observer variation associated with VCE interpretation by experts compared to trainees. The findings showed that the inter-observer differences were greatest for subtle lesions, which were missed more often by trainees. The inter-observer variation in the expert group (mean kappa value of 0.61, indicating substantial agreement) was lower than that in the trainee group (mean kappa value of 0.46, indicating moderate agreement). These findings highlight the importance of experience with conventional endoscopy in the review of VCE findings and the need for consensus regarding CEST terminology.²⁴

Capsule retention

Retention of capsule is one of the severe complications of VCE, and most cases need surgical intervention to remove

the retained capsule in patients who would have been treated medically otherwise.²⁵ To address several issues associated with capsule retentions, a nationwide study was performed. This study attempted to investigate the incidence and clinical outcomes of capsule retention and to determine the factors predictive of spontaneous capsule passage after retention.²⁶ We retrospectively reviewed the records of 1,291 patients who had a capsule endoscopy between February 2002 and July 2006 in Korea. Clinical and procedural characteristics and postprocedural outcomes were analyzed for the cases with capsule retention. Capsule retention occurred in 2.5% out of total cases (32/1,291). The major diseases accompanying capsule retention were Crohn's disease, malignant tumors, and tuberculous enterocolitis, in decreasing order. It was somewhat different from Western countries in which the prevalence of NSAID use is relatively high.²⁷ In 11 of the 32 patients (34.4%), early surgical or endoscopic interventions were instituted for diagnosis or treatment of diseases before the symp-

toms of retention developed. The remaining 21 (65.6%) patients initially received medical treatments. Of these, 10 (31.3%) ultimately underwent surgical intervention due to the development of symptoms of intestinal obstruction or medical treatment failure. The other 11 (34.4%) eventually passed the capsule. The presence of a larger lumen diameter (greater than two-thirds of the capsule diameter) at the stricture site was associated with spontaneous passage. In conclusion, the results of our study suggest that retention occurs infrequently during capsule endoscopy. Physicians should be aware of the potential risks of retention when using capsule endoscopy, particularly in cases of Crohn's disease, malignant tumors, or, in Korea, tuberculosis.²⁶

CONCLUSIONS

Since its development, VCE played an important role in the diagnosis of small bowel disease. It can be easily introduced into the patient's GI tract. The Korean Gut Images Group performed multicenter studies about the VCE in various fields. It is very important in that we collected almost all the data about VCE in Korea and the results were specific to Korean. Some of them were similar with previous western studies and others were different. In unexplained abdominal pain, VCE could be a useful diagnostic modality and, when combined with weight loss, they were independent risk factors of positive findings on VCE. The diagnostic yield of VCE for small bowel tumors was superior to that of any other currently available radiological procedures. The yield is even equivalent to that obtained by double balloon enteroscopy. We need larger scale studies on the effect of various bowel preparation methods on the diagnostic yield of capsule endoscopy. Further studies are also needed to better understand the learning curve for VCE and unique capsule endoscopic findings for small intestinal diseases in Korean patients.

Conflicts of Interest

The authors have no financial conflicts of interest.

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