INFLAMMATORY BOWEL DISEASE

Wireless capsule endoscopy versus ileocolonoscopy for the diagnosis of postoperative recurrence of Crohn's disease: a prospective study

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Background and aims: Following ileocolonic resection for Crohn's disease (CD), early endoscopic recurrence predicts recurrence of symptoms. The aim of the study was to compare ileocolonoscopy and wireless capsule endoscopy (WCE) for the detection of postoperative recurrence in CD.

Methods: WCE and ileocolonoscopy were performed within six months following surgery in 32 prospectively enrolled patients. Two independent observers interpreted the results of WCE. Recurrence in the neoterminal ileum was defined by a Rutgeerts score ≥ 1 . When observers at WCE did not concur, WCE results were considered as either true negative or true positive and sensitivity and specificity were calculated according to both assumptions.

Results: Recurrence occurred in 21 patients (68%) and was detected by ileocolonoscopy in 19 patients. Sensitivity was 90% and specificity 100%. Sensitivity of WCE was 62% and 76% and specificity was 100% and 90%, respectively, depending on assumptions. There was a correlation between the severity of the lesions measured by both methods ($p < 0.05$). Lesions located outside the scope of conventional endoscopy were detected by WCE in two thirds of patients with excellent interobserver agreement ($\kappa > 0.9$) for all lesions with the exception of ulceration ($\kappa = 0.7$).

Conclusions: The sensitivity of WCE in detecting recurrence in the neoterminal ileum was inferior to that of ileocolonoscopy. In contrast, WCE detected lesions outside the scope of ileocolonoscopy in more than two thirds of patients. Additional follow up studies are needed to assess the clinical relevance of such lesions. At the present time, it seems that WCE cannot systematically replace ileocolonoscopy in the regular management of patients after surgery.

Crohn's disease (CD) is a chronic inflammatory bowel disease that can involve any segment of the gastrointestinal tract. Despite the increasing use of immunosuppressive drugs, up to 70% of patients will undergo surgical resection during the course of their disease.^{1,2} After ileocolonic resection, despite removal of all macroscopic lesions, the disease typically recurs at the site of resection and extends to the neoterminal ileum following the same pattern as initially.

Before clinical relapse occurs, early features of endoscopic recurrence in the neoterminal ileum have been reported in 73-93% of cases at one year post surgery.³ Moreover, the severity of endoscopic lesions detected within the first year following surgery is the best predictor of the postoperative course of the disease. Patients with severe lesions in the neoterminal ileum are at higher risk of early symptomatic relapse compared with patients with either mild lesions or without lesions.³ Even if the clinical importance of an early endoscopic recurrence has not been evaluated in prospective controlled studies, it has been proposed that postoperative endoscopic examination of the neoterminal ileum six months after surgery may be used to determine the therapeutic management of CD patients after surgery. Detection of severe lesions in the neoterminal ileum could justify per se commencement of a prophylactic therapy, even in asymptomatic patients.⁴

Ileocolonoscopy is currently considered to be the "gold standard technique" for the detection of postoperative endoscopic recurrence. Unfortunately, ileocolonoscopy is an invasive procedure which frequently requires sedation or anaesthesia and thus is considered to be unpleasant for the

majority of patients. Furthermore, only a limited distal part of the small bowel can be explored.

Recently, a wireless capsule enteroscope (WCE) has been developed and is now available in routine practice.⁵ The WCE offers the following potential advantages over other traditional endoscopic procedures: (a) full length visualisation of the small bowel, including the neoterminal ileum, (b) ability to detect small lesions, (c) sedation or anaesthesia is not required, and (d) well tolerated by patients. The superiority of this new technique, when compared with traditional endoscopic or radiological procedures, has been demonstrated in various situations.⁶⁻¹² In patients with suspected or known CD, the diagnostic yield of WCE has been found to be superior to small bowel follow through and computerised tomography (CT).^{7-10,12}

As a result of its improved diagnostic yield and ability to detect small lesions, WCE has the potential to detect early recurrences and thus to identify patients who may be at higher risk of symptomatic relapse. However, there is currently no available data to support such a role in the management of patients following ileocolonic resection. The aims of the present prospective study were therefore: (i) to compare lesions detected by WCE and ileocolonoscopy in the distal small bowel (that is, in the segment explored by both methods) within the six month period following surgery; (ii) to explore the entire length of the remaining small bowel;

Abbreviations: CD, Crohn's disease; WCE, wireless capsule endoscopy; CT, computed tomography; PEG, polyethylene glycol solution; IQR, interquartile range

and (iii) to assess interobserver concurrence in the detection and description of macroscopic lesions.

PATIENTS AND METHODS

Study design

Patients between 18 and 75 years of age, with known CD, undergoing an ileocolonic resection, were prospectively enrolled in the study from September 2003 until February 2005. The study was approved by the institutional review board of our hospital "CCPPRB No 2 Pays de la Loire-Ethics Committee" and all patients gave informed written consent before entry into the study.

The diagnosis of CD was based on established clinical, radiological, endoscopic, and histological criteria. Patients were included at the time of the endoscopic procedures. All patients underwent an ileocolonic resection 3–6 months before their enrolment. In cases with a diverting stoma, the study began 3–6 months after its closure. Surgical resection was performed with the intention of removing visible macroscopic lesions. All of the anastomoses were visualised by subsequent ileocolonoscopy. Treatment with aminosaliculates, antibiotics, steroids, and immunosuppressants or immunomodulators was allowed after surgery, as is often required.

Demographic data and gastrointestinal medical history were recorded. When the delay between surgery and inclusion into the study exceeded five months, even in the absence of symptoms, either an entero-CT scan or a barium follow through were performed to detect any stricture. In the absence of contraindications (that is, symptomatic stricture or stenosis detected radiologically), patients swallowed the capsule and ileocolonoscopy was performed. WCE and ileocolonoscopy were completed within one week of each other with WCE always preceding ileocolonoscopy.

Capsule endoscopy procedure

Details of the Given M2A capsule (Given Imaging, Maison-Laffitte, France) have been described previously.⁵

WCE was performed after an overnight fast. In order to optimise visualisation of the small bowel, patients underwent a preparation with 1 litre of polyethylene glycol solution (PEG) two hours before starting the procedure. Patients were free to drink clear liquids two hours after ingesting the capsule and to eat a meal four hours later. Ease of ingestion, time of discharge, and occurrence of any signs or symptoms, such as discomfort, during the procedure were recorded.

The capsule video film was recorded for each patient. Two independent observers in each centre were allocated to visualisation of the videos. The observers were involved in the development of this new technique in each centre and had a similar practice for analysis of WCE. Observers of

groups 1 and 2 were blind to each other and also to the results of ileocolonoscopy, which was performed by an independent investigator. Each observer assessed the presence or absence of prespecified abnormal potential findings (that is, erythema, villous denudation, erosion, and ulceration), their locations in the proximal or distal jejunum and ileum, the quality of the procedure, and duration of interpretation. For ileal lesions we used the severity grading scale defined by Rutgeerts.³ Intestinal transit time between the pylorus and ileocolonic anastomosis was recorded and the limit between upper and lower small bowel was set at half the transit time.¹³

Ileocolonoscopy procedure

All patients underwent ileocolonoscopy under sedation or anaesthesia within seven days following the capsule procedure. One day prior to the procedure, bowel preparation was achieved with at least 4 l of PEG solution. For each patient, an independent gastroenterologist (blind to the capsule observers) performed the endoscopy. Postoperative endoscopic recurrence of CD in the neoterminal ileum and the ileocolonic anastomosis was evaluated using the same score.³ Finally, the quality of bowel preparation and duration of the procedure were also assessed.

Classification and statistical analysis

Recurrence in the neoterminal ileum was defined as the presence of one or more erosions or ulcerations (that is, Rutgeerts score ≥ 1) detected at ileocolonoscopy or by two concordant WCE results. Therefore, all recurrences found at ileocolonoscopy were considered true positive results. In contrast, for patients with recurrence at ileocolonoscopy and discordant results at WCE, we calculated the sensitivity of WCE according to two different hypotheses: we considered that it may correspond to either a true positive (highest sensitivity value) or a true negative result (lowest sensitivity value). Specificity values were calculated accordingly with respect to the group of patients without recurrence (table 1). As a Rutgeerts score ≥ 2 has previously been used in therapeutic trials as a cut off for the definition of endoscopic recurrence, all prior calculations were repeated for this cut off value.

Due to the absence of preliminary data in this specific population of patients, statistics were mainly descriptive and we arbitrarily decided to include 30 patients in the study. The characteristics of the population were described according to data collected at the time of inclusion. Categorical variables were described using frequencies and percentages; continuous variables were summarised using frequency, mean (SD), or median (interquartile range (IQR)). Interobserver agreement for the description of lesions detected by WCE

Table 1 Definition of recurrence and classification of results for colonoscopy and wireless capsule endoscopy (WCE)

	Recurrence (yes/no)	Classification of results	
		Colonoscopy	WCE
Colonoscopy+, WCE+/-	Yes	TP	TP
Colonoscopy+, WCE+/-	Yes	TP	TP (highest sen) FN (lowest sen)
Colonoscopy+, WCE-/-	Yes	TP	FN
Colonoscopy-, WCE-/-	No	TN	TN
Colonoscopy-, WCE+/-	No	TN	FP (lowest spec) TN (highest spec)
Colonoscopy-, WCE+/-	Yes	FN	TP

Colonoscopy was classified as (+) when lesions were visualised and (-) in the absence of lesions. WCE was classified as (+/+) when two observers visualised lesions, (+/-) when one observer visualised lesions, and (-/-) in the absence of lesions.

TP, true positive; TN, true negative; FP, false positive; FN, false negative; sen, sensitivity; spec, specificity.

over the entire length of the small bowel (that is, erythema, villous denudation, erosion, and ulceration) was evaluated using the kappa coefficient. Correlation between the severity of lesions seen at WCE and ileocolonoscopy was assessed using Spearman's correlation rank test. Results were considered significant when the *p* value was less than 0.05.

RESULTS

Demographic characteristics of the patients

Thirty two patients (10 males, 22 females; median age 27 years (23–33)) completed the study. Baseline characteristics of the patients are shown in table 2. At the time of either endoscopic procedure, none of the patients was taking non-steroidal anti-inflammatory drugs which are potentially harmful to the small intestine. Seven patients (22%) were receiving aminosalicylates and three patients (9%) immunosuppressants. The main indications for surgery were fistulas and abscesses, but despite these complications, only three patients had a diverting stoma created (table 2). These patients were included in the study six months after closure of the ileostomy. Median delay between surgery and endoscopic procedures was six months (IQR 4–7). When the delay exceeded five months, a barium follow through or an entero-CT scan was systematically performed prior to the capsule procedure. Thus 13 patients (41%) underwent a barium follow through and three patients (9%) an entero-CT scan. No investigation detected a stricture. All patients swallowed the capsule easily and no symptoms were reported during the procedure. The capsule reached the colon in all cases and bowel preparation was considered to be good in more than 90% of patients. Mean (SD) duration of interpretation of the capsule video films was 54 (20) minutes. Mean (SD) duration of ileocolonoscopy, excluding the time required for initiation of sedation, was significantly shorter at 25 (8) minutes ($p < 0.05$, Student's *t* test).

Postoperative endoscopic recurrence in the neoterminal ileum

The neoterminal ileum was reached and explored by ileocolonoscopy in 31 patients (97%). In the remaining patient in whom WCE was negative according to both investigators and the ileum not seen at ileocolonoscopy, classification was impossible and this individual was excluded from calculation of diagnostic indicators (but not for the description of lesions by WCE).

According to the definition of recurrence, 21 patients (68%) had a recurrence in the distal ileum.

Table 2 Patient demographics at baseline

	Patients (n = 32)
Sex (M/F)	10/22
Age (y)*	27 (23–33)
Disease duration (months)*	42 (7–96)
Postoperative treatment (n (%))†	
None	9 (28)
Aminosalicylates	7 (22)
Immunosuppressants	3 (9)
Steroids	1 (3)
Others	14 (44)
Indication for resection (n (%))	
Resistance to medical treatment	6 (19)
Stenosis	12 (37)
Abscess or fistula	14 (44)
Diverting stoma (n (%))	3 (9)
Delay between surgery and WCE (months)*	6 (4–7)

*Values are median (interquartile range).

†Patients could have more than one medication.

Table 3 Results of ileal exploration by wireless capsule endoscopy (WCE) and ileocolonoscopy in 31 patients following surgery for Crohn's disease

	WCE		Ileocolonoscopy
	Group 1	Group 2	
Grade i0	18	14	12
Grade i1	4	7	7
Grade i2	7	8	6
Grade i3	2	2	6
Grade i4	0	0	0

Data are expressed as Rutgeerts scores.³ One patient was excluded as the ileum was not visualised at ileocolonoscopy.

Figure 1 Correlation between severity of the lesions visualised at wireless capsule endoscopy (WCE) by group 1 (A) and group 2 (B) observers and ileocolonoscopy assessed by the Rutgeerts score.³ The correlation was calculated using Spearman's rank order correlation test. The diameter of each circle is proportional to the number of patients.

Endoscopic recurrences were seen at ileocolonoscopy in 19 patients (61%): i1 (n = 7); i2 (n = 6); i3 (n = 6). None of the patients had an i4 endoscopic recurrence. In two patients, endoscopic recurrence in the neoterminal ileum was not seen by ileocolonoscopy but obviously by WCE. In the first case, the two observers visualised ulcerations and recurrence was graded as i2. In the second case, ulcerations and erosions were seen and recurrence was graded i1 by one and i2 by the second observer at WCE. Characteristics of lesions detected by group 1 and group 2 observers at WCE are described in table 3. Grades of severity of the lesions seen at ileocolonoscopy and by the two groups of observers at WCE were significantly correlated ($p < 0.05$; Spearman's rank order correlation) (fig 1). However, there was a trend for underestimation of the severity of lesions by WCE (fig 1). Patients with endoscopic ileal recurrence had concurrent jejunal lesions (10 of 21); in contrast, no proximal lesions were

detected in patients with a normal ileum (0 of 10) at WCE ($p = 0.01$; Fisher's test).

Overall, using a cut off value of i1, sensitivity and specificity values of ileocolonoscopy and WCE for the detection of ileal recurrence are summarised in table 4. Sensitivity values of WCE for diagnosis of this recurrence were 62% (lower estimate) and 76% (upper estimate). Corresponding specificity values were 90% (lower estimate) and 100% (upper estimate).

Using a cut off value of i2 for the definition of endoscopic recurrence yielded the following values: 14 patients (45%) had a recurrence in the distal ileum. The sensitivity and the specificity values of ileocolonoscopy were 86% and 100%. Sensitivity values of WCE were 50% (lower estimate) and 79% (upper estimate). Corresponding specificity values were 100% and 94%.

Additional lesions detected at WCE

Group 1 observers detected lesions (that is, patchy erythema, villous denudation, erosions, and ulcerations) in the small intestine outside the scope of conventional endoscopy in 66% of patients and group 2 observers in 72% of patients (table 5). The lesions were distributed throughout the length of the small intestine. The lesions were localised to the upper small bowel in 56% of patients in group 1 and in 50% of patients in group 2. In the upper small bowel, all observers in both groups described erythema in four patients (12%) and villous denudation in only one patient. Erosions and ulcerations in particular were the most frequently encountered lesions (table 5). Lesions were located in the lower small bowel in 17 patients (53%) according to group 1 observers and in 22 patients (69%) according to group 2 observers. Erythema was seen in the lower small bowel of two patients and no observer reported villous denudation. For group 1, ulcerations were detected in 16 patients (50%) and in 20 patients in group 2 (63%) (table 5).

Interobserver agreement for the description of the lesions was evaluated using the kappa coefficient. Concordance was excellent for description of erythema or villous denudation with a kappa coefficient of 1.0 for both lesions, and for the description of erosions, a kappa coefficient of 0.9 was found. Concordance was good for the description of ulcerations, with a kappa coefficient of 0.7. Even if interobserver concordance was assessed segment by segment (that is, upper and lower small bowel), agreement was consistently good with a kappa coefficient above 0.8 for all lesions in both segments, with the exception of the description of ileal ulceration. In this case, concordance was only acceptable, with a kappa coefficient of 0.6. The observers in the two groups were in agreement regarding localisation of lesions in the upper or lower small bowel, or both, or absence of lesions in 84% of cases.

DISCUSSION

To our knowledge, ours is the first prospective evaluation of WCE in the early postoperative follow up of patients with CD.

Table 4 Sensitivity and specificity of ileocolonoscopy and wireless capsule enteroscopy (WCE) for detection of endoscopic recurrences in the terminal ileum

	WCE		Ileocolonoscopy
	WCE $\pm$ = FN*	WCE $\pm$ = TP*	
Sensitivity (%)	62	76	90
Specificity (%)	100	91	100

*Recurrence was defined as the presence of one or more erosions or ulcerations detected by ileocolonoscopy and/or by two concordant WCE results. When observers were discordant, WCE was classified as $\pm$ and was considered either a false negative (FN) or true positive (TP) result.

Table 5 Characteristics and prevalence of lesions detected at wireless capsule endoscopy in the small intestine by the two groups of observers

	Patients with lesions (n (%))	
	Group 1	Group 2
Small intestine	21 (66)	23 (72)
Upper small bowel	18 (56)	16 (50)
Erythema	4 (12)	4 (12)
Villous denudation	1 (3)	1 (3)
Erosions	7 (22)	5 (16)
Ulcerations	13 (41)	12 (38)
Lower small bowel	17 (53)	22 (69)
Erythema	2 (6)	2 (6)
Villous denudation	0 (0)	0 (0)
Erosions	6 (19)	6 (19)
Ulcerations	16 (50)	20 (63)

They study also direct compared WCE with ileocolonoscopy in the evaluation of early endoscopic recurrence in the distal ileum. With ileocolonoscopy, endoscopic recurrence was found in the neoterminal ileum in 61% of cases. The sensitivity of WCE for diagnosis of this recurrence ranged from 62% to 76%, and specificity from 90% to 100%, based on lower and upper estimates. Furthermore, the majority of patients had lesions distributed on the entire length of the small intestine, which were ignored at ileocolonoscopy.

Our results showed that neoterminal involvement occurred in two thirds of patients. It has been well demonstrated that early lesions in the neoterminal ileum after CD resection do not originate from pre-existing disease or inflammation left at the time of surgery and can reliably be defined as postoperative recurrences.¹⁴ Ileocolonoscopy is currently considered the "gold standard technique" for exploration of the neoterminal ileum. However, several shortcomings (that is, difficulty in reaching and passing through the anastomosis, visualisation limited to the few distal centimetres) could explain underevaluation of the frequency of recurrences in a few cases. In contrast, WCE provides the opportunity of exploring the entire length of the small intestine, including the neoterminal ileum. According to our definition, the sensitivity of ileocolonoscopy in detecting recurrence was 90% and specificity was 100%. In the absence of ileal recurrence, no proximal lesions were detected at WCE and in contrast 10 of 21 patients with ileal recurrences had concurrent lesions in their jejunum. WCE also detected recurrences in two cases missed by ileocolonoscopy. In the first case, the two observers visualised ulcerations, and recurrence was graded as i2. In the second case, ulcerations and erosions were seen, and recurrence was graded as i1 by one observer and as i2 by the second observer at WCE. Overall, there was a good correlation between Rutgeerts scores determined by ileocolonoscopy and by WCE despite significant underscoring by the later compared with the former. This underestimation could be explained by technical difficulties related to WCE such as persistence of liquid stools in the distal ileum and irregular propagation of the capsule. Endoscopic recurrence was defined by the presence of lesions in the neoterminal ileum (that is, Rutgeerts score ≥ 1) in our study. However, in postoperative therapeutic trials, recurrence has been defined by the presence of more severe lesions (that is, Rutgeerts score ≥ 2).^{15 16} Using this cut off value, sensitivities of WCE ranged from 50% to 79% and specificity values were above 90%. Despite this lack of sensitivity, WCE may be useful as a firstline evaluation of postoperative recurrence due to its good tolerability.

Involvement of the small intestine, outside the scope of conventional endoscopy, occurred in approximately two

thirds of patients operated on less than six months previously. Strengths of the present work included prospectively describing elemental lesions and assessing interobserver agreement. Lesions were described according to previous literature on CD and terms such as erosion, ulceration, villous denudation, and erythema were pre-defined for each investigator in order that the same vocabulary was used on the record forms. Intestinal transit time between the pylorus and ileocolonic anastomosis was recorded and the limit between the upper and lower small bowel was set at half the transit time. Using this arbitrary limit, interobserver agreement was generally good or excellent, irrespective of the type and location of lesions. However, concordance for description of ulcerations (especially in the ileum) was surprisingly poorer than expected, with a kappa coefficient of only 0.6. Difference in observer expertise is unlikely to have played a major role as the majority of the WCE investigators had undergone previous similar training and experience of the technology. Again, incomplete cleansing of the distal small bowel and persistence of liquid stools or debris in the distal ileum could account for the lack of visualisation of some lesions by investigators.

Our study was not specifically designed to detect all early recurrences affecting the entire small bowel. For both practical and economic reasons, the protocol did not include a systematic peroperative endoscopic exploration of the small intestine or an immediate postoperative assessment with WCE. It is therefore impossible to claim that all lesions detected in the small bowel above the ileum within the six month period after resection were not already present at the time of surgery. Indeed, lesions localised along the small intestine were visualised by peroperative enteroscopy in 65% of patients with CD who underwent surgical resection.¹⁷ Aphthoid ulcerations were most frequently identified, but deep ulcerations or ulcerated stenoses were also found. Some of these lesions were not recognised on surgical inspection and could be left in place; moreover, it has been demonstrated that external changes in the bowel wall are an unreliable guide to the extent of mucosal inflammation.^{17, 18} However, such a high prevalence of remaining lesions after an apparently complete surgical resection may also represent overestimation due to the invasiveness of the peroperative enteroscopic investigation itself.¹⁹ In any case, the clinical significance of such lesions is not well understood. A previous study by Klein *et al* suggested that small bowel lesions left in place at surgery did not influence the rate of postoperative recurrence.¹⁹ Further prospective studies are needed to address this critical issue.

The WCE investigation carries a theoretical risk of impaction of the capsule in general and in CD in particular.^{9, 12, 20, 21} No capsule retention was observed in this series but it is worth remembering that no patient had a Rutgeerts score of i4, which is associated with narrowing. To avoid capsule entrapment, some authorities have recommended systematic enteroclysis or CT scan prior to a WCE procedure. In the future, a more attractive option might include the use of a "patency capsule", especially in patients with symptoms suggestive of small bowel obstruction. However, very few data are available on this new device and the case of transitory small bowel obstruction induced by a "patency capsule" needs to clarify conditions for its use in CD patients.²²

In summary, we have demonstrated that WCE can be used safely in patients who have recently undergone surgical resection. The sensitivity of WCE in detecting recurrence is the neoterminal ileum was inferior to that of ileocolonoscopy. On the other hand, WCE detected lesions evenly distributed in the jejunum and ileum in more than two thirds of patients, which were ignored at ileocolonoscopy. The clinical relevance of these lesions deserves further study with a more prolonged

follow up time. At present, it seems that WCE cannot systematically replace ileocolonoscopy in the regular management of patients after surgery.

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REFERENCES

- 1 **Farmer RG**, Whelan G, Fazio VW. Long-term follow-up of patients with Crohn's disease. Relationship between the clinical pattern and prognosis. *Gastroenterology* 1985;**88**:1818-25.
- 2 **Cosnes J**, Nion-Larmurier I, Beaugerie L, *et al*. Impact of the increasing use of immunosuppressants in Crohn's disease on the need for intestinal surgery. *Gut* 2005;**54**:237-41.
- 3 **Rutgeerts P**, Geboes K, Vantrappen G, *et al*. Predictability of the postoperative course of Crohn's disease. *Gastroenterology* 1990;**99**:956-63.
- 4 **Rutgeerts P**. Strategies in the prevention of post-operative recurrence in Crohn's disease. *Best Pract Res Clin Gastroenterol* 2003;**17**:63-73.
- 5 **Iddan G**, Meron G, Glukhovsky A, *et al*. Wireless capsule endoscopy. *Nature* 2000;**405**:417.
- 6 **Pennazio M**, Santucci R, Rondonotti E, *et al*. Outcome of patients with obscure gastrointestinal bleeding after capsule endoscopy: report of 100 consecutive cases. *Gastroenterology* 2004;**126**:643-53.
- 7 **Fireman Z**, Mahajna E, Broide E, *et al*. Diagnosing small bowel Crohn's disease with wireless capsule endoscopy. *Gut* 2003;**52**:390-2.
- 8 **Eliakim R**, Suissa A, Yassin K, *et al*. Wireless capsule video endoscopy compared to barium follow-through and computerized tomography in patients with suspected Crohn's disease-final report. *Dig Liv Dis* 2004;**36**:519-22.
- 9 **Ge ZZ**, Hu YB, Xiao SD. Capsule endoscopy in diagnosis of small bowel Crohn's disease. *World J Gastroenterol* 2004;**10**:1349-52.
- 10 **Costamagna G**, Shah SK, Riccioni ME, *et al*. A prospective trial comparing small bowel radiographs and video capsule endoscopy for suspected small bowel disease. *Gastroenterology* 2002;**123**:999-1005.
- 11 **Herrerias JM**, Caunedo A, Rodriguez-Tellez M, *et al*. Capsule endoscopy in patients with suspected Crohn's disease negative endoscopy. *Endoscopy* 2003;**35**:564-8.
- 12 **Voderholzer WA**, Beinhöhl J, Rogalla P, *et al*. Small bowel involvement in Crohn's disease: a prospective comparison of wireless capsule endoscopy and computed tomography enteroclysis. *Gut* 2005;**54**:369-73.
- 13 **Saurin JC**, Delvaux M, Gaudin JL, *et al*. Diagnostic value of endoscopic capsule in patients with obscure digestive bleeding: blinded comparison with video-push enteroscopy. *Endoscopy* 2003;**35**:576-84.
- 14 **Olaion G**, Smedh K, Sjödal R. Natural course of Crohn's disease after ileocolic resection: endoscopically visualized ileal ulcers preceding symptoms. *Gut* 1992;**33**:331-5.
- 15 **Hanauer SB**, Korelitz BI, Rutgeerts P, *et al*. Postoperative maintenance of Crohn's disease remission with 6-mercaptopurine, mesalazine or placebo: 2-year trial. *Gastroenterology* 2004;**127**:723-9.
- 16 **Rutgeerts P**, Van Assche G, Vermeire S, *et al*. Ornidazole for prophylaxis of postoperative Crohn's disease recurrence: A randomized, double-blind, placebo-controlled trial. *Gastroenterology* 2005;**128**:856-61.
- 17 **Lescut D**, Vanco D, Bonnière P, *et al*. Perioperative endoscopy of the whole small bowel in Crohn's disease. *Gut* 1993;**34**:647-9.
- 18 **Smedh K**, Olaion G, Nyström PO, *et al*. Intraoperative enteroscopy in Crohn's disease. *Br J Surg* 1993;**80**:897-900.
- 19 **Klein O**, Colombel JF, Lescut D, *et al*. Remaining small bowel endoscopic lesions at surgery have no influence on early anastomotic recurrences in Crohn's disease. *Am J Gastroenterol* 1995;**90**:1949-52.
- 20 **Swain P**. Wireless capsule endoscopy and Crohn's disease. *Gut* 2005;**54**:323-6.
- 21 **Mow WS**, Lo SK, Targan SR, *et al*. Initial experience with wireless capsule endoscopy in the diagnosis and management of inflammatory bowel disease. *Clin Gastroenterol Hepatol* 2004;**2**:31-40.
- 22 **Gay G**, Delvaux M, Laurent V, *et al*. Temporary intestinal obstruction induced by a "patency capsule" in a patient with Crohn's disease. *Endoscopy* 2005;**37**:174-7.