CASE REPORT

Feasibility of small bowel capsule endoscopy in children under the age of 4 years: a single centre experience

Babu Vadamalayan,¹ Michael Hii,¹ Justin Kark,¹ Ingvar Bjarnason²

¹Pediatric Liver, GI and Nutrition Centre, King's College Hospital, London, UK

²Department of Gastroenterology, King's College Hospital, London, UK

Correspondence to

Dr Babu Vadamalayan,
Paediatric Liver, GI and Nutrition
Centre, King's College Hospital,
Denmark Hill, London SE5 9RS,
UK;
babu.vadamalayan@nhs.net

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Abstract

Data on the use of wireless capsule endoscopy (WCE) in younger children remain limited. However, this single centre study suggests that it is a relatively complication-free procedure that may be considered in younger children below 4 years of age, when small bowel pathology is suspected. We retrospectively reviewed the King's College Hospital WCE database between August 2009 and August 2011. Patients aged 4 years or younger were included in the study. Six children fulfilled the inclusion criteria. The indications for WCE were unexplained gastrointestinal tract (GIT) bleeding (n=4), chronic diarrhoea with (n=1) and without (n=1) GIT bleeding (n=1). All had an oesophagogastroduodenoscopy and an ileocolonoscopy before WCE. The mean age at the time of WCE was 2 years 6 months (range 1 year 7 months to 3 years 7 months). The mean weight at WCE was 13.3 kg (range 9–17 kg). Four children had a complete study.

Introduction

Wireless capsule endoscopy (WCE) was first described in 1981 in an attempt to obtain images of the small bowel, in a minimally invasive manner. The first prototype was produced by Given Imaging (Yokneam, Israel) in the mid-1990s. In August 2001, the US Food and Drug Administration approved WCE for use as a method for investigating small bowel disease, and by January 2004 WCE was approved for use in the paediatric population above the age of 10 years. However, at present, there are no agreed guidelines for the use of WCE in the paediatric population in the UK. To date, only a handful of studies has examined the complications of WCE in young children.^{1–3} The aims of

this study were to assess and identify the potential complications of WCE in young children.

Patients and methods

We retrospectively reviewed the departmental WCE database at King's College Hospital between August 2009 and August 2011. Patients aged 4 years or younger were included in the study. Clinical and demographical data were obtained for all (see table 1). All patients received standard bowel preparation with senokot and sodium picosulfate the night before WCE. Two makes of capsule were used PillCam SB (Given Imaging) and MiroCam (IntroMedic, Seoul, Korea). The capsule was introduced into the duodenum by direct placement via gastroscope under general anaesthesia. Placement was performed using the Roth Net retrieval device or capsule endoscope introducer (US Endoscopy, Mentor, Ohio, USA). Patients were permitted to drink and eat 2 h and 6 h, respectively, after the release of WCE. WCE was discontinued after 8 h of recording time had elapsed. Completion of the study was defined by the passage of the capsule to the caecum. Passage of WCE from the gastrointestinal tract (GIT) was confirmed by direct examination of the stool or abdominal x-ray. Retention of the capsule was defined by failure of the capsule to exit the GIT after 2 weeks or more, requiring endoscopic or surgical intervention.

Results

Six children fulfilled the inclusion criteria. Four children had an underlying primary

Table 1 Demographic and clinical data

Patient	Sex	Age at WCE	Weight at WCE (kg)	Primary diagnosis	Indication for WCE	Risk factors	Completion yes/no, duration (min)	Complications yes/no	Findings	Follow-up (days)
1	F	1 year 7 months	9	Biliary atresia	GIT bleed	Previous surgery	Yes 88 min	No	Bleeding from roux loop anastomosis	347
2	M	2 years 3 months	11.5	—	GIT bleed	—	Yes 325 min	No	Ileal polyp/suspected MD	382
3	F	2 years 4 months	17	Autosomal recessive polycystic kidney disease	GIT bleed +diarrhoea	Aspirin	No 240 min	No	Normal	651
4	F	2 years 6 months	13.5	Biliary atresia	Chronic diarrhoea	Previous surgery	Yes 228 min	No	Jejunal angiodysplasia/polyp	63
5	F	2 years 10 months	13	α -1-Antitrypsin deficiency	GIT bleed	Previous surgery	Yes NA	No	Normal	15
6	F	3 years 7 months	15.9	—	GIT bleed	—	Yes 355 min	No	LNH/Ileal polyp	336

GIT, gastrointestinal tract; LNH, lymphonodular hyperplasia; MD, Meckel's diverticulum; NA, not available; WCE, wireless capsule endoscopy.

chronic disease; autosomal recessive polycystic kidney disease (n=1), biliary atresia (n=2), α 1-antitrypsin deficiency (n=1). Of these four patients, at the time of WCE, three had previously had liver transplantation and one was awaiting kidney transplantation. The indications for WCE were unexplained GIT bleeding (n=4), chronic diarrhoea and GIT bleeding (n=1) and chronic diarrhoea (n=1). All had an oesophagogastro-duodenoscopy and ileocolonoscopy before WCE. Oesophagogastroduodenoscopy was normal in all except one patient who was found to have oesophageal and duodenal varices; these were not thought to be contributing significantly to the symptoms of the patient, who had melena stools and fresh per rectum (PR) bleeding. Pillcam SB was used in all six children except in one, in whom mirocam was used because of the availability in our unit.

Ileocolonoscopy had revealed abnormal findings in five patients (see table 2). The mean age at the time of WCE was 2 years 6 months (range 1 year 7 months to 3 years 7 months). The mean weight at WCE was

13.3 kg (range 9–17 kg). The mean post-WCE follow-up duration was 299 days (range 15–651 days). Bowel preparation was adequate in all six patients. Four children had a complete study (capsule exiting the ileocaecal valve). One child had a complete study but details of study duration were unavailable. One patient had an incomplete study. In the patients who had a complete study the mean time to caecum was 249 min (range 88–355 min). All patients had minor trauma to the oesophageal mucosa during the initial delivery of the capsule. None experienced complications during or after WCE, including retention of the capsule. One patient died of severe pulmonary haemorrhage secondary to disseminated intravascular coagulopathy 15 days post WCE, unrelated to the WCE procedure itself.

Individual patient details

Patient 1

A 1-year 7-month-old girl, weighing 9 kg, with a history of biliary atresia. She underwent a Kasai

Table 2 Investigations before WCE

Patient	BMFT	OGD	Ileocolonoscopy	Meckel's scan	Laparoscopy	Others
1	—	Normal	Normal	—	—	—
2	Normal	Normal	Blood mixed with bile in ileum	Normal	Normal	Normal bleeding scan
3	—	Normal	LNH/eosinophilic colitis Angiodysplasia in ileum	—	—	—
4	—	Normal	LNH Low-grade PTLD	—	—	—
5	Normal	Varices	Normal	—	—	—
6	—	Normal	Pinworms LNH	Normal	—	—

BMFT, barium meal follow through; LNH, lymphonodular hyperplasia; OGD, oesophagogastroduodenoscopy; PTLD, posttransplant lymphoproliferative disease; WCE, wireless capsule endoscopy.

portoenterostomy at 8 weeks of age and received a liver transplant aged 13 months. Her recovery post-transplant was complicated by two bowel perforations requiring surgical repairs. She presented 4 months after transplant with fresh PR bleeding and melena. Oesophagogastrroduodenoscopy was normal and ileocolonoscopy showed diffuse hyperaemia with multiple bleeding points and also several ulcers in the rectum and sigmoid, which were thought to be biopsy sites from a proctosigmoidoscopy performed 6 days earlier. WCE was complete; time to caecum was 88 min. It showed bleeding from the Roux loop anastomotic site, which was thought to account for the melena. Her PR bleeding and melena resolved spontaneously.

Patient 2

A previously well 2-year 3-month-old boy, weighing 11.5 kg, presented with a 6-month history of PR bleeding. Investigations performed at his referring hospital included Meckel's scan, oesophagogastrroduodenoscopy, proctosigmoidoscopy, laparoscopy, upper GIT contrast study and barium meal follow through—all of which were normal. At the study centre oesophagogastrroduodenoscopy was normal and ileocolonoscopy showed only fresh blood in the ileum. WCE study was complete and the caecum was reached in 325 min; it showed an area suspicious for Meckel's diverticulum and at repeat laparoscopy the presence of a Meckel's diverticulum was confirmed and subsequently resected, with resolution of symptoms.

Patient 3

A 2-year 4-month-old girl, weighing 17 kg, with a past medical history of end-stage renal disease secondary to autosomal recessive polycystic kidney disease (awaiting renal transplant). She was referred with a 4-month history of loose mucoid stools with PR bleeding and had been put on a dairy-free diet. At the time of referral the patient was receiving regular aspirin 3 days per week for haemodialysis requirement. Oesophagogastrroduodenoscopy was normal apart from mild changes possibly related to gastro-oesophageal reflux. Macroscopically, the ileocolonoscopy showed multiple lymphonodular hyperplasia (LNH) and angiodysplastic lesions throughout the colon. The WCE study lasted 240 min but was incomplete; the views of the small bowel that were obtained were normal.

Patient 4

A 2-year 6-month-old girl, weighing 13.5 kg, with a history of biliary atresia. She underwent a Kasai portoenterostomy at 7 weeks of age and later required a liver transplant aged 24 months. Posttransplant she required biliary reconstructive surgery for an anastomotic stricture. Two months after transplant she developed chronic diarrhoea and was treated with oral antibiotics for presumed bacterial overgrowth. Her symptoms did not resolve and therefore

oesophagogastrroduodenoscopy and ileocolonoscopy were performed. Oesophagogastrroduodenoscopy was normal, but ileocolonoscopy revealed circular raised rubbery lesions in the ileum and LNH in the sigmoid colon. Small bowel biopsy showed Epstein-Barr virus-encoded RNA-negative dense lymphoid aggregates with B-lymphocyte predominance suggestive of low-grade posttransplant lymphoproliferative disease (PTLD). She was treated with a course of rituximab (anti-CD20 monoclonal antibody). Repeat oesophagogastrroduodenoscopy, ileocolonoscopy and WCE were performed a month after treatment. Oesophagogastrroduodenoscopy and ileocolonoscopy at that time were normal. WCE was complete, lasting 228 min. It revealed jejunal angiectasia but no features of PTLD.

Patient 5

A 2-year 10-month-old girl, weighing 13 kg, diagnosed with α -1-antitrypsin deficiency at the age of 2 years 3 months. She underwent a liver transplant 2 months after diagnosis. Postoperatively she had multiple post-transplant complications. Early complications included portal vein thrombosis requiring reconstruction and later intra-abdominal sepsis, pleural and pericardial effusions and ventilator dependence requiring tracheostomy. In addition to these complications she underwent three laparotomies: two for abdominal washout for intra-abdominal sepsis and the third for repair of a bowel perforation. One month postlaparotomy for repair of bowel perforation, she developed melena and fresh PR bleeding. Oesophagogastrroduodenoscopy showed oesophageal and duodenal varices but no active bleeding. Ileocolonoscopy did not reveal a source of bleeding. WCE was complete and showed only old blood in the small bowel, but no bleeding point. The data regarding duration of WCE were unavailable.

Patient 6

A 3-year 7-month-old girl, weighing 15.9 kg, was referred with a 31-month history of intermittent PR bleeding, abdominal pain and constipation. Investigations before referral included Meckel's scan, oesophagogastrroduodenoscopy and ileocolonoscopy, all of which were normal. At the study centre repeat oesophagogastrroduodenoscopy was unremarkable and ileocolonoscopy revealed two pinworms (*Enterobius vermicularis*) but was otherwise normal macroscopically. WCE was complete, lasting 355 min. It revealed an area suspicious for Meckel's diverticulum and also LNH. She proceeded to have a laparoscopy, which was negative for Meckel's diverticulum. At present she continues to have intermittent PR bleeding and is awaiting further investigation.

Discussion

The common indications for the use of WCE are unexplained anaemia, obscure GIT bleeding,

suspected Crohn's disease or evaluation of the extent of small bowel involvement in Crohn's disease, chronic diarrhoea and polyps screening. The contraindications for WCE are known swallowing disorders, the presence of bowel strictures or fistulae, suspected bowel obstruction, previous radiation therapy and chronic use of non-steroidal anti-inflammatory drugs especially when associated with obstructive symptoms. WCE appears to be superior in detecting small bowel disease and offers higher diagnostic yield compared to small bowel barium series,⁴⁻⁸ conventional ileocolonoscopy^{6,9} or push enteroscopy.¹⁰⁻²³ However, its use in younger children is less common due to the fear of capsule retention. Until 2006, the youngest patient who underwent WCE was a 2.5-year-old girl weighing 12 kg, who presented with melanic stools.²⁴ She was found to have haemangioma-angiomatosis lesions in the small bowel and underwent jejunal resection, which led to the resolution of symptoms. In 2009, Fritscher-Ravens *et al*¹ and Ma *et al*²⁵ published a multicentre European study of WCE in children under the age of 8 years. The youngest child in the study was 1.5 years old. A recent study by Jensen *et al*²⁶ of WCE in 117 children included a 10-month-old infant weighing 11.5 kg and Nuutinen *et al*³ has also reported the feasibility of capsule endoscopy in children as young as 8 months of age. In our series, the youngest patient is a 1-year 7-month-old girl who weighed only 9 kg.

The rate of capsule retention in adult varies from 0.75% to 3.6%.^{27,28} A recent meta-analysis had found a capsule retention rate of 2.6% (gastric 0.5%, small bowel 1.9%) in 723 children who underwent 740 WCE procedures, similar to those rates observed in adults.²⁹ In the study by Fritscher-Ravens *et al*,¹ no capsule retention occurred among the 83 children aged 8 years and below. However, a recent study by Moy and Levine⁷ demonstrated a high capsule retention rate of 20%, which was due to the high proportion of patients with Crohn's disease in their study cohort. The incidence of capsule retention varies from 8.8% to 11.9% in the Crohn's disease patient group.^{9,30} In our series, none of the patients had retention of capsule despite the presence of risk factors (three had previous bowel surgery; one had chronic usage of non-steroidal anti-inflammatory drugs). WCE was found to be safe in a series of 10 patients who had previous bowel resection for bowel obstruction.³¹ We may have underestimated gastric capsule retention as the capsules were all placed beyond the pylorus via gastroscope. The absence of capsule retention in our series could be due to a lack of Crohn's disease in our patient group. Previous bowel surgery did not appear to increase the risk of capsule retention. None of our patients had patency capsules before the launch of the WCE study. Perhaps patency capsules could be selectively used for suspected Crohn's disease patients before a WCE study,

this is particularly relevant as Crohn's disease in children has a greater possibility of affecting the small bowel compared to their adult counterparts.

It is possible that the integrity of the bowel mucosa, forward peristaltic movement and the presence or absence of strictures rather than the absolute size of the small bowel largely determines capsule retention. It is important to note that a normal barium contrast does not preclude capsule retention.^{2,32,33} Capsule retention in itself could be diagnostic for identifying an obstructive lesion, and corrective surgery could be performed at the same time as capsule removal.

Conclusions

Data on the use of WCE in younger children remain limited. However, this single centre study suggests that it is a relatively complication-free procedure that may be considered in younger children when small bowel pathology is suspected. Extra precautions are required when considering WCE in patients with Crohn's disease when small bowel strictures are suspected. Patency capsules can be used as a dummy run before performing WCE in such patients.

Contributors BV: Lead author and primary investigator who performed the procedure, analysed and led the study. MH: Collected the data and created the draft paper. JK: Collected data and created the draft article. IB: Analysed the study and reviewed the paper.

Competing interests None.

Ethics approval Retrospective review.

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