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ORIGINAL ARTICLE

Comparing swallowing of capsule to endoscopic placement of capsule endoscopy in children

Christopher J Burgess,*,† Emma C McIntyre,*,[1] Geoffrey D Withers* and Looi C Ee*

*Department of Gastroenterology, Hepatology and Liver Transplant, Lady Cilento Children's Hospital and †Discipline of Paediatrics and Child Health, University of Queensland, Brisbane, Queensland, Australia

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Correspondence
Dr Christopher J Burgess, Department of Gastroenterology, Hepatology and Liver Transplant, Lady Cilento Children's Hospital, 501 Stanley Street, Brisbane, QLD 4101, Australia.
Email: christopher.burgess@hotmail.com

[1]**Present address:** Mater Children's Private Hospital, Mater Medical Centre, Brisbane, Queensland, Australia.

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Abstract

Background and Aim: Capsule endoscopy (CE) offers a method of directly visualizing areas of the small bowel not accessible by conventional endoscopy. Some children are unable to swallow the capsule requiring endoscopic placement under general anesthesia. The aim of the present study was to identify any differences between children requiring endoscopic placement and those able to swallow the capsule.

Methods: Retrospective chart review of consecutive CE in a tertiary pediatric center was conducted. Patient demographics, outcomes, and complications between the two groups were noted. Paired *t*-test comparing continuous variables and Fisher exact test for categorical data were used.

Results: A total of 104 CEs were performed in 88 patients, median age 12.8 (range: 1.6–18.5) years. Almost half, 49% (51/104), swallowed the capsule. Children requiring endoscopic placement were significantly younger (9.8 *vs* 14.2 years; $P < 0.001$), lighter (34.5 *vs* 54.9 kg; $P < 0.0001$), and had longer small intestinal transit time (308 *vs* 229 min; $P < 0.0001$). Positive findings were more likely in those who swallowed the capsule (50% *vs* 30%, $P = 0.017$), likely a reflection of the indications for procedure. Poor views were found in 30% (16/53) of patients in the endoscopic placement group due to iatrogenic bleeding from biopsies taken from concurrent procedures but did not affect outcome or subsequent patient management.

Conclusions: CE is safe and well tolerated in children. Children requiring endoscopic placement were significantly younger, lighter, had longer small intestine transit time, and less likely to have positive findings. Concurrent biopsies during capsule placement increase the likelihood of inadequate views but did not affect outcome or management.

Introduction

Capsule endoscopy (CE) is increasingly being used to diagnose small bowel pathology in adults and children. It enables direct visualization of the small bowel which cannot be reached by conventional endoscopy. The current clinical indications for CE set out by the American Society for Gastrointestinal Endoscopy include obscure gastrointestinal bleeding and iron deficiency anemia (OGIB + IDA), inflammatory bowel disease (IBD), abdominal pain, polyp surveillance, and other.[1] The relative frequency of indications in the pediatric setting differs from adult practice with a large number of children being investigated for suspected or known IBD and relatively few children being investigated for bleeding.[2] The general benefits of CE compared with other diagnostic modalities for the gastrointestinal tract are that it does not involve radiation, does not require general anesthesia (GA), and is noninvasive. In pediatric patients, however, some are unable to swallow the capsule requiring the capsule to be placed endoscopically and therefore removing many of these benefits. There is very limited information on children requiring capsule placement compared with those who are able to swallow the capsule. The aim of the present study was therefore to compare indications, outcomes, and complications of children who required endoscopic capsule placement to those who were able to swallow the capsule.

Methods

Retrospective review of all children having consecutive CE procedures in a tertiary pediatric gastroenterology center from 2008 to 2015 was undertaken. The present study was approved by the Human Research Ethics Committee of the Lady Cilento Children's Hospital, Brisbane. The patients were divided into two groups: those who swallowed the capsule and those who had the capsule placed endoscopically under GA. Capsules used were Pillcam SB (Given Imaging, Yokneam, Israel) and endoscopic placement was performed using a capsule delivery device (AdvanCE; US Endoscopy, Mentor, OH, USA). Patient demographics, indication for CE, outcomes, and complications were

Table 1 Patient demographics

	Swallowed (n = 51)	Endoscopic (n = 53)	P-value
Male	61% (31/51)	51% (27/53)	0.33
Age in years; median (range)	14.2 (8.1–18.5)	9.8 (1.6–17.0)	<0.0001
Weight in kg; mean ± SD	54.9 ± 16.4	34.5 ± 19.3	<0.0001
Small intestine time (min)	229 ± 98	308 ± 129	<0.0001
Positive findings	55% (28/51)	30% (16/53)	0.017
Change in management	46% (13/28)	50% (8/16)	>0.99

noted. Gastric holdup was considered to have occurred if the capsule was still within the stomach 2 h after swallowing. Small intestinal transit time was calculated by marking the time between the first duodenal image and the first cecal image. Studies were considered incomplete if the capsule did not reach the cecum during the study period (generally 11 h). Diagnostic yield of CE was calculated by comparing positive findings to total procedures performed and changes in patient management directly resulting from CE findings were recorded. The effect of concurrent procedures on views in patients having endoscopic placement was also examined. Statistical analyses were performed using paired t-tests for continuous variables and the Fisher exact test for categorical data using GraphPad software (La Jolla, CA, USA). A P-value of <0.05 was considered significant.

At our center, all children were assessed as to whether they were able to swallow tablets with some encouraged to practice with large jelly beans beforehand. All children prepared for CE with a clear fluid diet for 12 h and subsequent 4 h fast before CE. Children who were able to swallow the capsule were then allowed to start drinking clear fluids 2 h after ingestion and resumed a light diet after 3 h. Recommendations were similar in patients requiring GA. Some patients having CE under GA also had concomitant gastroscopy and colonoscopy during the same episode of anesthesia at the discretion of the treating clinician.

Results

Patient demographics and diagnostic yield. There were 104 capsule studies performed on 88 patients. The median age was 12.8 (range: 1.6–18.5) years with the youngest patient aged 1.6 years and weighing 10 kg. The youngest patient to swallow the capsule was aged 8.1 years. Table 1 shows the demographics and diagnostic yield of the two groups. Children who required endoscopic placement of the capsule were significantly younger, lighter, and had longer small intestinal transit time. Patients who were able to swallow the capsule were significantly more likely to have positive findings than those requiring endoscopic placement; however, there was no difference in how often this directly lead to a change in management.

Clinical indication. Clinical indications for CE in our cohort are shown in Table 2. Significantly more children being investigated for IBD were able to swallow the capsule compared with endoscopic placement. There was a trend for children being investigated for obscure bleeding and iron deficiency to have it placed endoscopically, although this did not reach statistical significance.

Complications. The complications after CE are shown in Table 3. There were no episodes of capsule retention in our cohort. Gastric holdup was significantly more common in those who swallowed the capsule (P = 0.03). Overall, 6.5% (7/104) studies were incomplete, but no difference was noted between groups. Suboptimal views were significantly more likely in those with endoscopic placement (P < 0.0001) compared with patients who swallowed the capsule.

Effect of concurrent procedures. The effect of concurrent procedures in children having endoscopic CE placement is shown in Table 4. A total of 70% (37/53) of patients undergoing endoscopic placement had concurrent procedures performed, mainly upper endoscopy and colonoscopy with biopsies. No significant difference was found in the number of positive findings in those who had concurrent procedures (13/37, 35%) against those who had CE placement only (3/16, 19%) (P = 0.33) while under GA.

Discussion

CE is considered a painless, noninvasive, low-risk procedure but does depend on the ability of the patient to swallow the capsule. In children, the ability and willingness to swallow endoscopic capsules can be influenced by the child's age and cognitive understanding, personality, acceptance by parents, and skill of

Table 2 Clinical indication for capsule endoscopy

	Swallowed (n = 51)	Endoscopic (n = 53)	P-value	Diagnostic yield (%)
OGIB + IDA	14	24	0.07	34
IBD	21	11	0.03	53
Abdominal pain	5	5	>0.99	10
Polyps	8	9	>0.99	59
Other	3	4	>0.99	29

IBD, inflammatory bowel disease; OGIB + IDA, obscure gastrointestinal bleeding and iron deficiency anemia.

Table 3 Complications

	Swallowed (n = 51)	Endoscopic (n = 53)	P-value
Retained capsule	0	0	–
Gastric holdup[†]	7	1	0.03
Incomplete study[‡]	1 × Gastric holdup	1 × Gastric holdup 2 × Slow transit 3 × Hardware failure	0.11
Iatrogenic blood	0	16 (30%)	<0.0001

[†]Capsule remaining in the stomach for >2 h.

[‡]Capsule not reaching the cecum within the recording period.

the investigator in turning the ingestion into an interactive game.[3] However, even in adolescents, up to one-third of patients describe difficulties swallowing standard size tablets.[4] In our cohort, about half required endoscopic placement. These children, as expected, were significantly younger and therefore lighter than those able to swallow the capsule. This is consistent with normal observation in pediatric practice that the ability of patients to swallow large tablets improves with increasing age and developmental progression. These children also had significantly longer small intestinal transit time, similar to that previously reported in a Japanese cohort of 26 children.[5] This is presumably due to reduced gastrointestinal motility caused by anesthetic agents. Two patients in our cohort had intestinal transit time sufficiently slow to prevent the capsule from reaching the cecum within its recording time, although in general slow intestinal transit did not affect the study outcomes.

The significantly higher diagnostic yield in children able to swallow the capsule (55% *vs* 30%; $P = 0.017$) is likely related to the underlying indication for CE, rather than age or size of the patient. Children who were able to swallow the capsule were more likely to have IBD as an indication for this procedure ($P = 0.03$). IBD as an indication for CE has a high diagnostic yield (53%) because these patients are often known to have small bowel disease and require repeated reassessment of small bowel mucosa often at times of worsening clinical and biochemical markers. Conversely, children with OGIB + IDA were generally younger, and although not statistically significant, less likely to be able to swallow the capsule ($P = 0.07$). The diagnostic yield of CE for OGIB + IDA is also relatively low (34%) for multiple reasons including wide potential differential diagnoses, bleeding likely intermittent, and time delay between bleeding and performing the procedure.

One of the major measures of validity for any investigation including CE is whether it leads to a direct change in the patient's management. The rate of this was similar regardless of whether the capsule was swallowed or placed endoscopically and occurred approximately half of the time. Most commonly, these included changes to medical management of IBD, or progress to further therapeutic investigations such as surgery, enteroscopy, or endoscopy with polypectomy.

Whether swallowed or placed, CE is well tolerated and preferred by most pediatric patients when compared with endoscopic and radiological procedures.[6] Capsule retention is the most discussed potential complication in CE. While it was initially thought that younger children had a higher risk of capsule retention, it is now clear that the underlying indication rather than age is more important. In the largest reported pediatric series, the highest risk factors for capsule retention include known IBD (5.2% risk), previous small bowel follow-through demonstrating small bowel Crohn's disease (35.7% risk), and a body mass index <5th percentile combined with known IBD (43% risk).[7] A meta-analysis of 1013 pediatric patients produced a pooled retention rate of 2.3%.[8] Fortunately, we had no episodes of capsule retention in this cohort despite our youngest patient being 19 months of age and weighing 10 kg.

Another common complication of CE is delayed gastric passage, which occurred in 7 out of 104 of our cohort. However, only one episode was sufficiently delayed to potentially affect the study outcome with the capsule not reaching the cecum within its recording time. In small children, even endoscopic placement of the capsule can result in gastric holdup as the capsule release device is sometimes unable to fit through the narrow pylorus.

An unexpected finding in our cohort was the significant number of studies (30%, $P < 0.0001$), with suboptimal views because of bleeding in patients having endoscopically placed CE. This was presumed to be secondary to biopsies collected during concurrent procedures, or scope trauma at the time of capsule insertion. However, further analyses of patients having endoscopic CE placement found no significant differences in demographics, size, transit time, positive findings, or rate of management change in those having concurrent gastroscopy/colonoscopy compared with those having only CE placement. Therefore, while not ideal, performing an endoscopy and colonoscopy at the same time as capsule insertion did not significantly impact the rate of positive findings despite increased likelihood of suboptimal views.

Conclusions

CE is safe and well tolerated in children. Children requiring placement of CE under GA are significantly younger and lighter and have a longer small intestinal transit time. Children able to

Table 4 Effect of concurrent procedures in patients with endoscopically placed CE

	Concurrent procedures (n = 37)	CE only (n = 16)	P-value
Age in years; median (range)	10.5 (1.6–17.1)	8.9 (2.4–16.8)	0.38
Weight in kg; mean ± SD	38.0 ± 20.5	24.0 ± 9.7	0.34
Small intestine time (min)	318.5 ± 140.1	286.7 ± 107.0	0.36
Positive findings	35% (13/37)	19% (3/16)	0.33
Change in management	30% (11/37)	13% (2/16)	0.30

CE, capsule endoscopy.

swallow the capsule are more likely to have positive findings, most likely because of their clinical indications for CE rather than patient demographics. When an abnormal finding is made on CE, a change in medical management occurs approximately 50% of the time. Concurrent biopsies increase the likelihood of inadequate views but do not affect the outcome of the study.

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