

Comparison of Pentax HiLine and Olympus Lucera systems at screening colonoscopy

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Abstract

AIM: To compare the performance characteristics of Pentax HiLine (PHL) (with i-scan) and Olympus Lucera (OL) systems in a screening population.

METHODS: Screening colonoscopies in asymptomatic guaiac faecal occult blood test-positive patients with PHL ($n = 58$) and OL ($n = 425$) colonoscopes were analysed. All procedures were performed by a single colonoscopist. PHL used white-light endoscopy (WLE) on scope insertion and contrast/surface enhancement (i-scan 1) on withdrawal, and OL utilised WLE both on insertion and withdrawal. Patient age, sex, instrument insertion and withdrawal times, nurse assessed patient comfort scores, midazolam and fentanyl doses, procedure completion and rates of lesion detection were recorded separately for each group. Comparisons between the groups were made using either Fisher's exact test (for dichotomous variables) or Mann-Whitney U test (for ordinal and continuous variables).

RESULTS: Colonoscopy completion rates were similar

in both groups: 413/425 (97.2%) for OL and 55/58 (94.9%) for PHL ($P = 0.24$). For complete colonoscopies, the two groups were well matched for age, sex, colonoscopy insertion times (mean 11.1 min in OL vs 11.6 min in PHL, $P = 0.93$) and normal colonoscopy withdrawal times (mean 15.6 min in OL vs 14.7 min in PHL, $P = 0.2$). Patients in the PHL group experienced a small increase in discomfort (mean patient comfort scores were 0.49 in the OL and 0.95 in the PHL group, $P < 0.0001$). While Fentanyl doses required were similar between groups (mean 57.5 μg in OL vs 61.4 μg in PHL, $P = 0.13$), slightly more Midazolam was required in the PHL group (mean 2.1 mg in OL vs 2.4 mg in PHL, $P = 0.035$). There was no difference in polyp (58% in OL vs 67% in PHL) or adenoma (49% in OL vs 56% in PHL) detection rates between the groups. Neither the total number of polyps and adenomas, nor the characteristics of these (including size, location or presence of advanced features) were different between the two systems.

CONCLUSION: This study suggests that there is no advantage of either colonoscopy system in lesion detection.

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Key words: Pentax HiLine; i-scan; Polyp; Adenoma; Colonoscopy

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INTRODUCTION

Colonoscopy is the gold-standard test for the diagnosis of colorectal neoplasia. Aside from diagnosis of

colorectal carcinoma (CRC), detection and removal of pre-malignant precursor lesions is an essential part of colonoscopy and has been shown to significantly reduce mortality from CRC^[1].

Even with the most thorough colonoscopic examination, adenoma miss rates, as established by same-day tandem colonoscopies, remain significant and are higher in patients with at least 2 adenomas found on baseline colonoscopy with an inverse correlation with adenoma size (between 6% for large adenomas ≥ 1 cm and 27% for those ≤ 5 mm)^[2]. The expected incidence of CRC in one study, based on missed adenomas at screening colonoscopy, was 1.1 per 1000 persons within 5 years^[3].

The effect of a variety of technical manoeuvres and mucosal enhancement technologies on adenoma detection and miss rates has been studied, including prolongation of colonoscope withdrawal time^[4], systematic patient positioning^[5], pancolonic dye-spray chromoendoscopy^[6], cap-assisted colonoscopy^[7], narrow band imaging (NBI)^[8] and endoscopic trimodal imaging^[9], with variable degrees of success.

The i-scan technology was developed and introduced by Pentax (Japan) and is based on digital surface, contrast and tone enhancement, designed to reveal minute mucosal irregularities and subtle changes in colour that are not visible at conventional white light endoscopy (WLE)^[10]. This technology has been incorporated into the Pentax HiLine (PHL) system representing a latest generation of high definition (HD+) colonoscopes.

The efficacy of i-scan compared to standard white-light colonoscopy has been studied in prospective trials and the results are somewhat conflicting. One randomized study of the PHL system utilising surface enhancement on withdrawal demonstrated its superiority to standard Pentax video colonoscopes in neoplastic (adenomatous and cancerous) lesion detection (38% *vs* 13%)^[11]. Another prospective study, which randomised patients into 3 groups, each using a distinct modality on withdrawal (conventional high-definition WLE *vs* contrast/surface enhancement *vs* contrast/surface/tone enhancement), concluded there was no advantage in using i-scan for adenoma detection (31.9% *vs* 36.5% *vs* 33.1%, $P = 0.742$) and miss (22.9% *vs* 19.3% *vs* 15.9%, $P = 0.513$) rates^[12]. One more non-randomised study, however, suggests a superior polyp detection rate (PDR) with PHL compared to Olympus Lucera (OL) (66% *vs* 44%, $P = 0.01$) with no difference in median polyp size between the groups (3 mm *vs* 4 mm, $P = 0.98$)^[13]. This study enrolled 269 colonoscopies performed in the setting of the English National Bowel Cancer Screening Programme (BCSP) at a single centre. Neither surface nor tone enhancement was used systematically for lesion detection in this study.

We sought to determine whether there were advantages in terms of lesion detection with either OL WLE or PHL with routine use of i-scan surface enhancement on withdrawal.

MATERIALS AND METHODS

The BCSP in England offers biennial guaiac based faecal

occult blood testing (FOBT) between the ages of 60 and 74 and colonoscopy for those testing positive. As part of equipment familiarisation in preparation for a trial, we have intermittently utilised PHL since May 2010.

All patients undergoing baseline colonoscopy performed by a single endoscopist (EC) between receipt of the PHL system (18th May, 2010) and the beginning of the study (27th September, 2011) were identified from the Endoscopy Department reporting system. Cases were included if either PHL colonoscopes or OL Q-series colonoscopes were used. Colonoscopies utilising alternative systems, incomplete and those performed for post-polypectomy surveillance were excluded.

For OL, insertion and withdrawal was performed using WLE with NBI at the discretion of EC for lesion characterisation. For PHL, insertion was performed using WLE. On intubation of the caecal pole, the mode was switched to contrast/surface enhancement (i-scan 1) for withdrawal with utilisation of contrast/surface/tone enhancement (i-scan 2) for lesion characterisation at the discretion of the EC. Chromoendoscopy was not used in any case.

Data on patient age, sex, colonoscopy completion and limiting factors, Midazolam (mg) and Fentanyl (μ g) doses, nurse-assessed patient comfort score (0 = none, 1 = minimal, 2 = mild, 3 = moderate and 4 = severe), colonoscope insertion and withdrawal times (minutes), and the total number of polyps were collected for each colonoscopy. Each polyp detected was then characterized by its location in the colon, size (mm), morphology (stalked/sessile), histology (tubular/tubulo-villous or serrated adenoma, hyperplastic, or inflammatory), and presence of dysplasia (low- or high-grade) or cancer.

Intergroup comparisons were then made for each measure using either the Fisher's exact test or Mann-Whitney *U* test with the polyp data divided according to numbers of polyps and adenomas, adenomas proximal to the splenic flexure (proximal adenomas) and advanced adenomas (*i.e.*, > 1 cm in size, villous, or containing high-grade dysplasia or cancer). Polyp (PDR) and adenoma (ADR) detection rates were calculated for each group. For withdrawal times, only normal colonoscopies were included to remove any effect of polypectomy on duration. A power calculation was performed to determine whether these cohorts were of an appropriate size to detect the differences described by Banks *et al*^[13].

As a retrospective service evaluation, this study did not require ethics committee approval under NHS Research Governance arrangements^[14] and was registered with the local Risk and Patient Safety Department.

RESULTS

Colonoscopy completion rates were similar in both groups: 413/425 (97.2%) in the OL group and 55/58 (94.9%) in the PHL group ($P = 0.24$) with 3/12 (OL) and 2/3 (PHL) of the incomplete cases due to obstructing cancers. The two groups were matched for age and sex, and there was no difference in cancer detection rates (OL

Table 1 Colonoscopy completion rates, patient demographics, sedation doses, procedure times and comfort scores in the Olympus Lucera and Pentax HiLine groups

Indicator	Olympus Lucera	Pentax HiLine	P value
	<i>n</i> (% of total) ¹		
Complete colonoscopies	413/425 (97.2)	55/58 (94.9)	0.24
Male patients	239/413 (57.9)	35/55 (63.7)	0.5
	mean \pm SD ²		
Patient age (yr)	66.3 \pm 4.3	65.8 \pm 4.7	0.36
Fentanyl dose (μ g)	57.5 \pm 18.0	61.4 \pm 18.5	0.13
Midazolam dose (mg)	2.1 \pm 0.6	2.4 \pm 0.7	0.035
Comfort score	0.49 \pm 0.6	0.95 \pm 0.6	< 0.0001
Insertion time (min)	11.1 \pm 6.6	11.6 \pm 7.5	0.93
Normal colonoscopy withdrawal time (min)	15.6 \pm 8.2	14.7 \pm 8.0	0.20

Comparisons made using Fisher's exact test¹ or Mann-Whitney *U* test².

7.7% *vs* PHL 7.3%, *P* = 1.0).

The colonoscope insertion and normal colonoscopy withdrawal times were similar with OL and PHL (Table 1). There was a small but statistically significant increase in mean \pm SD, discomfort score in the PHL group. Although the average fentanyl dose was not different between the groups, there was also a small significant increase in midazolam requirements for the PHL patients.

There were no statistically significant differences in any of the polyp or adenoma detection measures between the two systems used. The comparison included the PDR, ADR (Table 2), mean numbers of polyps (MNP), adenomas (MNA), proximal and advanced adenomas, and polyps of large (> 1cm), small (\leq 1cm) and diminutive (\leq 5 mm) size (Table 3).

Our study had an 88% power to detect the differences found by Banks *et al*^[13].

DISCUSSION

One of the challenges of modern colonoscopy is to minimise the rate of missed pathology. It has been hoped that improvements in image quality might translate into increasing adenoma detection and there have been some suggestions from previous studies^[11,13] that this might be the case. In this study, however, we have not been able to identify any benefit even when subclassifying according to location and size of polyp.

Our data is discordant with the results of a previous similar study^[13]. There are several possible explanations for this, although it is noteworthy that our study has several advantages over the previous work, which would support the validity of our data. Firstly, our cohort was larger than that reported previously (*n* = 468 *vs* *n* = 269)^[13], and accordingly this study was well-powered to detect the described effect size. Secondly, we compare the performance of a single colonoscopist rather than pooling colonoscopies performed by 5 ECs using OL and comparing them to those performed by a single EC with PHL. It is therefore plausible that at least some of the difference previously identified might be explained by

Table 2 Polyp and adenoma detection rates in the Olympus Lucera and Pentax HiLine groups

	Olympus Lucera	Pentax HiLine	P value
With \geq 1 polyp	239/413 (58%)	37/55 (67%)	0.19
With \geq 1 adenoma	202/413 (49%)	31/55 (56%)	0.3

Comparisons made using Fisher's exact test.

Table 3 Polyps and adenomas of various characteristics in the Olympus Lucera and Pentax HiLine groups (mean \pm SD)

Size location	Olympus Lucera		Pentax HiLine		P value
	<i>n</i>	mean \pm SD	<i>n</i>	mean \pm SD	
Polyps					
All	586	1.42 \pm 1.96	87	1.58 \pm 1.73	0.19
> 1 cm	109	0.26 \pm 0.53	16	0.29 \pm 0.50	0.51
\leq 1 cm	477	1.15 \pm 1.78	70	1.27 \pm 1.58	0.27
\leq 0.5 cm	368	0.89 \pm 1.53	54	0.98 \pm 1.27	0.22
Adenomas					
All	414	1.00 \pm 1.54	59	1.07 \pm 1.27	0.27
Proximal	164	0.4 \pm 0.9	21	0.38 \pm 0.7	0.74
> 1 cm	97	0.23 \pm 0.50	14	0.25 \pm 0.48	0.6
\leq 1 cm	317	0.77 \pm 1.38	45	0.82 \pm 1.11	0.29
\leq 0.5 cm	229	0.55 \pm 1.13	31	0.56 \pm 0.96	0.63
Advanced adenomas					
All	145	0.35 \pm 0.7	16	0.29 \pm 0.5	0.64

Comparisons made using Mann-Whitney *U* test.

variation in performance between colonoscopists rather than systems. ADRs were markedly lower in this earlier study. Although not specifically reported, a PDR of 44% with OL will translate into an ADR much lower than the 49% with OL in our study. As adenoma detection increases, the potential for missed adenomas reduces and with it the potential for measurable differences between groups. It is theoretically possible that the use of i-scan 1 during colonoscopy withdrawal could have reduced lesion detection compared to PHL WLE without enhancements, although the high ADR in the PHL group in our study (56%) and the results of the study by Hoffman *et al*^[11] would argue against this. Thirdly, the earlier study by Hoffman *et al*^[11] suggested a marked advantage of high definition Pentax colonoscopes over standard WLE. Part of this advantage might be explained by the rather low ADR in the standard colonoscopy group (13% *vs* 38%). This study also included a heterogeneous patient population with patients undergoing screening colonoscopy, post-polypectomy surveillance or positive for faecal occult blood. The burden of pathology in these disparate patient groups is likely to be substantially different. Whilst no statistically significant difference was demonstrated in indications or sex of patients, there were some sizeable differences (more post-polypectomy surveillance and men with HD+) which in combination could have influenced the frequency of adenomas in each study arm. In addition, patients undergoing post-polypectomy surveillance represent a very heterogeneous group both by the size and numbers of previously detected adenomas^[15].

In contrast, our study comprises a homogenous group of patients (asymptomatic, FOBt-positive, aged between 60 and 74), which overcomes these limitations.

In addition to assessing the most widely used quality indicators for colonoscopy (ADR, PDR, MNA and MNP), we also analysed two further indicators. We considered the detection of proximal adenomas (*i.e.*, those proximal to the splenic flexure) as concerns have been raised about the performance of colonoscopy in the right colon^[16-18]. We also studied the detection of advanced adenomas since the detection of these lesions is most important, due to their increased likelihood to develop into CRC. One might expect that an effective image enhancement technology would significantly improve the discrimination of smaller polyps from the background mucosa to a greater degree than of larger polyps as the majority of the latter should be readily identifiable by WLE alone, unless they are hidden from view. We therefore also performed a detailed subgroup analysis of MNP/MNA of large (> 1 cm), small (\leq 1 cm) and diminutive (\leq 5 mm) size in each patient group. These sub-analyses did not detect any differences in the performance of the two endoscopy systems.

Our findings suggest that patients in the PHL group experienced small but statistically significant increases in discomfort and required slightly more Midazolam. A slight increase in discomfort with this system has been described previously^[13].

Although this data has several advantages over previous reports, there are some notable limitations. These include that our evaluation was not prospective or randomised and, as a single EC experience, it may not be generalisable.

In any cohort of patients, the number of detectable adenomas is finite. With increasingly thorough and systematic examination, the proportion of detected adenomas will approach a limit beyond which the contribution of any image enhancing technology will be negligible. Whilst studies tend to be carried out by high performing ECs, consideration should be given to evaluation in average performance settings.

In this detailed retrospective cohort study on a homogenous sample of FOBt-positive patients undergoing bowel cancer screening, we were unable to demonstrate any added benefit of either the HD+ PHL or the high-resolution OL system. All studied colonoscopy quality yield indicators were similar in the two studied patient groups. A randomised controlled study is required to fully evaluate the relative performance characteristics of these two systems.

COMMENTS

Background

Successful detection and removal of adenomas at colonoscopy is vital in reducing mortality from colorectal cancer. A number of optical image enhancement technologies have been developed and introduced into practical use with the aim of improving polyp detection from the background colonic mucosa. The i-scan technology is used in the Pentax HiLine (PHL) system of high-definition (HD+) colonoscopes and has been shown to produce better colonic polyp de-

tection in comparison with the same system's white light endoscopy (WLE).

Research frontiers

This study assessed and compared the performance of PHL with i-scan 1 (contrast/surface enhancement) mode and WLE with Olympus Lucera (OL), a high-resolution video-colonoscopy system also widely and successfully used in modern endoscopy units.

Innovations and breakthroughs

This study featured a high-quality methodology to evaluate for potential differences in polyp detection, patient comfort and sedation requirements at colonoscopies performed with the two equipment systems, PHL with i-scan 1 and OL WLE in a homogenous group of 468 faecal occult blood test positive patients enrolled in the National Bowel Cancer Screening Programme at a single tertiary care centre in England. As compared with the only other similar published study (Banks *et al.*, *World J Gastroenterol* 2011), this investigation is based on a larger series of patients ($n = 468$ vs $n = 269$), represents a single- (rather than single-compared with multiple-) colonoscopist performance, thus minimizing operator-dependent differences in polyp detection, and includes a detailed sub-group analysis by polyp size, type, location and advanced pre-malignant features.

Applications

Based on the results of this study, neither PHL with i-scan 1, nor OL WLE offer an advantage for the detection of colonic polyps of various sizes, type, location and advanced pre-malignant features. OL instruments are associated with lower degrees of patient discomfort and lower requirements for Midazolam during colonoscopy.

Terminology

I-scan - optical imaging technology invented by Pentax, Japan, based on the application of digital colour filters to achieve tone, contrast and surface enhancement of gastrointestinal mucosa as an alternative to the standard (white-light) endoscopy. PHL - a latest-generation system of HD+ colonoscopes equipped with the i-scan technology in addition to the standard white-light endoscopy mode.

Peer review

Publication was recommended by the reviewers as the study had demonstrated conflicting results compared to another similar but much smaller study ($n = 269$) published earlier, and statistical calculations were found to have been very well performed in this study.

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