

The yield of dysplasia and serrated lesions in a single-centre tertiary inflammatory bowel disease cohort

Fiona Yeaman^{ID} and Lena Thin^{ID}

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Abstract

Background: Chromoendoscopy is preferred over high-definition white light endoscopy (HDWLE) for dysplasia surveillance in inflammatory bowel disease (IBD) patients, but is more time-consuming to perform and real-world evidence is limited. The prevalence of sessile serrated lesions (SSLs) in IBD patients is also unknown.

Objective: To determine the yield of polypoid and non-polypoid dysplasia and SSLs in IBD patients undergoing dysplasia surveillance and the associations for these lesions.

Design: A retrospective cohort study from a tertiary IBD centre.

Methods: A keyword search of the colonoscopy reporting system was performed. IBD patients with colonic disease that underwent colonoscopy for surveillance between 1 February 2015 and 1 February 2018 were included. Clinical, endoscopic and histopathological outcomes were extracted for the analysis.

Results: Of 2114 patients identified, 276 eligible colonoscopies in 126 patients were analysed. The median age at colonoscopy was 51 years (interquartile range: 42–58 years). 71/126 (56%) of colonoscopies were performed in male patients, with 57/126 (45%) having ulcerative colitis, 68/126 (54%) Crohn's colitis and 1/126 (0.79%) IBD-unspecified. The prevalence for any neoplasia was 75/276 (27%). The prevalence for all serrated lesions was 43/276 (16%). Increased age was a risk factor for finding a neoplastic lesion on both univariate and multivariate analyses. Chromoendoscopy was associated with twice the odds of finding a neoplastic lesion (odds ratio: 1.99, 95% confidence interval: 1.13–3.51, $p=0.02$), on multivariate analysis. No factor was associated with an increased risk of finding a serrated lesion.

Conclusion: Significant neoplastic lesions and serrated lesions were detected in 27% and 16% of colonoscopies performed in IBD patients, respectively, with the highest yield in older patients. Chromoendoscopy significantly increased neoplasia yield compared to HDWLE and still has a robust utility in this pragmatic real-world study.

Keywords: chromoendoscopy, colonoscopy, dysplasia, inflammatory bowel disease, surveillance

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Introduction

Patients with inflammatory bowel disease (IBD) affecting the colon have a higher risk of developing colorectal cancer (CRC) compared to patients without colonic inflammation.^{1–3} Regular colonoscopies are thus performed for dysplasia surveillance in these patients.⁴ In recent years, sessile

serrated lesions (SSLs) have been identified as an additional precursor leading to CRC in the general population.^{5,6} Polyps previously classified 'hyperplastic', may, under the 2019 World Health Organization (WHO) criteria have been misclassified, particularly those that were proximal to the splenic flexure and/or greater than 10 mm. We

Correspondence to:

Lena Thin
Department of Internal
Medicine, UWA Medical
School, University of
Western Australia

Department of
Gastroenterology, Fiona
Stanley Hospital, 11 Robin
Warren Drive, Perth,
WA 6009, Murdoch, WA,
Australia.

Lena.Thin@health.wa.gov.au

Fiona Yeaman
Department of
Gastroenterology, Fiona
Stanley Hospital, Murdoch,
WA, Australia

Department of Internal
Medicine, UWA Medical
School, University of
Western Australia, Perth,
WA, Australia

have therefore termed these hyperplastic lesions as ‘Clinically significant serrated polyps’ (CSSPs).^{7–10}

The data on the prevalence of SSLs in IBD cohorts have been contradictory, with reports that IBD cohorts have both higher and lower prevalence of these lesions compared to non-IBD populations.^{11–13} SSLs have been associated with advanced neoplasia, perhaps even more so than in conventional dysplasia.^{14,15} The significance of serrated lesions in IBD patients remains to be established, as to whether their occurrence confers a greater malignant potential compared to their occurrence in non-IBD patients.¹⁶ A recent study from Netherlands identified an increased risk of advanced colorectal neoplasia in IBD patients who had dysplastic SSLs and traditional serrated adenomas (TSAs) on the index colonoscopy, but not in patients with non-dysplastic SSLs; however, non-IBD controls were not included for comparison.¹⁷ It is also unknown whether chronic inflammation promotes the development of SSLs and/or conventional adenomas, and, if these are truly observed at a higher frequency in IBD populations.

Colonic IBD patients are at risk of developing both conventional dysplasia, such as tubular adenoma (TA)-like and tubulo-villous adenoma (TVA)-like dysplasia, and non-conventional dysplasia.¹⁴ Non-conventional dysplasia incorporates multiple sub-types: hyper-mucinous dysplasia, crypt cell dysplasia, dysplasia with increased Paneth cell differentiation, goblet cell deficient dysplasia, SSL-like dysplasia, TSA-like dysplasia, and serrated dysplasia not otherwise specified.¹⁵ Despite being ‘low grade’ in morphology, non-conventional dysplasia appears to have higher malignant potential than conventional dysplasia and therefore requires careful recognition and follow up.¹⁵ Based on pathological studies, IBD patients are at increased risk of acquiring conventional adenomas and SSLs¹⁵; however, contradicting real-world data show a lower incidence of these neoplasia in IBD patients also exists.¹² Further clarification of such data would inform gastroenterologists of the benchmark lesion detection rate to aim for when performing colonoscopies in IBD patients and enhance key quality endoscopy indicators in IBD patients.

The evidence would suggest that the yield of chromoendoscopy is considered superior to

high-definition white light endoscopy (HDWLE)¹⁸ and it is recommended for dysplasia surveillance in IBD consensus guidelines.^{19–25} More recent data have shown mixed results, with HDWLE potentially rivalling the results obtained with chromoendoscopy.^{26–28} High-definition chromoendoscopy has performed better than HDWLE alone, when conditions were optimal for chromoendoscopy^{18,27,29}; however, there are also real-world data and results of meta-analyses that contradict these observations.^{30,31} Poor adherence to chromoendoscopy recommendations for various factors such as inexperience and perceived time constraints limit its use.³² Thus, there is a need for more real-world results on how the yield of chromoendoscopy with HDWLE compare with HDWLE alone in the surveillance of IBD patients.

Aims

We conducted a pragmatic real-world study with the primary aim of determining the yield of any significant lesions (ASLs, defined as polypoid and/or non-polypoid/flat dysplasia and SSLs including CSSPs) during colonoscopies performed for the primary intention of dysplasia surveillance in a cohort of tertiary IBD patients. The secondary aim was to identify the clinical predictors for neoplasia yield, with a focus on whether chromoendoscopy with HDWLE conferred a higher neoplasia yield.

Materials and methods

Inclusion criteria

The study was performed and reported in concordance with the STROBE guidelines.³³ Patients were included if they had a definite diagnosis of Crohn’s disease (CD) with colitis, ulcerative colitis (UC) or IBD-unspecified with colonic involvement for greater than 8 years. Complete colonoscopies performed with patient consent at the inception date for the purpose of dysplasia surveillance and any subsequent follow-up colonoscopies were included. A complete colonoscopy was considered one where caecal intubation occurred. Thus, those with stricturing disease were only included if strictures were passable and complete intubation to the caecum was achieved.

Patients were excluded if they had no formal IBD diagnosis, had an inadequate bowel preparation (as defined by the Aronchick scale ‘inadequate or

poor³⁴), had isolated proctitis or isolated ileal CD. Patients who had macroscopically active inflammation evident on colonoscopic insertion, did not undergo chromoendoscopy. Instead, HDWLE was performed and standard segmental biopsies were taken as described below. Virtual chromoendoscopy (VCE) was not utilised during the study period as recommended by the SCENIC guidelines¹⁹ at that time.

Clinical disease-related factors and demographics were extracted from a prospectively maintained IBD clinical registry. Colonoscopies were all performed by gastroenterologists, with the majority being subspecialist IBD physicians who have had specific training in chromoendoscopy. Patients that were allocated to a gastroenterologist list not trained in chromoendoscopy had, by default, HDWLE performed, with standardised biopsies taken in every segment which approximates to 4 biopsies for every 10 cm or 32 biopsies per colonoscopy.

Patients were selected consecutively following a keyword search on the hospital endoscopy reporting database, from 1 February 2015 to 31 January 2018. Search terms came from a free-text field, and typographical errors accounted for. Search terms used were as follows: ‘chromoendoscopy’, ‘chromo’, ‘chormo’ (to account for spelling errors), ‘blue’, ‘indigo’, ‘carmin’, ‘dysplasia’ and ‘surveillance’. The colonoscopy indication was searched using the terms, ‘f/u colitis or f/u Crohn’s disease’. Patients were followed for a minimum of 36 months and up to 72 months for additional follow-up colonoscopies *via* a chart review. Colonoscopies repeated for the same patient up to 31st of January 2021 were included in the study sample. All included patients had complete data for the variables of interest in this study.

Definitions

In this study, given the inclusion of cases prior to the change in definition of serrated lesions in the WHO 2019 guidelines,³⁵ we defined ‘CSSPs’ as any hyperplastic polyps greater than 10 mm in size and/or proximal to the splenic flexure. ASL was defined as the total of any polypoid or non-polypoid flat dysplasia (including TAs, TVA, villous adenoma, traditional serrated adenomas (TS)), SSLs, and CSSPs. Invisible flat dysplasia was defined as dysplasia that was not identified on chromoendoscopy or HDWLE but on histopathological examination of a biopsy specimen.

As prior areas of colonic inflammation were not always described, the focus of the study was on the *totality of all neoplastic lesions* rather than specific dysplastic lesions derived from areas previously affected by colitis. Colitis-associated dysplastic lesions specifically were impossible to determine retrospectively for all patients due to do endoscopists’ reporting variability.

Chromoendoscopy method

The chromoendoscopy was performed using high-definition colonoscopes (Olympus 190-series). We used methylene blue (1%, 5 ml ampoule diluted in 250 ml of water) or indigo carmine at a concentration of 0.5% administered *via* the foot pump. Targeted biopsies were taken of suspicious lesions and routine biopsies were taken of each segment to determine histological activity. Where possible, polypoid adenomatous-like lesions were resected whole or piecemeal with four peri-polyp biopsies taken of the flat mucosa around the polyp. Piecemeal resections were followed up with another colonoscopy to ensure complete resection within 3–6 months. Patients who only underwent a colonoscopy with HDWLE without chromoendoscopy had visible polyps removed and random biopsies taken at each colonic segment. Patients with a significant amount of active colitis did not undergo chromoendoscopic examination.

Statistical analysis

SPSS version 20 was utilised for statistical analysis. Tests for normality were performed. Medians were reported for non-parametric variables. Univariate and multivariate logistic regression analyses were performed to determine the predictors for finding neoplasia. The covariates of interest included in the multivariate model were those known to influence neoplasia risk, or if the univariate analysis yielded a two-sided p value < 0.2 for an increased risk of finding neoplasia. Covariates with a two-sided $p > 0.05$ were removed in a stepwise manner leaving only the significant factors at the end of multivariate adjustment.

Results

Baseline characteristics

In all, 2114 patients were identified from the reporting search. In total, 276 eligible colonoscopies in 126 patients were available for analysis

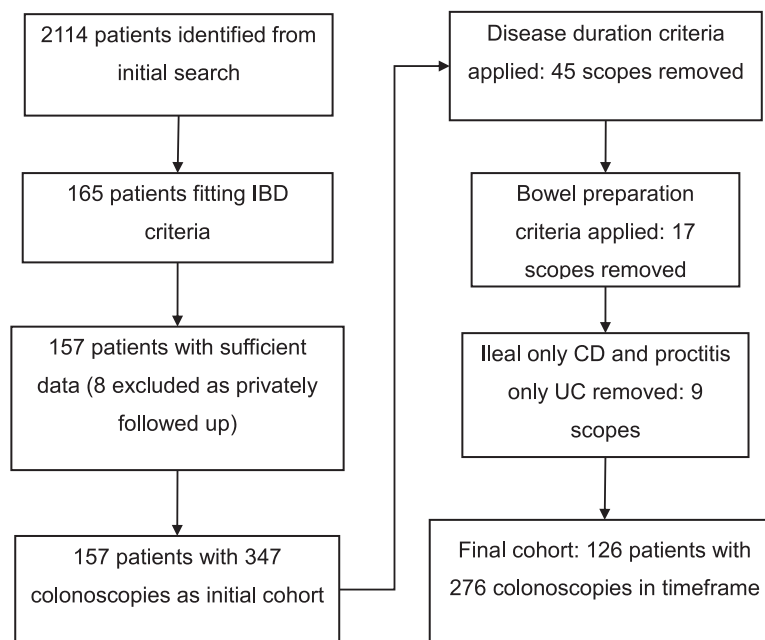


Figure 1. Case selection flow diagram.

after meeting the inclusion and exclusion criteria. Summary results are reported ‘per colonoscopy’. Figure 1 describes the criteria for case inclusion.

Table 1 summarises the complete results for baseline patient characteristics. The median age at colonoscopy was 51 years [interquartile range (IQR): 42–58 years]. 71 of 126 (56%) of colonoscopies were performed in male patients, with 57 of 126 (45%) having UC, 68 of 126 (54%) CD and 1 of 126 (0.8%) IBD-unspecified. The median disease duration at the time of the colonoscopy was 16 years (IQR 12–23 years). 15 of 126 (12%) of patients had a family history of CRC and 10 of 126 (7.9%) had primary sclerosing cholangitis (PSC). One patient had a personal history of colonic polyps prior to IBD dysplasia screening commencing. 151 of 276 colonoscopies (55%) were performed with chromoendoscopy and targeted biopsies (\pm random biopsies) and the rest were performed with HDWLE with random segmental biopsies. 41 of 276 (15%) colonoscopy specimens had active histological inflammation on biopsies. 24 (8.7%) patients were on steroids at the time of procedure, 13 (4.7%) of which still proceeded to chromoendoscopy. The reasons for corticosteroid exposure at the time of the colonoscopy were mixed and variably reported on chart review. Most patients were on a short weaning course of prednisolone to

ensure mucosal inflammation at the time of colonoscopy was minimal to maximise chromoendoscopy potential; with a few having had a flare of their IBD prior to their planned surveillance procedure.

Prevalence of neoplasia

The prevalence for ASLs was 75 of 276 colonoscopies (27%), an SSL was found in 20 of 276 colonoscopies (7.2%) and any serrated lesion (SSL, TSA or CSSP) was found in 43 of 276 colonoscopies (16%). No SSLs were found to be dysplastic. The histological breakdown of all lesions identified is summarised in Table 1. Importantly, no flat invisible dysplasia was detected (from random biopsies taken) in the entire cohort. Visible flat (non-adenomatous like) dysplasia or cancer was found in 4 of 276 colonoscopies (1.4%), and all 4 were detected in colonoscopies performed with chromoendoscopy and targeted biopsies. One of these patients had PSC and visible low-grade flat dysplastic changes on two sequential, annual colonoscopies, but was not further surveyed with subsequent colonoscopies due to a concurrent advanced cholangiocarcinoma. The second patient had a family history of bowel cancer and was an ex-smoker, with cancer being identified on a surveillance colonoscopy after having continuously active disease in the

Table 1. Baseline characteristics.

Patient characteristics (per patient)			
Sex (<i>n</i> , % male)		71 (56)	
Diagnosis (<i>n</i> , % UC)		57 (45)	
Concurrent PSC (<i>n</i> , %)		10 (8)	
Family history of bowel cancer (<i>n</i> , %)		15 (12)	
Personal history of polyps prior to IBD diagnosis (<i>n</i> , %)		1 (0.8)	
Patients that proceeded to surgery (<i>n</i> , %)		4 (3)	
Ulcerative colitis disease category (Montreal Classification) per patient			
A1	3 (4)	E1	0 (0)
A2	47 (69)	E2	23 (33)
A3	18 (26)	E3	46 (67)
CD category (Montreal Classification) per patient, <i>n</i> , %			
A1	6 (11)	B1	43 (75)
A2	41 (72)	B2	7 (12)
A3	10 (18)	B3	7 (12)
L1	0 (0)	P	11 (19)
L2	32 (56)		
L3	25 (44)		
L4	0 (0)		
Patient characteristics (per colonoscopy)			
Age (median, IQR, years)		51 (42–58)	
Disease duration (median, IQR, years)		17 (12–24)	
Smoking status			
Current (<i>n</i> , %)		41 (15)	
Former (<i>n</i> , %)		78 (28)	
Never (<i>n</i> , %)		161 (58)	
Concurrent PSC (<i>n</i> , %)		26 (9.4)	
Therapy (at colonoscopy, <i>n</i> , %)			
Nil		27 (10)	
5-aminosalicylate		87 (31)	
Immunomodulator		52 (19)	
Infliximab		55 (20)	

(Continued)

Table 1. (Continued)

Adalimumab	31 (11)
Vedolizumab	13 (5)
Ustekinumab	7 (3)
Combination biologic + immunomodulator	32 (11)
Corticosteroids (prednisolone or budesonide MMX)	24 (9)
Other immunosuppressant	12 (4)
Chromoendoscopy (n, %)	151 (54.7)
Endoscopy features n (%) per colonoscopy	
Pseudopolyps	122 (44)
Strictureing (colon or rectum)	9 (3.3)
Shortened tubular colon	80 (29)
Yield: Histological features (per colonoscopy, n, %)	
Active inflammation	41 (15)
Any significant lesion	75 (27)
CSSPs	28 (10)
SSL ²	20 (7)
TSA	2 (0.7)
Non-polypoid/flat dysplasia	
Low grade	2 (0.7)
High grade	1 (0.4)
Polypoid high-grade dysplasia/cancer	
Malignant lesion	1 (0.4)
Polypoid low-grade dysplasia	
Tubular adenoma	37 (13)
TVA	1 (0.4)
¹ SSLs and CSSPs, TSAs total.	
² Pre-WHO criteria change in 2019. ¹⁰	
CD, Crohn's disease; CSSPs, clinically significant serrated polyps; IQR, interquartile range; SSL, sessile serrated lesion; TSA, traditional serrated adenoma; TVA, tubulo-villous adenoma; UC, ulcerative colitis.	

preceding year. The third patient had refractory inflammatory disease but no additional risk factors for malignancy. On two prior colonoscopies not included in the study time frame, he had multifocal flat low-grade dysplasia and on the third, and included colonoscopy, he progressed to multifocal high-grade dysplasia on histopathological

examination that ultimately culminated in him having a colectomy.

Predictors for ASL and any serrated lesions
Any significant lesions (ASL). Table 2 summarises the univariate and multivariate findings for any

Table 2. ASL univariate and multivariate analyses.

Risk factor	ASL univariate			ASL multivariate ¹		
	Odds ratio	p Value	Confidence interval	Odds ratio	p Value	Confidence interval
Age at colonoscopy	1.03	0.003	1.01–1.05	1.03	0.02	1.005–1.057
Gender (reference group, female)	0.77	0.32	0.45–1.30	–	–	–
Disease duration at time of scope	1.02	0.24	0.99–1.05	–	–	–
Smoking history	1.12	0.33	0.86–1.56	–	–	–
Family history of CRC	1.32	0.47	0.63–2.79	–	–	–
Pseudopolyps	0.96	0.88	0.57–1.63	–	–	–
Colonic stricturing	0.00	0.99	0.01–0.71	–	–	–
Shortened, lead-pipe bowel	0.80	0.45	0.44–1.44	–	–	–
Active inflammation present	1.12	0.75	0.55–2.28	–	–	–
Chromoendoscopy used	1.61	0.08	0.94–2.74	1.99	0.02	1.13–3.51
PSC present	0.58	0.25	0.23–1.47	–	–	–

¹Covariates entered; age at colonoscopy, gender, disease duration at time of colonoscopy, smoking history, and whether chromoendoscopy was performed.
ASL, any significant lesion; CRC, colorectal cancer; PSC, primary sclerosing cholangitis.

significant neoplastic lesions. The univariate analysis found that an increased age [odds ratio (OR): 1.03, 95% confidence interval (CI): 1.01–1.05, $p=0.02$] was associated with a higher risk of finding ASL. Chromoendoscopy was associated with a non-significantly increased risk of detecting ASL compared to those who did not undergo chromoendoscopy (OR: 1.61, 95% CI: 0.94–2.74, $p=0.08$) on the univariate analysis.

The covariates that were entered into the multivariate logistic regression analysis included age at colonoscopy, gender, disease duration at time of colonoscopy, smoking history, and whether chromoendoscopy was performed as these either had a p value of <0.2 at univariate analysis or are known to be associated with neoplasia development in non-IBD cohorts. After adjusting for these covariates, a similar narrative was seen on the multivariate analysis whereby an increased age (OR: 1.03, 95% CI: 1.005–1.057, $p=0.02$) was associated with a higher risk of finding neoplasia. In addition, chromoendoscopy was found to confer twice the odds of finding any neoplasia than if chromoendoscopy was not performed (OR: 1.99, 95% CI: 1.13–3.51, $p=0.02$), Table 2.

Any serrated lesions (any of SSL, TSA or CSSP). The univariate analysis revealed that chromoendoscopy was once again numerically associated with an increased odds of serrated lesion detection; however, it did not reach statistical significance (OR: 1.68, 95% CI: 0.94–2.75, $p=0.08$). The multivariate analysis did not find any risk factors associated with serrated lesion detection (Table 3).

Discussion

Colonic inflammatory disease is an established risk factor for CRC.^{1–3} This risk begins at approximately 2% after 8 years and increases at approximately 0.5–1% per year of disease. There is also an increased risk with a greater extent of colonic involvement.^{1,22,36,37} Concomitant PSC, being a smoker, an older age, the presence of colonic strictures and a family history of colorectal carcinoma are also known risk factors for a higher incidence of CRC in inflammatory colitis patients.^{3,22,36,38–41} Active inflammation has been shown to be a driver of carcinogenesis in IBD.^{42,43} Chronic inflammatory burden, however, is difficult to quantify. Surrogate clinical markers of more active disease may include the need for higher

Table 3. Univariate and multivariate analyses for finding any serrated lesions.

Risk factor	Univariate			Multivariate		
	Odds ratio	p Value	Confidence interval	Odds ratio	p Value	Confidence interval
Age at colonoscopy	1.01	0.63	0.98–1.03	All $p > 0.05$		
Gender (reference group, female)	1.01	0.97	0.53–1.95			
Disease duration at time of scope	1.01	0.48	0.98–1.05			
Smoking history	0.96	0.81	0.66–1.39			
Family history of CRC	0.87	0.79	0.32–2.39			
Pseudopolyps	0.91	0.79	0.47–1.77			
Colonic stricturing	0	1	0			
Shortened, lead-pipe bowel	0.84	0.64	0.40–1.75			
Active inflammation present	1.83	0.12	0.84–4.15			
Chromoendoscopy used	1.68	0.08	0.94–2.75			
PSC present	0.80	0.69	0.26–2.41			

CRC, colorectal cancer; PSC, primary sclerosing cholangitis.

intensity immunosuppressive treatments and a longer disease duration.^{39,44} It is unknown if chronic inflammation also drives the development of conventional adenomatous neoplasia and SSLs in IBD patients. The existing literature comparing the prevalence of neoplasia in IBD patients with the general population is sparse, as comparative studies are difficult to conduct. Real-world studies on the prevalence of neoplasia in the IBD surveillance cohort show mixed and contradictory results.^{12,15,17} Thus, further study is needed to determine neoplasia detection rates in surveillance colonoscopies performed in IBD patients and to determine if chromoendoscopy, in the era of HDWLE, increases the yield of neoplasia.

Our study identified the prevalence of ASL to be 27% and any serrated lesion to be 16% of colonoscopies performed in a tertiary IBD surveillance cohort. Our results are in line with previous studies reporting neoplasia detection rates of 13–59% in IBD populations.^{12,29,45} Age was associated with a higher risk of finding ASL statistically, as did the utilisation of chromoendoscopy. Our findings add weight to the existing literature that chromoendoscopy increases neoplastic yield in surveying IBD patients despite the skill, endoscopy time and therefore costs incurred.

Serrated polyposis syndrome is now the most common polyposis syndrome, and serrated polyps have been identified in 15–27% of a *non-IBD*, CRC screening cohort.⁴⁶ In our IBD cohort, serrated lesions were seen in 16% of the cohort, with 7.2% having an SSL by the WHO definition predating the 2019 change.³⁵ Previous published studies have found the prevalence of SSLs in IBD cohorts to vary. Johnson *et al.*¹¹ and Lee *et al.*¹² have found it to be lower than the general, non-IBD population at 0.2–1.4%; however, these results were prior to the WHO definition alteration for SSL in 2019, and may have underestimated the true prevalence of SSLs. On the other hand, Iacucci *et al.* in 2014 identified the incidence of SSLs in IBD patients to be similar to our rate at 16%.¹³ Whether there is an increased prevalence of SSLs in the IBD population compared to the general population remains unanswered as there are no prospective studies comparing the yield of chromoendoscopy in an IBD cohort matched with a non-IBD or average risk cohort. These results show our IBD cohort to have at least similar rates of serrated lesions as population studies of non-IBD patients and concur with other studies of serrated lesion prevalence in IBD patients.¹³ Gastroenterologists performing surveillance colonoscopies in IBD patients should

therefore aim for similar serrated lesion detection rates, despite the younger median age of the IBD cohort.

Chromoendoscopy is regarded as the gold-standard for dysplasia detection in IBD¹⁹; however, excellent bowel preparation and adequate time allocation are paramount. In our cohort, all colonoscopies were performed with high-definition white light colonoscopes, which have been shown to improve dysplasia detection compared to standard definition colonoscopies.¹⁹ Chromoendoscopy was performed in 55% of the cohort, with bowel preparation quality and macroscopically visible inflammation being the main drivers for not proceeding with the chromoendoscopy. Our results intimate in favour of chromoendoscopy over white light examination in concordance with results that have been published elsewhere.^{27,29} Our relatively small cohort and possibly underpowered sample size still detected a significant benefit in detecting any significant lesions with twice the odds of finding a lesion compared to if chromoendoscopy was not used. VCE is not performed at our centre; however, the technology continues to evolve in this area and data are mixed to date, but holds promise.^{47,48}

A strength of this study was the real-world nature of the data acquired. The pragmatic nature of our results offers great relevance to the practising gastroenterologist dealing with IBD patients. Data were extracted from electronic medical records and a prospectively maintained registry that was up to date and considered complete. This study was carried out in a busy tertiary IBD centre with a cohort of patients that had multiple years of follow-up. The retrospective nature also removes the effect of observer bias which might confound prospective open label studies in endoscopy and demonstrate that despite the challenges of time restriction in real-world clinical practice, chromoendoscopy can be still be performed successfully with a high yield.

Several limitations in this study should be acknowledged. First, data were retrospectively accessed, introducing the risk of information as well as selection bias. Free-text reporting in colonoscopy reports limited the ability to remove information bias. Importantly, we lacked details surrounding previously affected areas of colitis to

differentiate colitis-associated dysplasia and spontaneous adenomas. We felt, however, the pragmatic nature of the study made this lack irrelevant, as the totality of all lesions detected was the focus of this study. Second, no specific data were expressly collected regarding specific endoscopist factors, but all were specialist gastroenterologists, and the majority sub-specialised in treating IBD. The number of random biopsies taken, however, were variable among the endoscopists, which may have influenced the yield of invisible dysplasia, albeit insignificantly. Third, inter-observer variability in neoplasia detection rates requires consideration. Fourth, our cohort was relatively small thus the magnitude of any findings may have been diminished from being underpowered. Finally, pathology definitions for SSLs are continuing to evolve, with the most recent change being in 2019.³⁵ This change corresponds to variability in histopathology reporting between 2015 and 2021, a significant time segment of our cohort. Funding was not available to enable histopathologists to retrospectively review the specimens; thus, we utilised the expanded definition of CSSP to account for the potentially misclassified lesions according to current definitions.

Conclusion

Significant neoplastic lesions were detected in 27% and serrated lesions in 16% of all colonoscopies in IBD patients undergoing a dysplasia surveillance program. Our data add to the literature on the expected neoplastic yield targets when surveying a patient with colonic IBD and supports the practice of performing chromoendoscopic surveillance.

Declarations

Ethics approval and consent to participate

The Fiona Stanley Hospital Ethics review board assessed the study and low-risk ethics approval was obtained (HREC no: 40149, approved 7 April 2021). Patients' identifying information were separated from the clinical details in the dataset and analysed in a de-identified manner with a robust process of keeping identifying information and research data separate and secure. Thus, patient consent was not required as per ethics approval.

Consent for publication

Individual patient consent for publication was not requested and this was approved by the institution's low risk ethics committee.

Author contribution(s)

Fiona Yeaman: Data curation; Formal analysis; Investigation; Methodology; Project administration; Writing – original draft; Writing – review & editing.

Lena Thin: Conceptualisation; Formal analysis; Investigation; Methodology; Resources; Software; Supervision; Writing – review & editing.

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Competing interests

The authors declare that there is no conflict of interest. This study was not funded

Availability of data and materials

Original data is available on request from the authors and release may be granted on approval by institution's ethics committee.

ORCID iDs

Fiona Yeaman  <https://orcid.org/0000-0001-7275-7051>

Lena Thin  <https://orcid.org/0000-0003-2816-3533>

Supplemental material

Supplemental material for this article is available online.

References

1. Ekblom A, Adami HO, Helmick C, *et al.* Increased risk of large-bowel cancer in Crohn's disease with colonic involvement. *Lancet* 1990; 336: 357–359.
2. Bernstein CN, Blanchard JF, Kliewer E, *et al.* Cancer risk in patients with inflammatory bowel disease. *Cancer* 2001; 91: 854–862.
3. Jess T, Rungoe C and Peyrin-Biroulet L. Risk of colorectal cancer in patients with ulcerative colitis: a meta-analysis of population-based cohort studies. *Clin Gastroenterol Hepatol* 2012; 10: 639–645.
4. Magro F, Gionchetti P, Eliakim R, *et al.* Third European evidence-based consensus on diagnosis and management of ulcerative colitis. Part 1: definitions, diagnosis, extra-intestinal manifestations, pregnancy, cancer surveillance, surgery, and ileo-anal pouch disorders. *J Crohns Colitis* 2017; 11: 649–670.
5. Dekker E, Bleijenberg A, Balaguer F, *et al.* Update on the world health organization criteria for diagnosis of serrated polyposis syndrome. *Gastroenterology* 2020; 158: 1520–1523.
6. Bleijenberg AGC, Ijspeert JEG, Hazewinkel Y, *et al.* The long-term outcomes and natural disease course of serrated polyposis syndrome: over 10 years of prospective follow-up in a specialized center. *Gastrointest Endosc* 2020; 92: 1098–1107.e1.
7. Rastogi A, Gupta N, Rao DS, *et al.* Association of right sided hyperplastic polyps, large hyperplastic polyps, and other serrated polyps with synchronous colonic neoplasia. *Gastroenterology* 2011; 140: S-407.
8. Rex DK, Ahnen DJ, Baron JA, *et al.* Serrated lesions of the colorectum: review and recommendations from an expert panel. *Am J Gastroenterol* 2012; 107: 1315–1329; quiz 1314, 1330.
9. Khalid O, Radaideh S, Cummings OW, *et al.* Reinterpretation of histology of proximal colon polyps called hyperplastic in 2001. *World J Gastroenterol* 2009; 15: 3767–3770.
10. Kim JH and Kang GH. Evolving pathologic concepts of serrated lesions of the colorectum. *J Pathol Transl Med* 2020; 54: 276–289.
11. Johnson DH, Khanna S, Smyrk TC, *et al.* Detection rate and outcome of colonic serrated epithelial changes in patients with ulcerative colitis or Crohn's colitis. *Aliment Pharmacol Ther* 2014; 39: 1408–1417.
12. Lee LH, Iacucci M, Fort Gasia M, *et al.* Prevalence and anatomic distribution of serrated and adenomatous lesions in patients with inflammatory bowel disease. *Can J Gastroenterol Hepatol* 2017; 2017: 5490803.
13. Iacucci M, Hassan C, Gasia MF, *et al.* Serrated adenoma prevalence in inflammatory bowel disease surveillance colonoscopy, and characteristics revealed by chromoendoscopy and

- virtual chromoendoscopy. *Can J Gastroenterol Hepatol* 2014; 28: 589–594.
14. Lee H, Rabinovitch PS, Mattis AN, *et al.* Non-conventional dysplasia in inflammatory bowel disease is more frequently associated with advanced neoplasia and aneuploidy than conventional dysplasia. *Histopathology* 2021; 78: 814–830.
 15. Choi WT. Non-conventional dysplastic subtypes in inflammatory bowel disease: a review of their diagnostic characteristics and potential clinical implications. *J Pathol Transl Med* 2021; 55: 83–93.
 16. Parian AM and Lazarev MG. Serrated colorectal lesions in patients with inflammatory bowel disease. *Gastroenterol Hepatol* 2018; 14: 19–25.
 17. de Jong ME, Nagtegaal ID, Vos S, *et al.* Increased colorectal neoplasia risk in patients with inflammatory bowel disease and serrated polyps with dysplasia. *Dig Dis Sci* 2022; 67: 5647–5656.
 18. Mohammed N, Kant P, Abid F, *et al.* High definition white light endoscopy (HDWLE) versus high definition with chromoendoscopy (HDCE) in the detection of dysplasia in long standing ulcerative colitis: a randomised controlled trial. *Gut* 2015; 64: A14–A15.
 19. Laine LMD, Kaltenbach TMD, Barkun AMD, *et al.* SCENIC international consensus statement on surveillance and management of dysplasia in inflammatory bowel disease. *Gastrointest Endosc* 2015; 81: 489–501.e26.
 20. Annese V, Beaugerie L, Egan L, *et al.* European evidence-based consensus: inflammatory bowel disease and malignancies. *J Crohns Colitis* 2015; 9: 945–965.
 21. Farraye FA, Odze RD, Eaden J, *et al.* AGA medical position statement on the diagnosis and management of colorectal neoplasia in inflammatory bowel disease. *Gastroenterology* 2010; 138: 738–745.
 22. Eaden JA and Mayberry JF. Guidelines for screening and surveillance of asymptomatic colorectal cancer in patients with inflammatory bowel disease. *Gut* 2002; 51: v10.
 23. Cancer Council Australia Surveillance Colonoscopy Guidelines Working Party. Clinical practice guidelines for surveillance colonoscopy, https://wiki.cancer.org.au/australia/Guidelines:Colorectal_cancer/Colonoscopy_surveillance (2019, accessed 26 February 2021).
 24. Murthy SK, Feuerstein JD, Nguyen GC, *et al.* AGA clinical practice update on endoscopic surveillance and management of colorectal dysplasia in inflammatory bowel diseases: expert review. *Gastroenterology* 2021; 161: 1043–1051.e4.
 25. Lamb CA, Kennedy NA, Raine T, *et al.* British Society of Gastroenterology consensus guidelines on the management of inflammatory bowel disease in adults. *Gut* 2019; 68: s1–s106.
 26. Clarke K, Kang M, Gorrepati VS, *et al.* Dysplasia detection is similar between chromoendoscopy and high-definition white-light colonoscopy in inflammatory bowel disease patients: a US-matched case-control study. *Int J Colorectal Dis* 2020; 35: 2301–2307.
 27. Wan J, Zhang Q, Liang SH, *et al.* Chromoendoscopy with targeted biopsies is superior to white-light endoscopy for the long-term follow-up detection of dysplasia in ulcerative colitis patients: a multicenter randomized-controlled trial. *Gastroenterol Rep (Oxf)* 2021; 9: 14–21.
 28. Yang DH, Park SJ, Kim HS, *et al.* High-definition chromoendoscopy versus high-definition white light colonoscopy for neoplasia surveillance in ulcerative colitis: a randomized controlled trial. *Am J Gastroenterol* 2019; 114: 1642–1648.
 29. Alexandersson B, Hamad Y, Andreasson A, *et al.* High-definition chromoendoscopy superior to high-definition white-light endoscopy in surveillance of inflammatory bowel diseases in a randomized trial. *Clin Gastroenterol Hepatol* 2020; 18: 2101–2107.
 30. Mooiweer E, van der Meulen-de Jong AE, Ponsioen CY, *et al.* Chromoendoscopy for surveillance in inflammatory bowel disease does not increase neoplasia detection compared with conventional colonoscopy with random biopsies: results from a large retrospective study. *Am J Gastroenterol* 2015; 110: 1014–1021.
 31. Feuerstein JD, Rakowsky S, Sattler L, *et al.* Meta-analysis of dye-based chromoendoscopy compared with standard- and high-definition white-light endoscopy in patients with inflammatory bowel disease at increased risk of colon cancer. *Gastrointest Endosc* 2019; 90: 186–195.e1.
 32. Santi G, Michetti P, Froehlich F, *et al.* Adherence to recommendations and quality of endoscopic colorectal cancer surveillance in long-standing ulcerative colitis. *Inflamm Intest Dis* 2021; 6: 25–31.

33. von Elm E, Altman DG, Egger M, *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; 370: 1453–1457.
34. Aronchick C, Lipshutz W, Wright S, *et al.* Validation of an instrument to assess colon cleansing. *Am J Gastroenterol* 1999; 94: 2667.
35. International Agency for Research on Cancer, World Health Organization and IARC Publications. *Digestive system tumours: WHO classification of tumours*. vol 1. 1st ed. IARC, 2019.
36. Eaden J. Colorectal carcinoma and inflammatory bowel disease: review: colorectal carcinoma and IBD. *Aliment Pharmacol Ther* 2004; 20: 24–30.
37. Eaden JA, Abrams KR and Mayberry JF. The risk of colorectal cancer in ulcerative colitis: a meta-analysis. *Gut* 2001; 48: 526–535.
38. Askling J, Dickman PW, Ekblom A, *et al.* Family history as a risk factor for colorectal cancer in inflammatory bowel disease. *Gastroenterology* 2001; 120: 1356–1362.
39. Rutter M, Saunders B, Wilkinson K, *et al.* Severity of inflammation is a risk factor for colorectal neoplasia in ulcerative colitis. *Gastroenterology* 2004; 126: 451–459.
40. Soetikno RM, Lin OS, Heidenreich PA, *et al.* Increased risk of colorectal neoplasia in patients with primary sclerosing cholangitis and ulcerative colitis: a meta-analysis. *Gastrointest Endosc* 2002; 56: 48–54.
41. Rutter MD, Saunders BP, Wilkinson KH, *et al.* Cancer surveillance in longstanding ulcerative colitis: endoscopic appearances help predict cancer risk. *Gut* 2004; 53: 1813–1816.
42. Romano M, De Francesco F, Zarantonello L, *et al.* From inflammation to cancer in inflammatory bowel disease: molecular perspectives. *Anticancer Res* 2016; 36: 1447–1460.
43. Moossavi S and Bishehsari F. Inflammation in sporadic colorectal cancer. *Arch Iran Med* 2012; 15: 166–170.
44. Saraiva S, Rosa I, Moleiro J, *et al.* Dysplasia surveillance in inflammatory bowel disease: a cohort study. *GE Port J Gastroenterol* 2021; 28: 97–105.
45. Carballal S, Maisterra S, Lopez-Serrano A, *et al.* Real-life chromoendoscopy for neoplasia detection and characterisation in long-standing IBD. *Gut* 2018; 67: 70–78.
46. IJspeert JEG, Bevan R, Senore C, *et al.* Detection rate of serrated polyps and serrated polyposis syndrome in colorectal cancer screening cohorts: a European overview. *Gut* 2017; 66: 1225–1232.
47. Rabinowitz LG, Kumta NA and Marion JF. Beyond the SCENIC route: updates in chromoendoscopy and dysplasia screening in patients with inflammatory bowel disease. *Gastrointest Endosc* 2022; 95: 30–37.
48. Kandiah K, Subramaniam S, Thayalasekaran S, *et al.* Multicentre randomised controlled trial on virtual chromoendoscopy in the detection of neoplasia during colitis surveillance high-definition colonoscopy (the VIRTUOSO trial). *Gut* 2021; 70: 1684–1690.