Colon polyps: updates in classification and management

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Purpose of review
Colon polyps are potential precursors to colorectal cancer (CRC), which remains one of the most common causes of cancer-associated death. The proper identification and management of these colorectal polyps is an important quality measure for colonoscopy outcomes. Here, we review colon polyp epidemiology, their natural history, and updates in endoscopic classification and management.

Recent findings
Colon polyps that form from not only the adenoma, but also the serrated polyp pathway have significant risk for future progression to CRC. Therefore, correct identification and management of sessile serrated lesions can improve the quality of screening colonoscopy. Malignant polyp recognition continues to be heavily reliant on well established endoscopic classification systems and plays an important role in intraprocedural management decisions. Hot snare remains the gold standard for pedunculated polyp resection. Nonpedunculated noninvasive lesions can be effectively removed by large forceps if diminutive, but cold snare is preferred for colon polyps 3–20 mm in diameter. Larger lesions at least 20 mm require endoscopic mucosal resection. Polyps with the endoscopic appearance of submucosal invasion require surgical referral or advanced endoscopic resection in select cases. Advances in artificial intelligence may revolutionize endoscopic polyp classification and improve both patient and cost-related outcomes of colonoscopy.

Summary
Clinicians should be aware of the most recent updates in colon polyp classification and management to provide the best care to their patients initiating screening colonoscopy.

Keywords
colonoscopy, endoscopic classification, polyp

INTRODUCTION

Colorectal cancer (CRC) remains the third most common cancer in both men and women in the USA. Colonoscopy has been established as an effective screening and prevention method to reduce CRC-related morbidity and mortality. In order to improve the quality of colonoscopy, it is important to accurately identify and classify colon polyps which represent potential precursors to CRC based on their endoscopic appearance. Correct endoscopic classification of a polyp will dictate the correct intraprocedure management plan. Here, we review colon polyp epidemiology, their natural history, endoscopic classification systems, current management guidelines and describe possible future directions for innovation and quality improvement.

THE EPIDEMIOLOGY AND NATURAL HISTORY OF COLON POLYPS

Screening measures such as colonoscopy are well established to halt the colon polyp to carcinoma progression [1,2]. Colorectal tumorigenesis was first described by the adenoma to carcinoma sequence, which results most commonly from chromosomal instability and mutations of the *APC* gene as the colonic epithelium ages giving rise to an early adenoma. Each early adenoma may then accumulate further mutations in KRAS and p53 promoting progression to the high-risk adenoma and subsequently carcinoma [3]. A second pathway to CRC, the sessile serrated pathway, has become increasingly recognized and now implicated in up to 30% of all CRC diagnoses [4–6]. The sessile serrated pathway, which is heavily reliant on mutations in the

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KEY POINTS

- Colonoscopy is the most effective tool for CRC prevention as it can detect and remove polyps of all sizes and early cancer.
- Several endoscopic imaging classifications tools are available and should be used in clinical practice.
- Cold polypectomy should be considered for most non pedunculated polyps.

BRAF oncogene, can give rise to precursor lesions now under heavier scrutiny as efforts grow to decrease CRC mortality and interval cancers that may arise from such lesions.

Adenomatous colon polyps

Current epidemiological data from postmortem and colonoscopy studies demonstrate a range of adenoma prevalence in the screening age population from 20 to 60% and it is known that adenoma prevalence increases with age. The occurrence of adenomas is evenly distributed anatomically in the colon (excluding early-onset individuals younger than age 50 who are recognized has having more distal colorectal involvement) with roughly one-third each occurring in the proximal colon, distal colon and rectum. Most early adenomas smaller than 10 mm in size have a low risk of progression to CRC, and even in such cases, the time to cancer is likely longer than 10 years [7,8]. However, advanced adenomas, defined as colon polyps with diameter at least 10 mm or with villous or high-grade dysplasia, can have up to a 5% annual progression rate to CRC [3].

Serrated colon polyps

The most recent 2019 WHO classification categorizes serrated colon polyps as hyperplastic polyp, sessile serrated lesion (SSL) and traditional serrated adenoma (TSA) [9,10]. The term SSL replaced the 2003 terminology 'sessile serrated adenoma' which had been the general terminology to describe such precancerous lesions arising from the serrated polyp pathway; however, its wide adoption and replacement of the older terminology continues to remain controversial [11].

Hyperplastic polyps are prevalent in about 20–30% of the population and are now diagnosed based on histological absence of any feature of SSL (such as serrated epithelium with crypt distortion). The anatomical location of most hyperplastic polyp polyps is in the distal colon and usually represent small, less than 5 mm, flat or sessile lesions thought to have very low malignant transformation potential.

SSLs are now thought to represent about one-fourth of all serrated lesions with overall prevalence of 5–15% in the general population. SSLs compared to hyperplastic polyps usually grow in the proximal colon, are larger in diameter with higher potential for malignancy, especially SSLs with dysplasia which can represents up to 8% of all SSLs. Older age is recognized as a risk factor for SSL with dysplasia. Like hyperplastic polyps, SSLs are flat, sessile lesions which may be difficult to identify especially on the backs of haustral folds on the inner curvatures of colonic flexures. Therefore, it has been recommended that retroflexion in the right colon or a second forward view reexamination can improve the quality of detection of these colon polyps. Currently, it is estimated that SSL are still underdiagnosed by pathologists who have not updated to the most recent WHO pathology classification guidelines [10]. If there is suspicion for an SSL in the right colon, the clinician can consult with the case pathologist to determine the likelihood of SSL pathology to make correct surveillance exam recommendations.

Finally, TSAs represent the smallest subcategory of distal serrated colorectal lesions with less than 1% prevalence with morphology that is usually pedunculated, polypoid and villous histology that is distinct from HPs and SSLs and more like adenomatous colon polyps [4–6].

UPDATES ON COLONOSCOPY SURVEILLANCE BASED ON COLON POLYP TYPE

Based on the 2020 consensus update, patients with one to two traditional adenomas less than 10 mm in size are now recommended to undergo surveillance in 7–10 years. In patients with three to four adenomas less than 10 mm, the recommendation is now a surveillance range of 3–5 years rather than a strict 3-year surveillance. Patients with 5–10 adenomas less than 10 mm or a high-risk adenoma will still undergo surveillance in 3 years and the patient with more than 10 adenomas is now recommended to have a one-year surveillance. Piecemeal resection of large polyps given the high risk for residual polyp and recurrence after the index exam are recommended to have a repeated surveillance interval of 6 months.

Surveillance intervals of sessile serrated lesions is also more granular: patients with one to two SSLs less than 10 mm in size should repeat surveillance between 5 and 10 years, patients with three to four SSLs less than 10 mm in size or a hyperplastic polyp

at least 10 mm should be surveyed in 3–5 years, and a 3-year surveillance interval is recommended for patients with 5–10 SSLs less than 10 mm in size, SSLs with dysplasia or TSAs [12].

It is important to recognize patients who meet the updated WHO 2019 diagnostic criteria for serrated polyposis syndrome (SPS) as these patients are at significantly increased risk for developing CRC and should be enrolled in annual colonoscopy surveillance. Patients who meet the current WHO diagnostic criteria for SPS include at least five serrated polyps proximal to the rectum, all at least 5 mm in size, with at least two polyps being at least 10 mm in size or 20 serrated polyps of any size distributed throughout the colon with at least five being proximal to the rectum. The lifetime cumulative serrated polyps count toward to the total to meet diagnostic criteria, therefore monitoring the total count at each subsequent surveillance colonoscopy is necessary – for this reason, it is thought that current prevalence of SPS is significantly underestimated [12,13].

REVIEW AND VALIDATION OF DEFINED ENDOSCOPIC CLASSIFICATION SYSTEMS

Narrow band imaging international colorectal endoscopic and Japanese Narrow Band imaging expert team (JNET) classification

The NBI International Colorectal Endoscopic (NICE) classification system created in 2009 classifies colon polyp morphology based on colour, distribution of vessels and surface pattern. Based on classification type, histology can be predicted with reasonable accuracy as summarized in Table 1 [14,15]. The NICE classification system highlights the importance of potential malignant polyp recognition. NICE Type 3 polyps should be recognized by the provider as highly suggestive of deep submucosal invasion not endoscopically resectable and require tattoo localization with referral for a surgical resection. The NICE system does not require the addition of magnification or special dyes and has appreciable accuracy [16,17]. In a recent study, endoscopy data for 534 colon polyps were retrospectively reviewed to determine the NICE classification system's accuracy for correct polyp histology. Accuracy was 98.5, 97.8 and 99.3% for type 1, type 2 and type 3 lesions, respectively [18]. However, other studies suggest lower accuracy rates in observers with less training or who do not use the NICE classification system in everyday practice [19].

In 2014, the Japanese Narrow Band Imaging Expert Team (JNET) established a new NBI colon polyp classification system, which requires the use of magnification endoscopy to further characterize NICE type 2 lesions into JNET 2a and 2b while maintaining the same criteria for type 1 and type 3 polyps. On endoscopic evaluation, 2a lesions have regular calibre and distribution of vessels as well as a surface pattern consisting of regular tubular, branched, or papillary structures in contrast to 2b lesions that have variable calibre and irregular vessel distribution along with irregular or obscured surface patterns. Histologically, 2a lesions correlate to low-grade dysplasia and 2b lesions suggest high-grade dysplasia or superficial submucosal invasion (< 1 mm invasion depth) [20]. The histologic accuracy of the JNET system has been studied and suggests respectable rates for type 2a and 2b close to 90%, but lower than NICE and worse for recognition of 2b than 2a lesions [21,22].

Paris classification

The Paris system is an endoscopic classification of colorectal lesions named after the 2002 consortium of endoscopists, pathologists surgeons at Paris [23]. All lesions as part of the Paris classification system are classified as Type 0 with all lesions limited to the mucosa and submucosa. Subtype 0-I describes polypoid lesions which are either pedunculated (0-Ip) or sessile (0-Is). Subtype 0-II are the remaining non-polypoid lesions, which can be minimally elevated (0-IIa), flat (0-IIb) or minimally depressed (0-IIc). Subtype 0-III lesions are excavated and often ulcerated. Depressed (0-IIc) lesions are uncommon

Table 1. NICE classification of Colon Polyps

NICE Type	Colour	Vessels	Surface pattern	Predicted histology
1	Same or lighter than surrounding mucosa	No or few isolated vessels	Uniformly sized dark or white spots	Serrated polyps (HP or SSL)
2	Brown or darker than surrounding mucosa	Brown vessels	Oval, tubular or branched white pits	Traditional adenomas
3	Dark brown to black	Disrupted or missing vessels	Amorphous or absent surface pattern	Deep submucosal invasion

representing 1–6% of nonpolypoid lesions, but have the highest risk of submucosal invasion, 27–36%, compared to 0.7–2.4% in flat (0-IIa) lesions. Virtually all large (>20 mm) and depressed (0-IIc) lesions have submucosal invasion [24–27]. While the Paris classification remains a validated classification system for polyps, the inter-provider agreement among endoscopists remains modest [28].

Laterally spreading tumours

Nonpolypoid lesions more than 10 mm are referred to as laterally spreading tumours (LSTs) and specifically describe flatter lesions that extend laterally along the wall of the colon rather than protrude vertically into the centre of the lumen. Granular-type LSTs (LST-G) have a nodular surface and can be further classified into homogenous even-sized and mixed nodular subtypes. Nongranular LSTs (LST-NG) are smooth and can be flat elevated or pseudo-depressed. The endoscopic classification of LSTs is linked to the submucosal fibrosis or the risk of submucosal invasion which subsequently guides the endoscopic resection plan. Homogenous LST-G have the lowest risk of submucosal invasion compared to pseudo-depressed LST-NG (0.5 vs. 31.6%). LST-NG lesions often have submucosal fibrosis, which can make their removal with simple snare resection or standard endoscopic mucosal resection (EMR) more technically challenging [29].

Kudo pit pattern classification

The Kudo pit pattern classification system was developed in the 1990 s requiring magnification colonoscopy with dye spray to evaluate polyps for malignancy through the characterization of pits as described in Table 2 [30–32]. The clinician should most importantly be able to recognize pit pattern V vs. I-IV given the management decision involves a referral to surgery due to high risk of deep submucosal invasion [33]. The Kudo pit pattern classification system is still recognized as a validated classification with appreciable accuracy. In a recent study, 11 clinicians were asked to classify 64 colon polyps using both the NICE and Kudo pit pattern classification systems. The accuracy for both classifications was comparable (82% for NICE vs. 81% for Kudo) [34]. Another surgical study of 138 colon lesions found that of 11 lesions with invasive adenocarcinoma with submucosal invasion, four had Kudo pit pattern IV and six had Kudo pit pattern V. In their study, a Kudo pit pattern of IV-V had a 91% sensitivity for submucosal invasion and a pattern of I-III had a negative predictive value of 98.7% [35].

UPDATES IN COLON POLYP RESECTION TECHNIQUE

Resection for pedunculated polyps

Current guidelines recommend a resection approach for pedunculated polyps based on the size of the polyp and thickness of the polyp stalk. For pedunculated polyps less than 20 mm in size with a stalk less than 5 mm hot snare polypectomy is appropriate and the transection margin should be at the mid to lower stalk. For pedunculated polyps at least 20 mm or with stalk at least 5 mm, there is increased risk for immediate postpolypectomy bleeding given the likelihood of a large vessel traveling through the polyp stalk at the point of transection. To decrease adverse events related to procedural bleeding, current guidelines recommend prophylactic measures including clipping, injection of diluted epinephrine or ligation with detachable loop devices prior to hot snare resection [36]. Prophylactic ligation was supported by a 2021 randomized controlled trial of 238 large pedunculated polyps, which compared postpolypectomy bleeding in two arms, prophylactic ligation clipping and no prophylaxis. The prophylactic clip group had significantly lower postpolypectomy bleeding compared to no prophylaxis (4.2 vs. 12.6%) [37].

Table 2. Kudos Pit pattern classification

Kudo pit pattern	Description	Associated histology
I	round and normal	Normal
II	stellate	Serrated or inflammatory polyps
III_S	round, tubular, and smaller than type I	Tubular adenoma
III_L	round, tubular, and larger than type I	Tubular adenoma
IV	dendritic or gyrus-like	Villous adenoma
V_N	nonstructured or amorphous	Invasive neoplasm
V_I	irregular arrangement	Invasive neoplasm

Resection for nonpedunculated polyps

Updated resection guidelines for nonpedunculated, sessile lesions are first stratified based on lesion size. Even for diminutive lesions less than 5 mm in size, the current guidelines recommend cold snare polypectomy whenever possible, as cold snare polypectomy is known to be more effective in decreasing the risk of residual polyp and recurrence. However, large cold forceps polypectomy can be considered based on the 2020 Multi-Society Task Force Guidelines for polyps 2–3 mm in size or less [36]. This recommendation was supported by a recent large meta-analysis of randomized controlled trials studying outcomes for endoscopic resection of diminutive polyps using cold snare versus large cold forceps. In this study of 1037 patients, diminutive polyps 3 mm in size or less were completely resected by both cold snare polypectomy and large-capacity or jumbo forceps with no significant difference in either trial arm [38]. However, cold snare is recommended for en bloc resection for sessile polyps 3–9 mm.

For sessile lesions at least 10 mm, it is first important to employ the reviewed polyp classification systems to determine the risk of malignancy in the polyp or submucosal invasion. For polyps considered to be at increased risk such as NICE Type 3 or Kudo V-VI, confirmatory biopsy and referral to a surgeon is recommended. In select cases and institutions, en bloc advanced resection techniques such as endoscopic submucosal dissection may also be considered following a multidisciplinary discussion and consideration of the patient's candidacy for surgery [36].

For noninvasive lesions 10–19 mm in size, cold snare polypectomy or cold EMR is becoming more popular with decreased adverse events related to postprocedural bleeding [39]. In a recent multicentre prospective study, 350 nonpedunculated polyps 10–19 mm in size were removed via cold snare polypectomy or cold EMR. The incomplete resection rate was 1.7% with a low adverse event rate of 3.4% (adverse events included postpolypectomy pain, self-limited postpolypectomy bleeds, postpolypectomy-like presentation and intraprocedural bleeding treated with clips – no perforations) [40▪▪].

Finally for noninvasive, nonpedunculated lesions at least 20 mm in size, EMR is recommended. The components of successful EMR include use of a viscous injection solution for adequate lift and evaluation of polyp margins, resection of all grossly visible polyp tissue with the use of adjuvant thermal ablation of the post-EMR margin if necessary and for lesions in the right colon, prophylactic clip closure of the EMR defect [36]. Following this guideline update, a recent randomized controlled trial of 231 patients undergoing EMR for large ($\geq$ 20 mm) nonpedunculated polyps in the right colon randomly assigned to prophylactic clipping or control (no clip) found an absolute risk reduction for clipping of 7.2% with a number needed to treat of 14 [41].

FUTURE DIRECTIONS

Adenoma detection rate (ADR) in addition to caecal intubation rate and bowel preparation scores has been well established as a quality measure of screening colonoscopy. Higher ADR, specifically a rate higher than at least 25% (30% in men and 20% in women) has been significantly associated with decreased risk in CRC morbidity and mortality with less postcolonoscopy cancers [42].

SSL detection rate is currently variable, endoscopist-dependent and lower in endoscopists in training. SSL detection rates were tracked at a large academic medical centre between 2008 and 2020. The SSL detection rates were lowest at the beginning of the study period, 0.37% in 2008 increasing to 7.94% in 2020. SSL detection rate was also found to be lower for first year fellows compared to second and third-year fellows [43]. Such improvement of SSL detection rate over the past two decades based on increased recognition of the serrated polyp pathway to CRC may have contributed to decreasing rates of CRC incidence during this time. A recent study of over 300 000 colonoscopies showed that the hazard ratio for a postcolonoscopy cancer was lower for endoscopists with higher SSL detection rate and ADR compared with those with lower SSL detection rate and similar ADR suggesting a significant inverse relationship between SSL detection and removal and interval CRCs [44]. This data have led multiple gastrointestinal societies to consider quality indicators for SSLs; however, much scrutiny remains regarding the acceptable detection rate (recent clinical practice guidelines suggest at least 7%) [45,46]. Emerging technologies with artificial intelligence that improve polyp detection may also obviate the need for additional polyp quality measures for screening colonoscopy.

Artificial intelligence was approved by the FDA in 2021 and its use for computer-assisted polyp detection has been studied. In a 2021 randomized controlled trial of 1440 patients, artificial intelligence assisted polyp detection was found to improve adenomas per colonoscopy compared to the standard arm. The ADR was also increased by approximately 4% [47▪▪]. Multiple uses for artificial intelligence are now being considered including its use in endoscopic polyp classification. Several models incorporating machine learning are currently in the development pipeline to assist in endoscopic pathology assessment

and once developed may revolutionize the current schema of endoscopic classification [48–50,51▪▪]. With a more standardized and reliable technology that can identify polyp pathology using machine learning, opportunities may arise for additional improvement in quality measures such as resect and discard, reducing the number of required pathology assessment and providing patients with real-time surveillance recommendations [52].

CONCLUSION

Screening colonoscopy is the most important tool for clinicians to prevent CRC by correctly identifying and managing colon polyps. Providers should incorporate updated surveillance guidelines into their practice and be mindful of the correction identification and management of SSLs. Endoscopic classification systems including NICE continue to remain the current foundation for polyp characterization during the exam and correct classification remains important for management decisions. Future directions for improvement may include the addition of quality benchmarks such as SSL detection rates or the incorporation of new machine learning using artificial intelligence and computer-assisted detection to help providers with real-time histology analysis – this technology has the potential to improve both the efficiency and effectiveness of screening colonoscopy.

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Conflicts of interest

None for all authors.

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