REVIEW

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Pathogenesis and Management of Serrated Polyps: Current Status and Future Directions

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Hyperplastic or serrated polyps were once believed to have little to no clinical significance. A subset of these polyps are now considered to be precursors to colorectal cancers (CRC) in the serrated pathway that may account for at least 15% of all tumors. The serrated pathway is distinct from the two other CRC pathways and involves an epigenetic hypermethylation mechanism of CpG islands within promoter regions of tumor suppressor genes. This process results in the formation of CpG island methylator phenotype tumors. Serrated polyps are divided into hyperplastic polyps, sessile serrated adenomas/polyps (SSA/Ps), and traditional serrated adenomas (TSAs). The SSA/P and the TSA have the potential for dysplasia and subsequent malignant transformation. The SSA/Ps are more common and are more likely to be flat than TSAs. Their flat morphology may make them difficult to detect and thus explain the variation in detection rates among endoscopists. Challenges for endoscopists also include the difficulty in pathological interpretation as well surveillance of these lesions. Furthermore, serrated polyps may be inadequately resected by endoscopists. Thus, it is not surprising that the serrated pathway has been linked with interval cancers. This review will provide the physician or clinician with the knowledge to manage patients with serrated polyps. **(Gut Liver 2014;8:582-589)**

Key Words: Serrated; Hyperplastic; Sessile serrated adenoma/polyp; Hypermethylation; Serrated polyposis syndrome

INTRODUCTION

The previous set of recommendations for surveillance of resected polyps recommended an interval of 10 years for a repeat colonoscopy in patients with hyperplastic polyps (HPs) or equal to those with normal examinations.[1] As reflected in those recommendations, HPs were believed to have no potential for malignancy. However, in the past 30 years, a subset of these polyps with a unique pathway has been identified as being precursors for colorectal cancer (CRC).[2,3] Recently, an updated version of these surveillance guidelines contains recommendations for certain serrated lesions with intervals as short as 1 year.[4] In addition, an expert panel has also published recommendations for large and proximal hyperplastic lesions.[5]

The endoscopy community, especially in Western countries, lagged behind with regards to recognizing the potential significance of serrated polyps. However, at the close of the previous century, two reports had noted that large proximal hyperplastic lesions exist in the right colon and might warrant full endoscopic resection.[6,7] Another report noted that these lesions had a distinctive endoscopic appearance in the form of a mucous cap.[8] The authors suggested these features which predict hyperplastic tissue might aid in the diagnosis of the polyp, possibly obviating the resection of these large lesions. However, the authors cautioned that more data from other endoscopists were required before any recommendations could be made. This report was followed by a case series which detailed a few proximal hyperplastic lesions which also had mucous caps.[9] The authors noted that a pathologic analysis had revealed that one of the polyps had dysplasia. Thus, those authors recommended that complete resection of these large HPs might be required to prevent further progression of these lesions. These four case reports likely represent the first observations regarding the endoscopic description and management issues related to the sessile serrated adenoma with and without dysplasia.

The serrated pathway is now recognized as a process that can lead to cancer. It is estimated that at least 15% of all CRC may be related to the serrated pathway. In this paper, we will provide

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an overview that will guide the physician and other clinicians in the detection, resection, diagnosis and surveillance of serrated polyps.

CLASSIFICATION AND EPIDEMIOLOGY OF SERRATED POLYPS

Histologically, serrated polyps consist of three subtypes; HPs, sessile serrated adenomas/polyps (SSA/Ps), and traditional serrated adenomas (TSAs).[5,10] The hallmark of serrated lesions are the serrated or "saw tooth like" appearance of the crypts. Some of the subtypes may exhibit this serrated pattern more than others. Features regarding these subtypes will be discussed in this article and are shown in Table 1.

The most common serrated polyps are the HPs which tend to be flat, small (<5 mm) and located in the distal colon. They likely account for more than three quarters of all serrated lesions. After reclassification of all serrated lesions, these polyps are still believed to have little clinical significance. Patients with these polyps are at no risk for metachronous lesions. In addition, they are the only subtype with no dysplastic progression. HPs can be further divided into microvesicular (MVHP), goblet cell (GCHP), and mucin poor polyps. The implications of these subtypes with regards to surveillance and management will be discussed in a subsequent section.

SSA/Ps likely account for almost one quarter of all serrated lesions. These lesions are flat and tend to occur proximally but can be observed distal to the splenic flexure. One retrospective study of 120 SSA/Ps demonstrated that over one-third of the polyps were distal. While all of the proximal SSA/Ps were flat, a little over three-fourths of the distal polyps were flat. SSA/Ps are also characterized by the occasional presence of a yellow mucous cap that may make them easier to identify endoscopically. SSA/Ps are the most clinically important serrated polyp due to their frequency as well as their potential for dysplasia.

TSA are the least common of the three subtypes, accounting for less than 1% of all serrated polyps. These polyps are typically pedunculated and located distally. Like the SSA/Ps, these

Table 1. Serrated Polyp Characteristics and Management

Serrated subtype	Pathological highlights	Dysplastic potential?	Molecular marker	Endoscopic description	USMSTF recommended interval	Expert panel recommended interval
Microvesicular hyperplastic polyp (MVHP)	Small droplets of mucin in cell cytoplasm & straight & serrated crypts at luminal surface	It may if it is a precursor to SSA/P	BRAF	Flat & distal With GCHP account for 75% of all serrated polyps	None	If proximal and >5 mm then 5 years
Goblet cell hyperplastic polyp (GCHP)	Nearly all cells are goblet and crypts are straight	No	*KRAS*	Flat & distal With MVHP account for 75% of all serrated polyps	None	If proximal and >5 mm then 5 years
Sessile serrated adenoma/polyp	Feature dilated and distorted crypts at base with L or anchor shape	Yes	BRAF *MLH1* methylation with dysplasia	Flat & proximal 25% of all serrated polyps	If <10 mm then 5 years If ≥10 mm or dysplasia present then 3 years	If <10 mm then 5 years If ≥10 mm or any size & ≥3 in number then 3 years If ≥10 mm and 2 or more or dysplasia present then 1-3 years
Traditional serrated adenoma	Complex villous or filiform projections of eosinophilic cells	Yes	BRAF *KRAS*	Distal & pedunculated <1% of all serrated polyps	3 Years	If <10 mm then 5 years If >10 mm or any size & >2 in number then 3 years

USMSTF, United States Multi-Society Task Force; SSA/P, sessile serrated adenomas/polyp.

lesions also have a potential to become dysplastic. Given their low numbers as well as their protruding morphology (making them easier to detect), the clinical concern for TSAs may be lower than that for SSA/Ps.

PATHOGENESIS, MOLECULAR PROFILES

The serrated pathway is characterized by an epigenetic mechanism that involves abnormal hypermethylation of CpG islands in the promoter regions of tumor suppressor genes. Since methylation of promoter genes does not alter DNA, it is considered an epigenetic process. The serrated pathway is also associated with mutations of the oncogene BRAF. These mutations play the equivalent role that *KRAS* mutations play in chromosomal instability CRCs.[11,12] Development of SSA/Ps from normal mucosa likely involves methylation, leading to small aberrant crypt foci with serrated glands. Further methylation is likely associated with the development of small HPs or MVHPs. These lesions are felt to be the precursors to SSA/Ps. Further methylation may be associated with dysplasia and then ultimately cancer. These tumors, like their precursors, are characterized by the CpG island mutation phenotype or CIMP.

Within the serrated pathway, there is also the possibility that there may be methylation of *MLH*1 which is associated with SSA/Ps with dysplasia. These lesions with mismatch repair gene mutations and dysplasia are felt to progress to CRC rapidly. These tumors may resemble those tumors seen in Lynch syndrome.

Whereas, MVHPs and SSA/Ps have BRAF abnormalities, GCHP lesions are more likely to have *KRAS* mutations. TSAs on the other hand may have *KRAS* as well as BRAF mutations.

ABERRANT CRYPT FOCI AND THE SERRATED PATHWAY

Aberrant crypt foci are small lesions which can consist of a few crypts and deserve mention in the discussion about the serrated pathway. Despite their size, ACF exhibit molecular profiles that may help to distinguish the serrated from nonserrated subtypes. Specifically, Rosenberg *et al*.[13] in their analysis observed that serrated ACF, a possible precursor to MVHPs were more likely to have BRAF mutations. Conversely, nonserrated lesions, precursors to GCHPs, were more likely to KRAS lesions. One study demonstrated that those patients with a high frequency of distal ACF may be at higher risk for synchronous advanced neoplasia.[14] These investigators also observed that those patients with a higher frequency of distal ACF might also be at risk for metachronous advanced pathology.[15] Thus, ACF may not only serve as biomarkers but may also represent a field effect for advanced pathology.

PATHOLOGICAL INTERPRETATION OF SERRATED POLYPS

All serrated polyps may feature serrated crypt patterns but there are differences which may help to differentiate these polyps. HPs are distinguished by the presence of straight crypts. GCHPs are characterized by the presence of goblet cells and may have little to no serration. MVHPs on the other hand may feature serration (near the luminal surface) in addition to small mucin droplets in the cytoplasm. The rarely seen MPs are characterized by the distinct lack of cytoplasmic mucus. The TSAs are characterized by a complex architecture that gives the crypts a filiform appearance. In addition, these lesions feature an abundance of eosinophilic cytoplasm. Thus, TSAs are histologically distinct from other serrated lesions.

SSA/Ps are characterized by the presence of serrated crypts. Unlike the MVHPs, the crypts are tortuous and dilated, especially at the base. The distorted and dilated crypts at the base can form an "L" shape which are a unique feature of SSA/Ps. Although the serration in MVHPs may occur at the luminal surface as opposed to the basal surface, MVHPs may be difficult to distinguish from SSA/Ps. Other technical factors such as orientation of the specimen on the slide as well as the physical break up of polyps upon retrieval may make it difficult for the pathologist to determine if dilation or distortion of the gland is present at the base. Given the potential dysplasia associated with SSA/Ps, this may be problematic for physicians and will be discussed further in a section below. A recent expert panel has suggested that the presence of 1 dilated crypt may be sufficient to diagnose an SSA/P. The base of an SSA/P may also feature hyperserration with mature goblet and mucinous cells. These cells can lead to an over production of mucous which may account for the characteristic mucous cap seen on endoscopy. Staining with Ki-67, a stain for proliferating cells, can aid in demonstrating an irregular pattern.[16]

As noted above, MVHPs can be difficult to distinguish from SSA/Ps due to the common feature of serration. This has lead some to postulate that the MVHP maybe a precursor to the SSA/P. The pathologic challenge related to distinguishing the HP (likely MVHP) from the SSA/P was demonstrated recently in a study that re-examined serrated polyps in Winnipeg, Canada.[17] These investigators observed that nearly one of five HPs which were larger than 5 mm or proximally located were more likely to be reclassified at SSA/Ps. Thus, serrated lesions in clinical practice which are large (>5 mm) and proximally located might be SSA/Ps. The implications for management will be discussed in the surveillance section of this paper.

The recent expert panel summary and recommendations for the management of serrated lesions has several key conclusions regarding serrated lesions. These are summarized by the following points:

1) Serrated polyps can be divided into three categories, HPs,

TSAs, and SSA/Ps.

2) Physicians and pathologists should work together and agree to a common usage for the nomenclature of serrated polyps.
3) There are occasionally lesions that cannot be classified but the pathologist should attempt to determine if dysplasia is present.
4) The two lesions with malignant potential are TSAs and SSA/Ps.
5) SSA/Ps can be distinguished from HP by the presence of crypt dilation and distortion, especially at the base.
6) One unequivocally architecturally distorted, dilated and/or horizontally branched crypt is sufficient to diagnose an SSA/P.
7) SSA/P with dysplasia is a more advanced lesion than SSA/P without dysplasia.

RISK FACTORS ASSOCIATED WITH SERRATED LESIONS

Unlike conventional adenomas, there have been few studies which have examined the risk factors associated with the clinically important SSA/Ps. One case control study examined the risk factors in 90 patients with SSA/Ps, 90 patients with tubular adenomas and 200 controls. They observed a strong correlation between smoking more than 20 pack years and SSA/Ps.[18] The association between smoking and SSA/Ps was stronger than that for smoking and adenomas. This finding is quite striking given the strong link between smoking and conventional adenomas.[19,20] Although tubular adenomas were more common in men, there was no gender difference for SSA/Ps. In addition, these authors also observed that SSA/Ps were associated with obesity and diabetes mellitus.

The same group also observed that smokers were more likely to have large (>1 cm) proximal SSA/Ps.[21] Smoking has been observed to be associated with smaller lesions known as aberrant crypt foci indicating that smoking may play a role in initiation of the growth of serrated lesions.[14] In addition, smoking has been linked with CIMP high cancers as well as BRAF mutations[22] and tumors with microsatellite instability.[23]

A recent case control study examined 628 adenoma cases, 549 serrated polyp cases, and 247 cases of both polyps and 1,037 polyp free controls.[24] These investigators also observed that the association with smoking was stronger for serrated polyps than for adenomas. With regards to specific subtypes, there was an almost 3 fold increased risk for SSA/Ps for current smokers as compared to nonsmokers. There was also a strong correlation between male sex and adenomas but no relationship with serrated polyps. Interestingly, there was a stronger correlation between smoking and distally located serrated polyps as compared to proximal polyps. One might expect that the association would be stronger in the proximal colon. However, it should be noted that the authors presented data on serrated polyps and did not break the group down into the subtypes, HPs and SSA/Ps.

Recently, investigators in The Netherlands developed a risk score to predict the detection of large, proximal, or dysplastic serrated polyps in patients undergoing colonoscopy.[25] The derivation cohort consisted of 2,244 patients and 2,402 patients in the validation cohort. In the model, points were given for age (2 for age >50 years), history of serrated polyps (3 if yes), smoking (2 for current), and 2 points for patients who did not take aspirin. In the validation cohort, a score of 5 or more was associated with the presence of a large, proximal or dysplastic serrated polyp. These data demonstrate the feasibility of predicting the detection of clinically important serrated polyps in using risk factors such as smoking.

SERRATED LESIONS, ADVANCED NEOPLASIA AND CRC

In addition, as described above, SSA/Ps have the potential for malignant transformation. Published case reports exist of SSA/Ps which have been left in situ and have developed into CRC,[26,27] In addition, there are also case reports of CRC which have associated SSA/P histology.[28,29]

There have been several studies which have demonstrated a strong association between synchronous advanced neoplasia and serrated polyps, especially those that are large and proximal. One study observed a strong relationship between large serrated polyps and colorectal neoplasia.[30] In a large multicenter study of 10,199 patients, they found that large serrated polyps were associated with advanced neoplasia and CRC. In particular, the large serrated polyps were strongly associated with proximal CRC. Another study showed a strong association between left and right sided advanced neoplasia in a sample of nearly 5,000 patients.[31] Thus, serrated polyps, especially large and proximal lesions, may coexist with advanced neoplasia and perhaps indicate a possible field effect.

THE SERRATED PATHWAY AND INTERVAL CANCERS

Several papers in the past decade demonstrated that exposure to a previous colonoscopy was more protective for the left side rather the right side of the colon.[32,33] These data highlighted the clinical significance of interval cancers or those tumors which are diagnosed between regularly scheduled colonoscopies. One study demonstrated that these tumors were more likely to be proximal and occur in female patients. These tumors share the characteristics of SSA/Ps and thus many experts have linked the serrated pathways and interval cancers. This link has been supported by data that showed that interval cancers were more likely to exhibit CIMP abnormalities. One study showed that SSA/Ps were frequently smaller than 6 mm and often had high grade dysplasia.[34] Thus, important lesions could be missed. Combined with their flat morphology as well fast progression to

cancer, SSA/Ps have become the focus of efforts to decrease the occurrence of interval cancers. What can be done endoscopically to increase the effectiveness of colonoscopic detection and resection of SSA/Ps?

SERRATED POLYPS AND ENDOSCOPY

A recent article examined the risk of distal and proximal lesions in patients who had a previous colonoscopy or sigmoidoscopy.[35] The risk for advanced adenomas detected on the follow-up colonoscopy was reduced significantly in the distal and proximal colon. However, the results for SSA/Ps demonstrated no effect of previous endoscopy on the risk for those polyps. The authors concluded that endoscopy was not as effective for serrated lesions as compared to conventional lesions. There may be several factors which may play a role in the ability of an endoscopist to detect and resect serrated polyps.

Serrated polyps, especially the SSA/Ps can be difficult to detect given their flat morphology as well as their indistinct borders. This may be evident in the variation in proximal serrated polyp detection that has been shown to exist among endoscopists. One study at an urban academic medical center observed a detection rate for HPs that varied from 7.7% to 31%.[36] A recent article of 15 gastroenterologists in two academic endoscopy centers reported that the proximal serrated detection rate ranged from 1% to 18%.[37] Of note, there was a correlation between adenoma and serrated detection rate. But the variation for adenoma detection rate was less disparate than for the proximal serrated lesions. These data might support the idea that detection of adenomas might differ than that for serrated polyps. Another study demonstrated that there was a wide variation of proximal serrated detection rates among endoscopy centers (0% to 9.8%).[38] Some centers never identified any SSA/Ps. These data might suggest the need for endoscopists to communicate with their pathologists about the interpretation of serrated polyps in their institutions or centers.

Can the variation in proximal serrated detection rates be attributed to quality measures that have been developed for conventional adenomas? There have been a few studies which have examined the effect of colon preparation on proximal serrated polyps as well as adenomas. In one study there was no correlation between quality of preparation rating and detection of proximal serrated polyps.[39] Conversely, there was a positive correlation for adenoma detection rate and quality of colon preparation. The authors postulated that perhaps a poor colon preparation aided serrated polyp detection by the presence of residual fecal which may adhere to the mucous cap on the serrated polyp. This may draw the attention of endoscopist to the polyp. Another study examined the impact of fair and poor bowel preparations on proximal serrated and adenoma detection rates.[40] Although poor bowel preparation was associated with reduced adenoma detection, there was no such reduction in proximal serrated polyp detection rates. These authors postulated that poor colon preparations maybe associated with excessive washing. This may cause the endoscopist to pay more attention to the mucosa perhaps preferentially benefiting serrated polyp over adenoma detection.

There have been a few articles that have examined the impact of withdrawal time on serrated polyp detection. Two small studies demonstrated that serrated polyp detection rate correlated with withdrawal time.[39,41] A larger study with 42 endoscopists at 14 centers also demonstrated a correlation between withdrawal time and serrated polyp detection.[40] The study observed that a withdrawal time of at least 9 minutes was associated with the increase in serrated polyp detection. Thus, careful attention to withdrawal and perhaps a longer time to examine the colon may aid endoscopists in increasing their serrated polyp detection.

Given the importance of the serrated pathway and the variation of serrated polyp detection, should there be a benchmark for serrated polyp detection similar to adenoma detection rates? Based on data from 15 endoscopists, one author suggested a proximal serrated polyp detection benchmark of 5%.[42]

This benchmark appears to be consistent with the findings of the New Hampshire Colonoscopy Registry study that found an overall rate of 8% with a corresponding adenoma detection rate of 25%.[43] The analysis was designed to determine if there was a difference between screening and surveillance adenoma and serrated polyp detection rates. Interestingly, they observed a difference in screening and surveillance adenoma detection rates but no difference for serrated polyp rates. This might suggest a difference in detection and as well as resection between serrated and adenomatous polyps.

There may also be challenges with regards to resection of serrated lesions. As noted above, they often have borders that may be difficult to distinguish from surrounding normal tissue. A recent endoscopic study was designed to examine the efficacy of polyp resection.[44] Biopsies from the resection site were performed after the polyp was removed with electro cautery. Although there was a high rate of incomplete resection for all polyps, the rate for serrated polyps was higher than for conventional adenomas (31% vs 10%). The rate was even higher for lesions larger than 1 cm. Thus, serrated lesions pose a large challenge to endoscopists with regards to resection. An expert panel has made some suggestions including the use of electro cautery to ensure adequate resection or ablation as well the use of dye to help delineate the lesion.[5] They do caution that although large serrated lesions can be easier to snare than conventional adenomas, the use of submucosal injections may make snaring more challenging.

The following points summarize the key conclusions of the expert panel with regards to endoscopy and serrated polyps:

1) Serrated polyps have indistinct borders and occasionally mucous caps.

2) Endoscopists should learn to recognize these lesions.
3) Endoscopists should use their adenoma detection rate as a surrogate for their serrated polyp detection rates.
4) All serrated polyps that are proximal to the sigmoid and larger than 5 mm should be resected completely.

SURVEILLANCE OF SERRATED POLYPS

As outlined above, until recently HPs were considered benign and clinically insignificant lesions. Currently, there exist two different guidelines with recommendations for serrated lesions. As stated in both guidelines, there is little published data regarding the surveillance and metachronous risk for patients with baseline serrated lesions.

One study based on data from Veteran's Affairs patients divided patients into groups based on the presence of proximal serrated polyps and conventional adenomas.[45] The point estimate for patients with proximal serrated polyps, versus patients with normal exams, for metachronous advanced neoplasia was over 2 fold. However, likely due to small numbers, the relationship failed to achieve statistical significance. The study did find that the patients with advanced neoplasia and proximal serrated polyps on baseline examination had a higher risk for advanced neoplasia on surveillance examination that those patients with only advanced neoplasia on initial colonoscopy.

The Veterans Affairs (VA) study did demonstrate a few challenges that plague researchers when attempting to address the metachronous risk associated with baseline serrated polyps. The first is the difficulty of distinguishing HPs from SSA/Ps. The VA study used proximal serrated polyps as the exposure variable and large proximal lesions as a surrogate for SSA/Ps. These classifications have been used as outcomes in other studies but there may be limitations related to grouping all serrated lesions together. The second challenge is the paucity patients with significant serrated lesions as well as those serrated lesions which do not have synchronous advanced neoplasia. This increased risk for synchronous advanced neoplasia in patients with large serrated lesions has been reported in other studies.[31,46] The valid question is whether the driver of an increased risk of advanced neoplasia is not the serrated polyps but the synchronous conventional advanced adenomas. Finally, are conventional advanced adenomas the proper outcome to assess the risk for clinically important baseline serrated polyps? A study that was performed over a decade ago showed that HPs on baseline predicted HPs and not adenomas on surveillance exam.[47] Thus, it may be more appropriate to examine clinically important serrated polyps as an outcome. Perhaps, if the database is large enough, cancers might also be appropriate as an outcome. Clearly more data from longitudinal studies are needed to aid in surveillance of serrated polyps.

The authors of the recent United States Multi-Society Task Force (USMSTF) on Colorectal Cancer guidelines for colonoscopy surveillance after screening and polypectomy, state that their recommendations are based on little published data.[4] In these guidelines, the authors divide SSA/Ps into large (≥1 cm) and small (<1 cm). They recommend that large SSA/Ps be treated as high risk adenomas and patients with these lesions should have a 3-year surveillance colonoscopy. Conversely, they recommend that smaller lesions have surveillance intervals of 5 years, similar to low risk adenomas. The authors do suggest that many experts might classify large proximal serrated lesions as SSA/Ps. However, they do not provide specific recommendations for non SSA/Ps (i.e., HPs) in the table which show the suggested intervals for resected polyps.

An expert panel provides more specific recommendations that include large or proximal HPs in addition to SSA/Ps. These may be more useful and practical for endoscopists given the large number of proximal hyperplastic or serrated polyps that might not be classified as SSA/Ps by their pathologist. The guidelines recommend that patients with HPs that are larger than 5 mm or proximal to the sigmoid should receive a surveillance interval of 5 years. These recommendations, based on size and location of HPs, are consistent with the findings in the Canadian pathology reassessment study.

SERRATED POLYPOSIS SYNDROME

This syndrome was formally known as hyperplastic polyposis syndrome and is characterized by multiple proximally located serrated polyps. The World Health Organization (WHO) criteria for diagnosing serrated polyposis syndrome (SPS) include any of the following:

1) At least five serrated polyps proximal to the sigmoid. 2 or more greater than 1 cm
2) Any number of serrated polyps proximal to the sigmoid, with first degree relative with this syndrome
3) The presence of more than 20 serrated polyps of any size and anywhere in the colon

The prevalence of SPS has been estimated to be less than 1% for patients undergoing CRC screening.[48] A few case studies have demonstrated an increased incidence of CRC of 7% in patients with SPS who have been followed for 5 years.[49] In addition, synchronous CRC may be present in up to 50% of all patients at their initial presentation.[50] In addition, there are data to suggest that SPS is a genetic disease. One study has demonstrated an increased risk for CRC in relatives of patients with SPS.[51] Unfortunately, despite the malignant potential of this syndrome, SPS is often not recognized by physicians. One study found that only one of 20 patients who met the WHO criteria for SPS was correctly identified by the treating physician.[52] Thus, more education regarding this syndrome is clearly needed.

Surveillance and management of SPS may be difficult given the multiple polyps as well as the paucity of data guiding endoscopists. Surgery may be required if the polyp burden is too

large for safe endoscopic management. The expert panel has recommended that patients with SPS have yearly colonoscopies with the goal of resecting all lesions larger than 5 mm. A recent study followed 50 patients with SPS who had annual colonoscopy surveillance with the goal of resecting all polyps greater than 3 mm.[53] During the 5-year surveillance period, there were no patients who were diagnosed with CRC and 12 of the patients were referred for surgery. This small study supports the recommendation for annual colonoscopies to prevent CRC.

CONCLUSIONS

In summary, we are clearly in the nascent stages of understanding the implications of the serrated pathways. More data regarding the surveillance of serrated polyps, especially SSA/Ps, will aid endoscopists in the management of these lesions. Molecular data may also aid in the differentiation and management of these polyps as well. Regardless of these developments, it is important that present day endoscopists become facile with the detection, resection and diagnosis of these polyps.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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