Population screening for colorectal cancer by colonoscopy

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DIFFERENCES IN PROXIMAL SERRATED POLYP DETECTION AMONG ENDOSCOPISTS ARE ASSOCIATED WITH VARIABILITY IN WITHDRAWAL TIME


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ABSTRACT

Background: Insufficient detection of proximal serrated polyps (PSP) might explain the occurrence of a proportion of interval carcinomas in colonoscopy surveillance programs.

Objective: To compare PSP detection between endoscopists and to identify patient and endoscopist-related factors associated with PSP detection.

Design: Prospective study in unselected patients.

Setting: Colonoscopy screening program for colorectal cancer at two academic medical centers.

Patients: Asymptomatic consecutive screening participants (50 to 75 years).

Interventions: Colonoscopies were performed by five experienced endoscopists. All detected polyps were removed. Multiple colonoscopy quality indicators were prospectively recorded.

Main outcome measurements: We compared PSP detection between endoscopists by calculating odds ratios (OR) with logistic regression analysis. Logistic regression was also used to identify patient features and colonoscopy factors associated with PSP detection.

Results: 1,354 subjects underwent a complete screening colonoscopy: 1,635 polyps were detected, of which 707 (43%) were adenomas and 685 (42%) were serrated polyps including 215 PSPs. In 167 patients (12%) one or more PSP were detected. The PSP detection rate differed significantly between endoscopists ranging from 6% to 22% (p<0.001). Longer withdrawal time (OR 1.12; 95% CI: 1.10 to 1.16) was significantly associated with better PSP detection, while patient age, gender and quality of bowel preparation were not.

Limitations: Limited number of highly experienced endoscopists.

Conclusions: The PSP detection rate differs among endoscopists. Longer withdrawal times are associated with better PSP detection, but patient features are not (Clinical trial registration number: NTR1888).

Take-home message: PSP detection is not so much patient related, but depends more on the skills of the endoscopist, such as withdrawal time.
INTRODUCTION

Colonoscopy has been recommended by the American College of Gastroenterology as the preferred strategy for colorectal cancer screening of average risk individuals. Colonoscopy is considered the most accurate method for the detection of colorectal neoplasia. Although its ability to identify left sided neoplasia is undisputed, this is less so for proximally located cancer. This can be explained by several factors. First, colonoscopies can be inadequate because of lack of cecal intubation or appropriate bowel preparation. Insufficient detection and removal of serrated polyps could be another explanation. Such polyps can develop into cancer through the serrated pathway, one that differs from the traditional adenoma-carcinoma sequence and is characterized by BRAF mutations and CpG island methylator phenotype (CIMP). Previous studies have demonstrated an association between proximal location of serrated polyps and synchronous advanced neoplasia and colorectal cancer, implying a higher risk of advanced neoplasia during surveillance.

Serrated polyps may be more easily missed during colonoscopy because of their flat morphology and ambiguous colour. This can be the case particularly in the proximal colon where the endoscopic view is often blurred because of insufficient bowel preparation. Serrated polyps also have traditionally been thought to be benign. Endoscopists may therefore be unaware of their malignant potential and decide not to remove these lesions during colonoscopy. Kahi et al. have shown that proximal serrated polyp detection varies among endoscopists.

We have performed a prospective study in unselected patients to compare detection of proximal serrated polyps among endoscopists in a primary colonoscopy screening program for colorectal cancer, and to evaluate associations between proximal serrated polyp detection and patient related and endoscopist related factors. In addition, we also compared the effect of these factors on the detection of adenomas.

METHODS

Study population

Data were collected in the randomized, multicenter Colonoscopy or Colonography for Screening (COCOS) trial. The overall design of this invitational population based colorectal cancer screening program, as well as its main results (participation and diagnostic yield), have been described in detail elsewhere. Screening participants allocated to the colonoscopy arm were included for this study. Between June 2009 and July 2010, a total of 6,600 asymptomatic individuals of the Amsterdam and Rotterdam region were randomly selected and invited for colonoscopy screening.

Patients with an end-stage disease were excluded, as were individuals who had been scheduled for surveillance colonoscopy, because of a personal history of colorectal cancer, colon adenomas or inflammatory bowel disease, as well as those who had undergone a full colonic examination in the previous 5 years with either a complete colonoscopy, CT colonography and/or double contrast barium enema.
The study was discussed during a pre-colonoscopy consultation, after which participants were invited to sign informed consent. Next, consenting eligible participants were scheduled for a primary screening colonoscopy. Ethical approval was obtained from the Dutch Health Council (2009/03WBO, The Hague, The Netherlands). The trial was registered in the Dutch Trial Register: NTR1829 (www.trialregister.nl).

**Colonoscopy and histopathology**

All colonoscopies were performed at the Academic Medical Center in Amsterdam and Erasmus University Medical Center in Rotterdam by senior gastroenterologists with an experience of at least 1,000 colonoscopies each in their careers. Each gastroenterologist performed all his/her colonoscopies at one center. Colonoscopies were recorded on DVD and performed according to the standard quality guidelines defined by the Society of Gastrointestinal Endoscopy.(14) Colonoscopes were 160 or 180 series variable stiffness instruments (Olympus Medical Systems, Tokyo, Japan). Participants received 2L of polyethylene electrolyte glycol solution (Moviprep; Norgine bv, Amsterdam, The Netherlands) and 2L transparent fluid, split-dose or single dose, dependent on time of procedure (morning or afternoon).

Research staff prospectively recorded a number of colonoscopy variables, including cecal intubation time, withdrawal time, endoscopist, field of view of the colonoscope (140° or 170°), definition of the colonoscope (high or low), use of a plastic cap at the tip of the colonoscope, timing of the colonoscopy (morning/afternoon), use of sedation (midazolam and/or fentanyl), use of antispasmodic medication (butylscopolamine) and quality of the bowel preparation. Quality of the bowel preparation was assessed by the validated Ottawa bowel preparation score, which includes three segment scores (0-4) and an overall score (0-2) and ranges from 0 (excellent bowel preparation in all three colonic segments) to 14 (very poor bowel preparation). (15) Endoscopists were instructed to intubate the cecum and to document the cecal landmarks (cecal valve and appendix orifice or intubation of terminal ileum). Withdrawal time was recorded by a stopwatch and was demanded to be at least six minutes, after subtracting the time needed for polypectomies. Polyps were directly removed during withdrawal and obtained for histological assessment. Polyp variables were prospectively recorded including location, size and morphology (pedunculated, sessile, flat). Proximal location was considered as proximal to the splenic flexure.

All polyps were evaluated by two expert gastro-intestinal pathologists, one in each center. Serrated polyps included hyperplastic polyps, sessile serrated lesions and traditional serrated lesions. Adenomas were classified as tubular, tubulovillous or villous; dysplasia was assessed as either low or high grade.(16) An advanced adenoma was defined as an adenoma ≥ 10 mm, ≥ 25% villous or with high grade dysplasia. Advanced neoplasia comprised advanced adenoma and CRC altogether.

**Outcome measures and statistical analysis**

First, we compared proximal serrated polyp detection among endoscopists with logistic regression analysis. The outcome variable was the detection of one or more proximal serrated polyps in a per-patient analysis. Endoscopists were included in the model using dummy variables, by using the endoscopist with the highest detection rate as the reference. To adjust
for potential confounders, we also included patient’s age, gender and quality of the bowel preparation in the logistic regression model. Intubation times and withdrawal times were compared among endoscopists by the Kruskal-Wallis test statistic.

Next, we intended to identify patient features and colonoscopy factors associated with the detection of one or more proximal serrated polyps in a per-patient analysis. We expressed the strength of the corresponding associations as odds ratios and estimated these using univariable and multivariable logistic regression analysis, once again using detection of a proximal serrated polyp as the outcome variable. We considered factors that may affect polyp detection as described in the literature. We evaluated the following patient-related factors: age (17), gender (17) and the quality of the bowel preparation (18). We also evaluated these colonoscopy-related factors: intubation time (19), withdrawal time (20), field of view of the colonoscope (140° or 170°) (21), definition of the endoscope (high or low) (22;23), use of a plastic cap (24), timing of the colonoscopy (morning/afternoon) (25), use of sedation (midazolam and/or fentanyl) (26), use of antispasmodic medication (butylscopolamine) (27) and Gloucester comfort score (28). We evaluated the same variables in a different set of logistic regression models, to estimate the strength of the corresponding associations with the detection of adenomas in the entire colon.

In all analyses we only included data from endoscopists who performed more than 50 colonoscopies in this study. We excluded participants with an incomplete colonoscopy, that is, those in which the cecum was not intubated because we could not assess detection of proximally located polyps and/or other quality indicators. Two-sided p-values of less than 0.05 were considered to indicate statistically significant differences. All analyses were performed by using PASW statistics version 18.0 for Windows.

**Sample size calculation**

The sample size calculation for the randomized trial in which this study was embedded is described in detail elsewhere (12;13). With approximately 1400 colonoscopies, and assuming a baseline detection rate of about 12%, we would have at least 80% power to detect an odds ratio of 1.53 for dichotomous variables in the logistic regression (at a 50% prevalence; 1.67 at a 20% prevalence), or an odds ratio of 1.3 for a change in one standard deviation from the mean in continuous variables.

**RESULTS**

A total of 1,426 invitees participated in the colonoscopy screening program of whom 1,407 (99%) underwent a complete screening colonoscopy. In this group, 1,354 colonoscopies were completed by endoscopists who had performed more than 50 colonoscopies. Of the corresponding study participants, 689 (51%) were men; their median age was 60 years (IQR 55 to 65 years). The median Ottawa bowel preparation score was 5 (IQR 3 to 8). The median net withdrawal time was 10 minutes (IQR 8 to 15 minutes).

Overall, 1,635 polyps were detected of which 707 (43%) were adenomas and 685 (42%) were serrated polyps. The mean number of adenomas per patient was 0.52 (SD 1.08). The mean number of serrated polyps per patient was 0.51 (SD 1.16). Of the detected serrated polyps, 215 (31%) were proximally located. These were detected in 167 patients (12%). The mean number of
proximal serrated polyps per patient was 0.16 (SD 0.48). The median proximal serrated polyp size was 4 mm (IQR 3 to 7). In 392 patients (29%) one or more adenomas were detected. The median adenoma size was 4 mm (IQR 3 to 7). An advanced adenoma was detected in 119 patients (9%) and advanced neoplasia in 125 patients (9%).

**Differences among endoscopists**

There were significant differences among endoscopists in PSP detection rates (p<0.001) and adenoma detection rates (p=0.002), as summarized in Table 1. Among experienced endoscopists, the PSP detection rate varied from 6% to 22%; the adenoma detection rate varied from 24% to 40%. These differences also were observed when we adjusted for differences in case-mix. When we included patient's age, gender and quality of the bowel preparation the differences among endoscopists were significant (p<0.001 and p=0.001, for PSP detection and adenoma detection respectively). Median intubation times differed significantly among endoscopists (p<.001); ranging from 5 to 13 minutes. Median withdrawal times were also significantly different (p<0.001); these varied from 8 to 16 minutes. The endoscopist with the highest PSP detection rate was third in adenoma detection. The endoscopist with the highest adenoma detection rate was fourth in PSP detection.

### Table 1: Endoscopist’s adenoma detection rates (ADR) and proximal serrated polyp (PSPR) detection rates

<table>
<thead>
<tr>
<th>Endoscopist</th>
<th>Colonoscopy experience (years)</th>
<th>Number of colonoscopies in the study</th>
<th>Intubation time (median, IQR)</th>
<th>Withdrawal time (median, IQR)</th>
<th>ADR</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endoscopist 1</td>
<td>9</td>
<td>147</td>
<td>13 (9-17)</td>
<td>16 (13-20)</td>
<td>33%</td>
<td>22%</td>
<td>N/A</td>
</tr>
<tr>
<td>Endoscopist 2</td>
<td>30</td>
<td>192</td>
<td>8 (6-12)</td>
<td>16 (13-20)</td>
<td>37%</td>
<td>20%</td>
<td>0.85</td>
</tr>
<tr>
<td>Endoscopist 3</td>
<td>9</td>
<td>310</td>
<td>7 (5-11)</td>
<td>9 (7-12)</td>
<td>30%</td>
<td>16%</td>
<td>0.65</td>
</tr>
<tr>
<td>Endoscopist 4</td>
<td>6</td>
<td>52</td>
<td>9 (6-13)</td>
<td>11 (9-15)</td>
<td>40%</td>
<td>15%</td>
<td>0.63</td>
</tr>
<tr>
<td>Endoscopist 5</td>
<td>35</td>
<td>653</td>
<td>5 (4-8)</td>
<td>8 (7-10)</td>
<td>24%</td>
<td>6%</td>
<td>0.22</td>
</tr>
</tbody>
</table>

**Factors associated with proximal serrated polyp and adenoma detection**

Associations between patient-related and procedure-related factors and the detection of proximal serrated polyps (PSP) and adenomas are summarized in Table 2. Significantly more adenomas were detected in elderly patients, in males and in patients with better bowel preparation. Including the proximal bowel preparation score instead of overall bowel preparation scores in an alternative multivariable model for PSP detection showed comparable results.

Of the procedure-related factors, withdrawal time was significantly associated with adenoma detection: more adenomas were detected in patients with longer withdrawal times. Adenoma detection differed significantly among subgroups defined by the Gloucester comfort score but no linearity was observed between higher adenoma detection and increasing discomfort. Use of butylscopolamine was associated with better adenoma detection in the univariable analysis; when we adjusted for case-mix this effect was no longer observed.
Table 2: Factors associated with the detection of proximal serrated polyps (PSP) and adenomas (AD)

<table>
<thead>
<tr>
<th>Factor</th>
<th>PSP detection</th>
<th>Adenoma detection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Univariable</td>
<td>Multivariable</td>
</tr>
<tr>
<td></td>
<td>OR 95% CI</td>
<td>p-value</td>
</tr>
<tr>
<td>Patient-related factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>1.00 0.98-1.03</td>
<td>.85</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>1.10 0.80-1.52</td>
<td>.56</td>
</tr>
<tr>
<td>Ottawa score (0-14)*</td>
<td>0.96 0.91-1.02</td>
<td>.17</td>
</tr>
<tr>
<td>Colonoscopy-related factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intubation time (min)</td>
<td>1.05 1.02-1.07</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Withdrawal time (min)</td>
<td>1.10 1.08-1.13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Definition of colonoscope (high)</td>
<td>1.33 0.84-2.12</td>
<td>.23</td>
</tr>
<tr>
<td>Field of view of colonoscope (170°)</td>
<td>1.10 0.74-1.63</td>
<td>.64</td>
</tr>
<tr>
<td>Use of transparent cap (yes)</td>
<td>1.11 0.81-1.53</td>
<td>.52</td>
</tr>
<tr>
<td>Use of midazolam and/or fentanyl (yes)</td>
<td>0.80 0.48-1.34</td>
<td>.39</td>
</tr>
<tr>
<td>Use of butylscopolamine (yes)</td>
<td>0.61 0.44-0.85</td>
<td>.003</td>
</tr>
<tr>
<td>Gloucester comfort scale**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 or 2 moments of mild discomfort, tolerable</td>
<td>0.65 0.44-0.96</td>
<td>.85</td>
</tr>
<tr>
<td>Several moments of discomfort, tolerable</td>
<td>0.85 0.54-1.36</td>
<td>.06</td>
</tr>
<tr>
<td>Several moments of discomfort, hardly tolerable</td>
<td>1.77 0.64-5.23</td>
<td>1.59</td>
</tr>
<tr>
<td>Frequent moments of extreme discomfort</td>
<td>1.94 0.74-5.05</td>
<td>2.53</td>
</tr>
<tr>
<td>Timing of colonoscopy (afternoon)</td>
<td>1.13 0.81-1.56</td>
<td>.47</td>
</tr>
</tbody>
</table>

* Ottawa score ranging from 0 (excellent bowel preparation in all three colonic segments) to 14 (very poor bowel preparation)
** Odds ratios relative to “no discomfort”
FACTORS ASSOCIATED WITH PSP DETECTION

PSP detection was found to be associated with intubation time, withdrawal time and use of butylscopolamine in the univariable analysis. These factors were no longer significant when taking patient factors and all colonoscopy factors into account. In the multivariable analysis, withdrawal time was the only factor significantly associated with PSP detection: PSP detection was significantly more likely during procedures with longer withdrawal times.

ASSOCIATION OF PROXIMAL SERRATED POLYP DETECTION AND ADENOMA DETECTION

Associations were observed between PSP detection and detection of colorectal neoplasia in the entire colon. In the univariable analysis, better PSP detection was associated with higher adenoma detection (OR 1.73; 95% CI 1.23 to 2.41; p=0.001), advanced adenoma detection (OR 2.43; 95% CI 1.53 to 3.84; p<0.001) and advanced neoplasia detection (OR 2.34; 95% CI 1.52 to 3.75; p<0.001). When we adjusted for patient features (age, gender and quality of bowel preparation), these associations were still observed. Better PSP detection was associated with higher adenoma detection (OR 1.74; 95% CI 1.23 to 2.46), advanced adenoma detection (OR 2.41; 95% CI 1.51 to 3.86) and advanced neoplasia detection (OR 2.37; 95% CI 1.49 to 3.76).

When we adjusted for patient features and colonoscopy factors, associations between PSP detection and detection of colorectal neoplasia (adenoma, advanced adenoma and advanced neoplasia) were no longer significant. In the multivariable analysis, including adenoma, advanced adenoma or advanced neoplasia detection, withdrawal time was the only factor consistently and significantly associated with PSP detection.

DISCUSSION

We performed a prospective study to compare proximal serrated polyp detection among endoscopists and to identify patient-related and procedure-related factors associated with the detection of proximal serrated polyps. PSP detection differed significantly among experienced endoscopists. In this population, we did not observe significant effects of age, gender or quality of the bowel preparation, but found withdrawal time to be strongly and significantly associated with PSP detection.

To our knowledge this is the first prospective study to identify factors associated with PSP detection during colonoscopy. Our study population is relatively homogenous, because we included participants who all underwent a primary screening colonoscopy. Research staff attended all colonoscopies and prospectively recorded various data on the quality of the colonoscopy and polyp detection ensuring accurate and optimal data-collection. Polyps were evaluated by only two expert gastro-intestinal pathologists minimizing inter-observer bias. All colonoscopies were performed by experienced endoscopists who were instructed to remove all detected polyps.

We included all patient features and colonoscopy factors that may affect polyp detection as known to us from literature. It is possible that we failed to include all factors that could influence polyp detection. The limited number of participating endoscopists could be another limitation of our study. Because of the low number we could not evaluate factors on the endoscopist level, such as endoscopist’s age, sex or technique. We cannot exclude an inter-observer variation in the distinction between serrated polyps and adenomas. A recent study in a screening
population showed inter-observer agreement for non-adenomatous or adenomatous polyps in 96% of cases, with a very good corresponding kappa value of 0.88 (29). Applying these findings to our study would suggest that inter-observer variation does not have a large effect. To minimize the risk of coincidental observations, we excluded 53 colonoscopies from our analyses because they had been performed by experienced endoscopists who completed less than 50 colonoscopies for this screening trial.

Adenoma detection rates of less than 20% are associated with a higher risk of interval cancer (30). Because of this, quality guidelines proposed this percentage as the lower achievable limit in average risk populations.(14;30) Our endoscopists had adenoma detection rates ranging from 24% to 40%, all thus fulfilling this quality condition. In line with the literature, age, sex, quality of bowel preparation and withdrawal time were associated with adenoma detection (17;18;20).

The endoscopists detected proximal serrated polyps in 12% of participants, but detection rates varied significantly between endoscopists, from 6% to 22%. A recent retrospective study by Kahi et al reported an overall PSP detection rate of 13%, ranging from 1% to 18% among individual endoscopists.(11) Because of the retrospective design, Kahi et al were not able to report on the influence of two important quality parameters for polyp detection: quality of the bowel preparation and withdrawal time.

In our study, net withdrawal time (corrected by subtracting the time taken for polypectomy) was associated with PSP detection; detection of at least one PSP was more likely in colonoscopies with longer withdrawal times. To our knowledge, no other studies identified withdrawal time as contributor to PSP detection. In the adenoma detection rate, the odds ratio for withdrawal time was comparable, with a similar confidence interval. This suggests that withdrawal time is equally powerful for predicting PSP detection as for adenoma detection.

Serrated polyps usually have a flat morphology and are identical in color to the normal mucosa. Detection of these lesions might further be hindered by a typical ‘mucus cap’, a coating of mucus over the surface. Adequate bowel preparation aids in adenoma detection and we postulated this also would be the case for PSP detection, especially because bowel preparation tends to be worst in the proximal colon. To our surprise, the quality of the bowel preparation was not significantly associated with PSP detection. Including an evaluation of the proximal bowel preparation score in our multivariable model for PSP detection, instead of overall bowel preparation scores, showed comparable results. It is possible that the mucus cap on the serrated polyp attaches some residual stool, attracting attention and highlighting the polyp, especially if the proximal colon is rinsed with water. If so, the endoscopist should be well trained in detecting serrated polyps and be made aware of the clinical importance to remove them. Our colonoscopies were performed by experienced endoscopists. They were aware that they were performing study colonoscopies and we emphasized the importance of removing all detected polyps in colorectal cancer screening.

Two previous studies have reported PSP detection not to depend on patient’s age or sex, and the results of our study are consistent with this conclusion.(10;11) Schreiner et al. suggested that higher age was not associated with PSP detection because they classified a traditional serrated adenoma with dysplasia as an adenoma. They presumed that non-dysplastic serrated lesions progressed to
FACTORS ASSOCIATED WITH PSP DETECTION

traditional serrated adenomas with increasing age. Because they classified a traditional serrated adenoma with dysplasia as an adenoma, they presumed that serrated polyp detection was underestimated in the higher age groups. In contrast, we defined hyperplastic polyps, sessile serrated lesions and traditional serrated lesions all as serrated polyps and found comparable results. From this we conclude that PSP prevalence may be comparable across age groups, which suggests that the risk of developing CRC via the serrated pathway does not depend on age.

Detection of PSP was associated with the detection of adenoma, advanced adenoma and advanced neoplasia in the univariable analysis, as previously described. (10;11) When we adjusted for patient features and colonoscopy factors these associations were no longer significant. Withdrawal time was the only factor significantly associated with PSP detection. Other prospective studies should be performed evaluating the effect of colonoscopy factors on PSP detection to confirm our results.

PSP detection rates and adenoma detection rates differed among endoscopists. These differences can be explained by the inspection skills of the endoscopist. Besides withdrawal time, withdrawal technique could be responsible for the variation in PSP detection. Rex et al. showed that adenoma detection rate depended on four quality criteria of withdrawal technique: (1) examining the proximal sides of flexures, folds and valves, (2) cleaning and suctioning, (3) adequacy of distention, and (4) adequacy of time spent viewing.(31) Likely, endoscopists with high PSP detection rates have a better withdrawal technique compared to endoscopists with low PSP detection rates. Further studies are required to confirm this hypothesis. Alternatively, it may also be that detection of proximal serrated adenomas depends on training, recognition, and focus. In that respect, it is notable that our results in terms of a correlation between PSP detection and withdrawal time are driven by the low PSP detection rate for one, elderly endoscopist with extensive colonoscopy experience. Although it was not part of our study, it seems reasonable to speculate that simple training and emphasis on removal of PSP lesions would help to improve the PSP detection rate for such endoscopists without the need for longer intubation and withdrawal times.

Endoscopists with lower PSP detection rates should be encouraged to detect and remove all polyps. For these endoscopists, increasing awareness of the risk of PSP may be necessary and additional training to improve SP detection could be beneficial. It is presumable that low PSP detection rates are associated with a higher risk for interval cancer, similar to the association between low adenoma detection rates (lower than 20%) and the higher interval cancer risk (30). To our knowledge, such an association has never been described in the literature. Further studies are needed to determine the association between PSP detection rates and the risk for interval cancer. If so, it would be logical to include PSP detection rate as a separate quality indicator for colonoscopy.

Recent studies demonstrated that patients with large PSPs are at increased risk of synchronous and likely metachronous advanced neoplasia and CRC.(9;10;32) These results might even justify surveying patients with PSPs henceforth. Terdiman and McQuaid recently proposed surveillance intervals for patients with serrated polyps.(33) Such a proposal will burden surveillance programs, colonoscopy capacity and medical costs, and should be weighed carefully against the risk of these patients developing CRC. The magnitude of that risk has to be clarified in future research.

In summary, our results suggest that PSP detection is not patient related, but that it depends on the skills of the endoscopist to detect PSP. Better PSP detection rates can probably be achieved by a longer withdrawal time during colonoscopy.
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