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Association between endoscopist adenoma detection rate and serrated polyp detection: Retrospective analysis of over 200,000 screening colonoscopies

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ABSTRACT

Background and study aims Serrated lesions have been identified as precursor lesions for 20% to 35% of colorectal cancers (CRCs) and may contribute to a significant proportion of interval-cancer. Sessile-serrated-lesions (SSLs), in particular, tend to be flat and located in the proximal colon, making their detection challenging and requiring expertise. It remains unclear whether the detection rate for serrated polyps should be considered as a quality indicator in addition to the adenoma detection rate (ADR). This study sought to assess whether the ADR has an effect on the detection rate for serrated polyps.

Patients and methods In this retrospective analysis, prospectively collected data from 212,668 screening colonoscopies performed between 2012 and September 2018 were included. Spearman correlation and Whitney-Mann U-test were used to assess the association of ADR and the detection rate of SSLs with (SDR) and without hyperplastic polyps (SPADRs), the sessile serrated detection rate (SSLDR) as well as the clinically relevant serrated detection rate (CRSDR), including all SSLs and traditional serrated adenoma, hyperplastic polyps (HPs) >10 mm anywhere in the colon or HPs > 5 mm proximal to the sigmoid.

Results The overall mean ADR was 21.78% (standard deviation [SD] 9.27), SDR 21.08% (SD 11.44), SPADR 2.19% (SD 2.49), and CRSDR was 3.81% (3.40). Significant correlations were found between the ADR and the SDR, SPADR, SSLDR, and CRSDR (rho = 0.73 vs. rho = 0.51 vs. rho = 0.51 vs. rho = 0.63; all P <0.001). Endoscopists with a mean ADR ≥25% had significantly higher SDR, SPADR, and CRSDR than endoscopists with a mean ADR <25% (all P <0.001; Mann-Whitney U-Test).

Conclusions This study shows that endoscopists with higher ADR detect significantly more serrated lesions than those with a lower ADR.

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Introduction

Colorectal cancer (CRC) represents 13.1% of all malignant tumors and is the second leading cause of cancer mortality worldwide [1]. The implementation of opportunistic colorectal cancer screening programs in Austria has led to decreases in incidence and mortality of colorectal cancer over the last decades [2]. In most European countries, including Austria, screening colonoscopy (SC) is the gold standard to prevent colorectal

cancer by the detection and removal of precursor lesions [3]. Recent studies showed that colonoscopies are more effective in the distal than in the proximal colon [4, 5]. Therefore, the adenoma detection rate (ADR) is the most important quality indicator in SC. Studies from Kaminski et al. [6] and Corley et al. [7] have shown that a higher ADR is associated with a lower risk of interval cancer. Because of these studies, guidelines recommend an overall ADR ≥25%, a minimum of 30% for men and 20% for women [8, 9].

In the last 20 years, serrated polyps, which are characterized by a sawtooth-like appearance in the epithelium, have been increasingly recognized. According to the World Health Organization (WHO) [10] serrated polyps are subclassified into hyperplastic polyps (HPs), sessile serrated lesions (SSLs) and traditional serrated adenomas (TSAs). In contrast to conventional adenomas, serrated polyps develop via an alternative pathway, called the serrated pathway. Furthermore, serrated polyps account for approximately 20% to 35% of colorectal cancers and may be responsible for a high number of interval cancers [11, 12, 13, 14]. The serrated pathway is characterized by a CpG island methylator phenotype (CIMP), *BRAF* mutation, and microsatellite instability (MSI) or microsatellite stable (MSS) [11, 15]. A study by Arain et al. [13] about interval cancer has shown that serrated polyps are associated with a significantly higher incidence of CIMP (57% vs. 33%) and MSI (29% vs.11%) and preferentially occur in the proximal colon (63% vs 39%) in contrast to non-interval cancers. For these reasons serrated polyps are getting more and more attention during colonoscopies and a benchmark for serrated polyps should be recommended.

Based on their flat morphology, serrated polyps and especially SSLs are difficult to detect during colonoscopy. Further, SSLs are typically larger than 5 mm, often covered by a yellow mucous cap, and located proximal [16, 17]. In contrast, HPs are the most common, smaller than SSLs, distally located, and have a low malignant potential. TSAs are rare, mostly distally located, and pedunculated or sessile [16, 17].

Because there is currently no established benchmark for identifying serrated polyps, we have created three separate detection rates to address this issue. The first rate, known as the serrated polyp detection rate (SDR), encompasses all serrated polyps (including HPs, SSLs, and TSAs) regardless of their size or location. The second rate, the serrated polyp and advanced detection rate (SPADR), includes all serrated polyps with malignant potential (SSLs and TSAs). Finally, the comprehensive serrated polyp detection rate (CRSDR) identifies all SSLs and TSAs, as well as HPs larger than 10 mm in any area of the colon or more than 5 mm proximal to the sigmoid [18]. The aim of the study was to investigate whether the rates are appropriate as additional quality indicators for screening and surveillance colonoscopies.

Patient and methods

This retrospective analysis of prospective collected data included 212,668 colonoscopies between 2012 and September 2018 performed by 290 endoscopists in the Austrian quality assurance program.

Our database of bowel preparation, based on the Aronchick scale (excellent, good, fair, poor, poor only in the right colon, not sufficient) was implemented in 2012/2013 and until 2014, we used the term “serrated” for both sessile and traditional serrated polyps.

In brief, in 2007, the OEGGH (Austrian Society of Gastroenterology and Hepatology) in cooperation with the HBV (Association of Austrian Social Security Institutions) and ÖKH (Austrian Cancer Aid) launched the project “Qualitätszertifikat Darmkrebsvorsorge” (Austrian Certificate of Quality Colonoscopy Screening). Forty-three percent of all Austrian endoscopists, consisting of specialists in internal medicine as well as surgeons participate in the project. Endoscopists can participate in the project if they fulfill the conditions and quality standards of the OEGGH, including information and consulting, offer premedication and sedation, complete video colonoscopy (cecal intubation), postoperative care, electronic documentation, and review of the results. Approximately 48% of participating endoscopists use high-definition endoscopes. In addition, a minimum of 200 complete colonoscopies (including cecal intubation) and 50 polypectomies under supervision as well as a minimum of 100 complete colonoscopies and 10 polypectomies per year are required. As part of the project, an annual hygiene control for endoscopes of participants is required. Further information about this project has been published in prior studies [19, 20, 21].

All men and women aged 50 to 100 years undergoing screening or surveillance colonoscopy between 2012 and September 2018 were included in our study. Furthermore, endoscopists had to perform more than 30 colonoscopies during the study period. Also, data from patients older than age 30 years who obtained colonoscopies were included. The study was approved by the Ethics Committee of the Medical University of Vienna as voting number 1510/2017.

Definitions of quality indicators

The endoscopists' ADR was defined as examinations during which at least one conventional adenoma (tubular, tubulovillous, villous) was found divided by the total number of endoscopies.

We calculated the SDR as the number of examinations in which at least one serrated polyp (HP, SSL, TSA) was found divided by the total number of colonoscopies performed.

The SPADR was defined as the number of examinations in which at least one SSL or TSA was found divided by the total number of performed colonoscopies.

The CRSDR was defined as the number of examinations in which at least one SSL, TSA, or HP >10 mm anywhere in the colon or HP > 5 mm proximal to the sigmoid was found divided by the number of performed colonoscopies.

The sessile serrated lesion detection rate was defined as the number of examinations in which at least one SSL was found divided by the total number of colonoscopies.

Statistical analysis

Categorical variables are described with absolute and relative frequencies. For continuous variables, the arithmetic mean and standard deviation (SD) was used. Detection rates were measured, and Spearman's rank-order correlation was used to assess whether there was a correlation between ADR and SDR, SPADR, SSLDR or CRSDR. Furthermore, endoscopists were grouped into ADR <25% and ≥25% and a Mann-Whitney U-test was used to evaluate differences in the SDR, SPADR, SSLDR, and CRSDR between the groups with low and high ADRs. Statistical significance was defined as $P \leq 0.05$. Statistical analysis was performed using IBM SPSS Statistics version 25.0, Microsoft Excel.

Results

A total of 212,668 colonoscopies (2012: n = 25.459; 2013: n = 29.247; 2014: n = 33.969; 2015: n = 32.990; 2016: n = 32.002; 2017: n = 35.800; 2018: n = 23.201;) performed by 290 physicians between 2012 and September 2018 were included. Of the patients, 107,725 (50.7%) were female and the mean age was 63.91 years (SD 9.40 years) (▶ **Table 1**).

The endoscopists (n = 290) were separated into office-based internists (44.5%; n = 129), clinic-based internists (19.6%; n = 57), clinic-based surgeons (4.5%; n = 13), office-based surgeons (28.6%; n = 83), and interdisciplinary endoscopists (2.8%; n = 8). The clinic-based surgeons performed a total of 4,008 colonoscopies (1.9%) and the office-based surgeons performed 70,530 (33.2%). Conversely, the clinical-based internists performed 41,566 colonoscopies (19.5%), the office-based internists performed 92,589 (43.5%), and the interdisciplinary endoscopists performed 3,975 (1.9%).

The cecum was reached in 97.0% of all cases (n = 206,303) and in 89.4% (n = 190,163), sedation was used (▶ **Table 1**). In 35.2% (n = 67,315), 48.8% (n = 93,274), and 11.9% (n = 22,739) of all colonoscopies the bowel preparation was reported to be excellent, good, and fair, respectively. In contrast, 4.1% of all bowel preparation (n = 7,775) was described as poor, poor only in the right colon, or not sufficient (▶ **Table 1**). Polyps and adenomas were found in 40.9% (n = 86,970) and 23.7% (n = 50,450) of all colonoscopies, respectively. Polypectomy was performed during 83,979 screening colonoscopies (39.5%). They were performed in 66.34% of patients (n = 55,591) with forceps, in 20.25% (n = 17,079) with snare, and in 13.41% (n = 11.309) with both forceps and snare.

Quality parameters

ADR

At least one conventional adenoma was found in 21.5% of screening colonoscopies (n = 45,784) and the endoscopists' overall mean ADR was 21.78% (SD 9.27) (▶ **Table 2**). The prevalence of conventional adenomas was 26.9% (n = 28,256) for men and 16.7% (n = 17,528) for women. Patients with conventional adenomas had a mean age of 65.98 years (SD 9.26 years). At 26.92%, (SD 11.25) the mean male ADR was significantly higher than the mean female ADR at 16.59 (SD 7.90) (P <0.001) (▶ **Table 3**). One hundred endoscopists had an ADR ≥ 25% with a mean ADR of 31.96% (SD 4.88). In contrast, the mean ADR for the 190 endoscopists with an ADR < 25% was 16.43% (SD 5.93) (▶ **Table 4**). Regarding to the time trend for the overall ADR, we observed no difference between 2012 and 2017 (22.03% vs 22.59%, P = 0.534) (▶ **Fig. 1**). We found the same results for men 27.16% in 2012 vs. 28.06% in 2017; P = 0.693; ▶ **Fig. 2** and women (16.09% 2012 vs. 17.16% in 2017; P = 0,686) (▶ **Table 5** and ▶ **Fig. 3**). The highest overall ADR was found in the group aged >90 years and for men and women in the group aged 80 to 89 years.

SDR

In 20.44% of all colonoscopies (n = 43.475) a HP, SSL, or TSA was found. The prevalence of serrated polyps in men of 21.97% (n = 23,052) was higher than in women at 21.74% (n = 20,423). The overall mean male SDR was higher than the female SDR (22.72% vs. 19.43%; P < 0.001) (▶ **Table 3**). Endoscopists with ADR ≥ 25% had a mean SDR of 30.43% (10.95), which was reached by 23.29% of them (n = 68). In contrast, the mean SDR for endoscopists with an ADR < 25% was 16.15% (SD 8.15%) (▶ **Table 4**). No differences were found between 2012 and 2017 for overall, male, or female SDR (▶ **Table 3**). ▶ **Table 2** shows the SDR for different age groups.

▶ **Table 1** Patient characteristics in all colonoscopies and for ADRs <25% and ≥25%.

Patient characteristic	All colonoscopies n = 212.668	ADR <25% n = 145,406	ADR ≥25% n = 67,262
Female – no (%)	107.725 (50.7)	74.228 (51.0)	33.497 (49.8)
Male – no (%)	104.943 (49.3)	71.178 (49.0)	33.765 (50.2)
Mean age (SD)	63.91 (9.40)	64.05 (9.51)	63.75 (9.15)
Cecal intubation (%)	206.303 (97.0)	140.315 (96.5)	65.988 (98.1)
Sedation (%)	190.163 (89.4)	129.236 (88.9)	60.924 (90.6)

ADR, adenoma detection rate; SD, standard deviation.

▶ **Table 2** Endoscopist characteristics by age group.

	Age						
	<50	**50–59**	**60–69**	**70–79**	**80–89**	**>90**	**P value**
Overall							
No. SC	3.513	65.658	74.718	50.891	16.753	1.135	
ADR % (SD)	12.06 (20.00)	16.89 (8.30)	21.71 (10.14)	27.15 (12.43)	29.89 (17.51)	**30.36 (32.74)**	<0.001
SDR % (SD)	19.52 (24.78)	20.86 (12.09)	**22.65 (12.57)**	21.01 (12.20)	15.73 (12.75)	14.03 (23.91)	<0.001
SPADR % (SD)	**5.46 (18.07)**	2.64 (3.38)	2.15 (2.70)	1.88 (2.46)	1.46 (6.83)	0.70 (3.98)	<0.001
CRSDR % (SD)	**7.26 (18.85)**	4.39 (4.63)	3.89 (3.97)	3.42 (3.39)	2.16 (7.00)	1.74 (7.57)	<0.001
Male							
No. SC	1.661	32.894	36.456	24.869	8.487	576	
ADR % (SD)	15.48 (23.86)	20.85 (10.54)	27.18 (13.22)	33.42 (15.08)	**36.75 (23.40)**	36.28 (38.17)	<0.001
SDR % (SD)	20.27 (26.58)	22.94 (13.19)	24.10 (13.74)	**22.21 (13.22)**	17.09 (16.57)	16.34 (29.71)	<0.001
SPADR % (SD)	**4.53 (15.61)**	2.44 (3.33)	2.25 (4.28)	1.82 (2.93)	1.16 (3.88)	0.80 (5.46)	<0.001
CRSDR % (SD)	**6.80 (18.60)**	4.34 (4.58)	4.08 (5.40)	3.57 (4.28)	2.02 (4.55)	1.98 (9.18)	<0.001
Female							
No. SC	1.852	32.764	38.262	26.022	8.266	559	< 0.001
ADR % (SD)	2.30 (8.00)	12.52 (7.68)	16.74 (9.48)	21.00 (12.70)	**23.40 (18.66)**	19.80 (28.52)	< 0.001
SDR % (SD)	3.45 (10.07)	18.51 (12.46)	**21.11 (12.96)**	19.98 (13.79)	14.16 (14.34)	12.58 (25.40)	< 0.001
SPADR % (SD)	0.42 (1.89)	**2.84 (4.49)**	2.16 (3.26)	2.02 (3.52)	0.24 (2.14)	0.63 (4.47)	< 0.001
CRSDR % (SD)	1.42 (7.96)	**4.33 (5.85)**	3.77 (4.75)	3.32 (4.34)	1.80 (6.75)	1.68 (9.69)	< 0.001

ADR, adenoma detection rate; SDR, serrated detection rate; SPADR, serrated adenoma detection rate; CRSDR, clinically serrated polyp detection rate; SD, standard deviation.

▶ **Table 3** Differences between men and women according to age and detection rates.

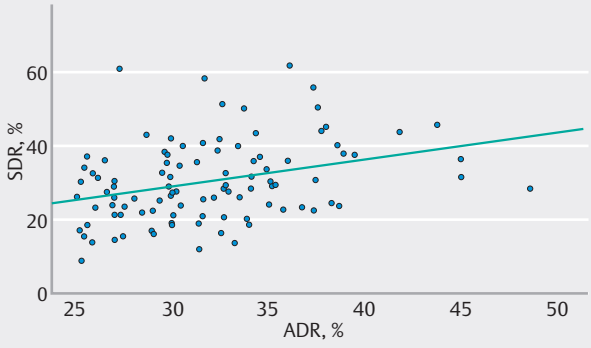
	All	**Men**	**Women**	**P value**
SC	212,668	104,943 (49.3%)	107,725 (50.7%)	
Age	63.91 (9.40)	63.91 (9.43)	665.68 (9.37)	= 0.920
Conventional adenomas	45.784	28.256 (61.72%)	17.528 (38.28%)	<0.001
Age (yr)	65.98 (9.26)	65.91 (9.25)	66.08 (9.26)	= 0.500
Detection rate	21.78% (9.27)	26.92 (11.25)	16.59 (7.90)	<0.001
Serrated adenoma (TSA or SSA/P)	4.666	2.293	2.373	= 0.543
Age (yr)	63.61 (8.97)	63.63 (9.00)	63.58 (8.94)	= 0.823
Detection rate	2.19 (2.49)	2.10 (2.38)	2.30 (3.09)	= 0.815
Serrated polyps	43.475	23.052	20.423	<0.001
Age (yr)	63.81 (8.78)	63.64 (8.81)	64.01 (8.74)	<0.001
Detection rate	21.08% (11.44)	22.72 (11.90)	19.43 (11.69)	<0.001
Clinically significant serrated polyp	8.124	4.197	3.927	<0.001
Age (yr)	64.03 (9.04)	64.13 (9.01)	63.93 (9.07)	= 0.313
Detection rate	3.81% (3.40)	3.89 (3.53)	3.73 (3.96)	= 0.062

SC, screening colonoscopy; TSA, traditional serrated adenoma; SSA/P, sessile serrated, adenoma/polyp.

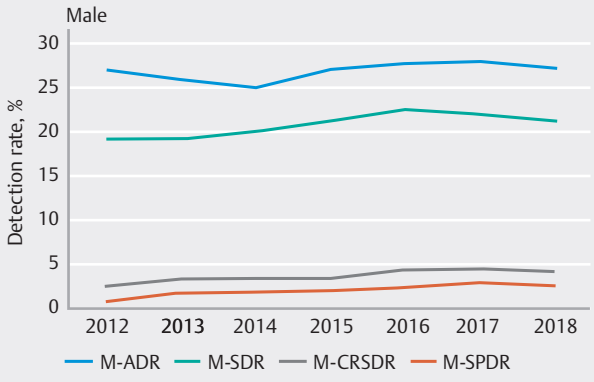
▶ **Table 4** Endoscopist characteristics for all colonoscopies and with ADR <25% and ≥25%.

Endoscopists characteristic	All colonoscopies n = 212,668	ADR <25%	ADR ≥25%	OR	*P* value
Number of endoscopists	290	190	100		
Mean ADR % (SD)	21.78% (9.27)	16.43 (5.93)	31.96 (4.88)	2.20 (2.06–2.35)	<0.001
Mean M-ADR % (SD)	26.92 (11.25)	20.72 (7.90)	38.86 (5.71)	2.63 (2.46–2.81)	<0.001
Mean F-ADR % (SD)	16.59 (7.90)	12.20 (4.90)	24.94 (5.37)	2.54 (2.37–2.73)	<0.001
Mean SDR % (SD)	21.08% (11.44)	16.15 (8.15)	30.43 (10.95)	2.25 (2.10–2.42)	<0.001
Mean M-SDR % (SD)	22.72 (11.90)	17.87 (8.80)	31.93 (11.65)	2.12 (1.98–2.27)	<0.001
Mean F-SDR % (SD)	19.43 (11.69)	14.45 (8.30)	28.89 (11.38)	2.44 (2.29–2.61)	<0.001
Mean SPADR % (SD)	2.19 (2.49)	1.49 (1.87)	3.52 (2.96)	5.42 (4.27–6.88)	<0.001
Mean M-SPADR % (SD)	2.10 (2.38)	1.56 (1.87)	3.14 (2.86)	2.41 (1.92–3.03)	<0.001
Mean F-SPADR % (SD)	2.30 (3.09)	1.43 (2.21)	3.95 (3.78)	2.97 (2.43–3.63)	<0.001
Mean CRSDR % (SD)	3.81% (3.40)	2.68 (2.47)	5.96 (3.87)	4.06 (3.37–4.91)	<0.001
Mean M-CRSDR % (SD)	3.89 (3.53)	2.92 (2.62)	5.71 (4.26)	2.71 (2.25–3.27)	<0.001
Mean F-CRSDR % (SD)	3.73 (3.96)	2.43 (2.82)	6.20 (4.60)	4.48 (3.72–5.40)	<0.001

ADR, adenoma detection rate; M, male; F, female; SDR, serrated detection rate; SPADR, serrated adenoma, detection rate; CRSDR, clinically serrated polyp detection rate; SD, standard deviation.



▶ **Fig. 1** Detection rate per year.



▶ **Fig. 2** Detection rate per year in male patients.

SPADR and SSLDR

At least one SSL or TSA was found in 2.19% of colonoscopies (n = 4,666). The overall mean SPADR was 2.19% (SD 2.49). Only SSLs were found in 1.78% of all colonoscopies (n = 3,784). The mean SSLDR was 1.75 (SD 2.12). The prevalence of serrated lesions was 2.2% (2,293) for men and 2.2% (n = 2,373) for women. There was no difference between the mean male and female SPADRs (2.10% vs. 2.30%; *P* = 0.815) (▶ **Table 3**). Endoscopists with ADRs ≥ 25% and < 25% had mean SPADRs of 3.52% (SD 2.96) and 1.49% (SD 1.87), respectively. Of the endoscopists, 19.17% (n = 56) had reached a SPADR higher than 3.61%. The overall SPADR in 2012 was 0.83% (SD 1.58) and increased to 3.01% (SD 3.82) in 2017 (▶ **Fig. 1**). Furthermore, we observed an increase by 2.03% from 0.83% (SD 1.80) in 2012 to 2.86% (SD 3.76) in 2017 for men (▶ **Fig. 2**), and for women, from 0.82% (SD 2.13) in 2012 to 3.13% (SD 5.10) in 2017 (all *P* < 0.001) (▶ **Table 5** and ▶ **Fig. 3**). ▶ **Table 2** shows the SPADR in different age groups.

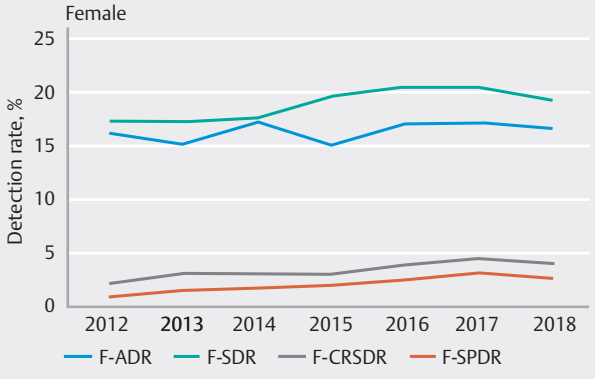
CRSDR

Clinically relevant serrated polyps were found in 3.82% of all examinations (n = 8,124). The overall mean CRSDR was 3.81% (SD 3.40%). For men, the prevalence of clinically relevant serrated polyps was 4.00% (n = 4,197), and for women, it was 2.65% (n = 3,927). Men had a mean CRSDR of 3.89% (SD 3.93) and women a mean CRSDR of 3.73% (SD 3.96) (▶ **Table 3**). The mean CRSDR for endoscopists with an ADR ≥ 25% was 5.96% (SD 3.87). This detection rate was reached by 16.44% of endoscopists (n = 48). In contrast, the mean CRSDR for endoscopists

▶ **Table 5** Trends in detection rates per year.

	2012	2013	2014	2015	2016	2017	2018	P value (2012–2017)
No. SC	25,459	29,247	33,969	32,990	32,002	35,800	23,201	
ADR % (SD)	22.03 (13.29)	20.75 (10.48)	21.99 (12.39)	22.29 (12.48)	22.93 (12.20)	22.59 (10.01)	22.16 (13.22)	0.534
F-ADR % (SD)	16.09 (12.52)	15.21 (10.15)	17.20 (13.28)	15.04 (10.15)	17.09 (11.50)	17.16 (9.94)	16.56 (12.85)	0.686
M-ADR % (SD)	27.16 (15.77)	26.04 (13.93)	25.15 (14.71)	27.18 (15.76)	27.85 (14.56)	28.06 (12.95)	27.27 (17.02)	0.693
SDR % (SD)	19.20 (12.57)	19.43 (12.73)	20.10 (12.71)	21.35 (13.18)	22.48 (13.94)	21.90 (13.18)	21.28 (14.85)	0.213
F-SDR % (SD)	17.32 (13.93)	17.30 (13.36)	17.69 (13.04)	19.74 (13.71)	20.48 (14.61)	20.51 (14.09)	19.34 (16.08)	0.246
M-SDR % (SD)	20.95 (13.86)	21.31 (14.44)	22.39 (15.28)	23.08 (14.72)	24.06 (15.29)	23.47 (14.78)	22.59 (17.08)	0.605
SPADR % (SD)	0.83 (1.58)	1.62 (2.68)	1.78 (2.47)	2.07 (2.93)	2.49 (4.45)	3.01 (3.81)	2.68 (3.62)	<0.01
F-SPADR % (SD)	0.82 (2.13)	1.52 (3.10)	1.69 (2.70)	2.03 (3.36)	2.46 (4.67)	3.13 (5.10)	2.68 (4.26)	<0.01
M-SPADR % (SD)	0.83 (1.80)	1.75 (2.97)	1.85 (2.90)	2.08 (3.52)	2.38 (4.68)	2.86 (3.76)	2.62 (4.15)	<0.01
CRSDR % (SD)	2.59 (3.67)	3.26 (4.13)	3.35 (3.66)	3.49 (3.74)	4.25 (5.52)	4.48 (4.61)	4.19 (4.75)	<0.01
F-CRSDR % (SD)	2.14 (3.71)	2.97 (4.72)	2.97 (3.93)	3.09 (3.96)	3.96 (5.50)	4.39 (6.03)	4.08 (5.53)	<0.01
M-CRSDR % (SD)	2.87 (5.01)	3.58 (4.75)	3.69 (4.30)	3.78 (5.00)	4.36 (6.26)	4.53 (4.63)	4.19 (5.72)	<0.01

F, female; M, male; ADR, adenoma detection rate; SDR, serrated detection rate; SPADR, serrated polyp detection rate; CRSDR, clinically serrated polyp detection rate; SD, standard deviation.



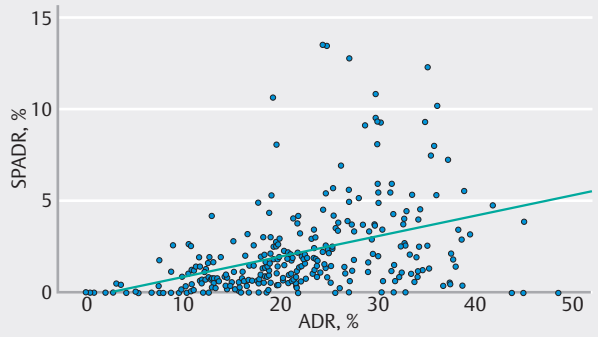
▶ **Fig. 3** Detection rate per year in female patients.

with an ADR < 25% was 2.68% (SD 2.47). The overall CRSDR increased by 1.92% from 2.59% (SD 3.67) in 2012 to 4.48% (SD 4.61) in 2017 ($P < 0.001$). For men, the CRSDR increased from 2.87% (SD 5.01) in 2012 to 4.53% (SD 4.63) in 2017 ($P < 0.001$) (▶ **Fig. 2**). For women the CRSDR increased from 2.14% (SD 3.71) in 2012 to 4.39% (SD 6.03) in 2017 ($P < 0.001$) (▶ **Fig. 3**). ▶ **Table 2** shows the CRSDR in different age groups.

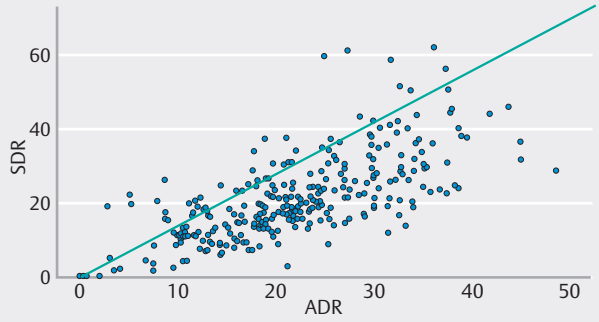
Comparison of the ADR and serrated polyp detection rates

Spearman rank order showed significant correlations between the ADR and SDR, SPADR, SSLDR, and CRSDR (rho = 0.730 vs. rho = 0.508 vs. rho = 0.508 vs. rho = 0.630; all $P < 0.01$) (▶ **Fig. 4**, ▶ **Fig. 5**, ▶ **Fig. 6**) (▶ **Table 6**). Furthermore, the ADR is significantly correlated with the SDR, SPADR, SSLDR, and CRSDR in the ADR < 25% group (rho = 0.580 vs. rho = 0.522 vs. rho = 0.417 rho = 0.512; all $P < 0.01$) (▶ **Fig. 7**, ▶ **Fig. 8**, ▶ **Fig. 9**). In contrast, the ADR was significantly correlated only with the SDR (rho = 0.355; $P < 0.01$) but not with the SPADR, SSLDR, or CRSDR in the ADR ≥25% group (rho = -0.085; $P = 0.400$ vs. rho = -0.037; $P = 0.677$; rho = 0.064; $P = 0.529$) (▶ **Fig. 10**, ▶ **Fig. 11**, ▶ **Fig. 12**).

According to the cut-off of ADR ≥25%, we found that SDR, SPADR, and SSLDR and CRSDR were significantly higher overall for female and male endoscopists with a mean ADR ≥25% than



▶ **Fig. 4** Correlation of ADR and SPADR.

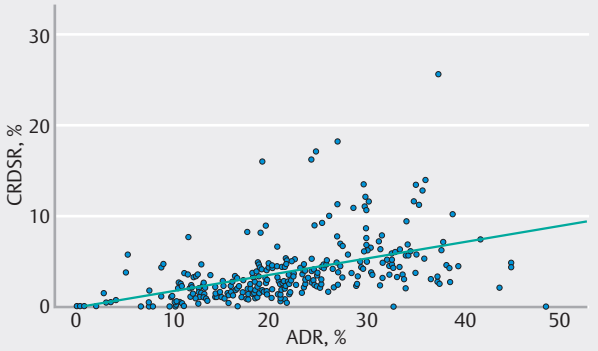


▶ **Fig. 5** Correlation of ADR and SDR.

among those with an ADR <25% (all *P* <0.01, Mann-Whitney-U-Test).

Discussion

In our study, we included 212,668 screening colonoscopies performed by 290 endoscopists. We evaluated different serrated polyp detection rates and found strong variability between endoscopists. The mean SDR, SPADR, and CRSDR were 21.07%, 2.19%, and 3.81%, respectively, and we documented strong significant correlations between the detection rates. Furthermore, practitioners in the higher ADR group (ADR



▶ **Fig. 6** Correlation of ADR and CRSDR.

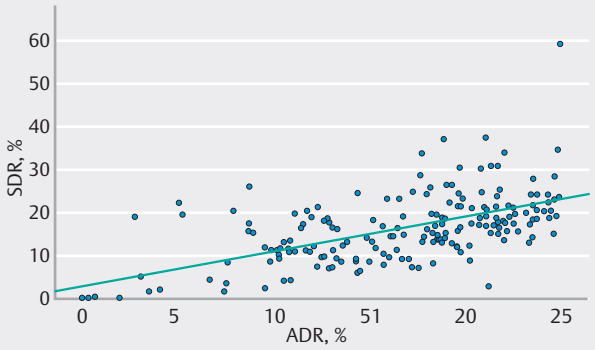
≥ 25%) had significantly higher serrated detection rates in comparison with the lower ADR group (ADR <25%).

A study by Anderson et al. [22] reported the results of 45,996 screening and surveillance colonoscopies. They investigated potential benchmarks for SDR based on the 25% and 35% ADR cut-offs. For endoscopists with ADRs > 25% and > 35%, the corresponding median SDR was 6.8% (interquartile range [IQR] 4.3%-8.6%) and 10.0% (IQR 8.5%-13.1%), respectively. CRSDR and ADR showed a significant correlation with a Spearman coefficient of 0.690 ($P < 0.01$). Two recent studies measured serrated polyp detection rates during surveillance and/or screening colonoscopies. First, Schramm et al. [23] analyzed 4,161 screening colonoscopies. They found at least one clinically relevant serrated polyp in 4.7% (95% CI 2.3%-7.2%) of all cases and a SDR of 19.4% (95% CI 13.5%-25.4%). A practitioner's ADR correlated significantly with the CRSDR (rho = 0.54; $P < 0.05$). Second, a multicenter study with 104,618 colonoscopies found an overall mean SPADR of 5.1% (SD 3.8) with a greater than 18-fold difference between the highest and lowest endoscopist (range 0%-18.8%). A significant correlation was found between ADR and SPADR (rho = 0.540; $P < 0.01$) [24]. Finally, a cohort study with two primary colonoscopy and three fecal occult blood tests (FOBT) screening cohorts showed detection rates for serrated polyps between 15.1% and 27.2% (median 29,5%) and for clinically relevant serrated polyps between 2.1% to 7.8% (median 4.6%). [18]

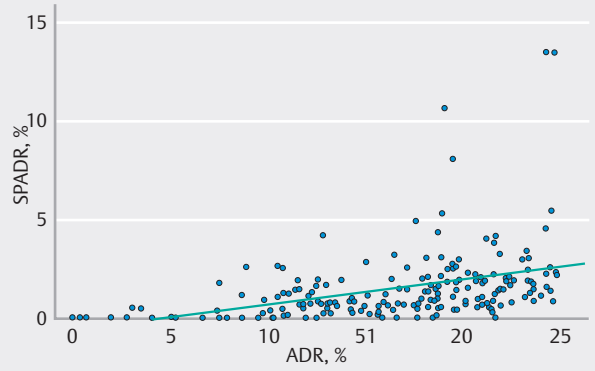
▶ **Table 6** Correlation between ADR and SDR and SPADR and CRSDR.

	ADR		ADR <25%		ADR ≥25%	
	Spearman coefficient	P value	Spearman coefficient	P value	Spearman coefficient	P value
SDR	0.730	< 0.01	0.580	< 0.01	0.355	< 0.01
SPADR	0.508	< 0.01	0.552	< 0.01	-0.085	= 0.400
CRSDR	0.630	< 0.01	0.512	< 0.01	0.064	= 0.529
SSLDR	0.508	< 0.01	0.417	< 0.01	-0.037	= 0.677

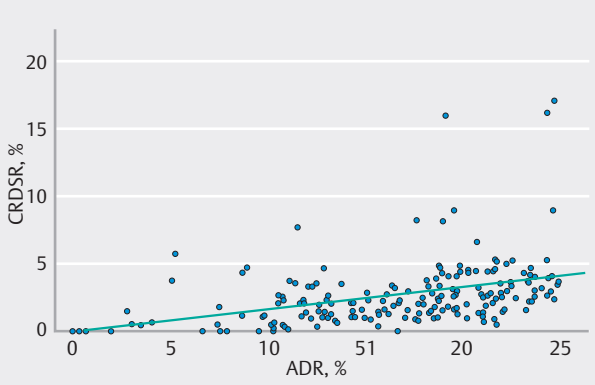
ADR, adenoma detection rate; SDR, serrated detection rate; SPADR, serrated polyp, detection rate; CRSDR, clinically serrated polyp detection rate; SSLDR, sessile serrated, lesion detection rate.



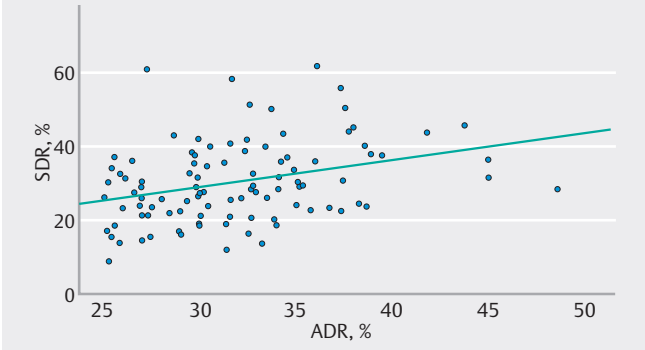
▶ **Fig. 7** Correlation of ADR and SDR in endoscopists with an ADR <25%.



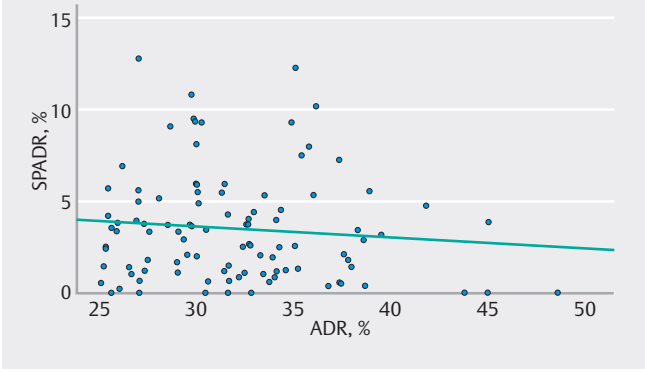
▶ **Fig. 8** Correlation of ADR and SPADR in endoscopists with an ADR <25%.



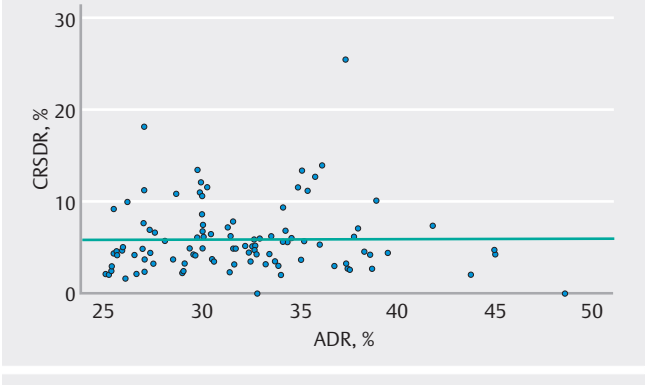
▶ **Fig. 9** Correlation of ADR and CRSDR in endoscopists with an ADR <25%.



▶ **Fig. 10** Correlation of ADR and SDR in endoscopists with an ADR >25%.



▶ **Fig. 11** Correlation of ADR and SPADR in endoscopists with an ADR >25%.



▶ **Fig. 12** Correlation of ADR and CRSDR in endoscopists with an ADR >25%.

Today, ADR is an accepted indicator for screening colonoscopies and a minimum of 25% is recommended (men: 30%, women: 20%). Based on the 25% ADR cut-off from the American College of Gastroenterology and the American Society of Gastrointestinal Endoscopy, we measured a mean ADR of 21.79% (SD 9.25), a SDR of 21.08% (SD 11.42), a SPADR of 2.19% (SD 2.49), and a CRSDR of 3.81% (SD 3.40). Similar to other studies, we demonstrated significant correlations between the ADR and the SDRs (SDR: rho = 0.730 vs. SPADR: rho = 0.508 vs. CRSDR: rho = 0.630; all P <0.01). However, a retrospective study by Liang et al. [25] showed no significant correlation between ADR and SDR (rho = 0.571; P = 0.237). In com-

parison with other studies, our detection rates were lower than all of them except the SDR in Schramm et al. [23]. Our study showed a significant difference between the SDR, SPADR, and CRSDR of endoscopists with ADRs <25% and ≥25% (all P <0.01).

▶ **Table 4** shows that endoscopists with an ADR ≥ 25% detect more conventional adenomas and serrated lesions. Endoscopists with an ADR ≥ 25% had a 2-fold increase in finding conventional adenomas, a 5-fold increase in finding serrated lesions, and a 4-fold increase in finding clinically relevant serrated polyps compared with the endoscopists in the lower ADR group. These findings were similar for men and women. These results could be explained by the fact that endoscopists with a higher ADR have increased skills, experience, and eventually more knowledge about serrated polyps. Increased detection of serrated lesions also may explain why a higher ADR is associated with a lower risk for interval cancer.

In the current study, we also observed strong variability in detection rates, which may have been caused by different levels of knowledge. On the one hand, some endoscopists disregard serrated polyps and do not biopsy or remove them because of their lack of knowledge. On the other hand, some physicians diagnose serrated polyps, especially diminutive HPs, as clinical irrelevant and correctly leave them behind.

We found that detection rates for serrated adenomas and clinically relevant serrated polyps increased significantly between 2012 and 2017. The same results were found for both genders (all P <0.01). The overall SPADR increased by 1.85% from 0.83% (SD 1.58) to 2.68% (SD 3.81) and the overall CRSDR by 1.89% from 2.59% (SD 3.67) to 4.48% (SD 4.61). These positive trends are the result of many factors, including increasing knowledge about the importance of serrated adenomas in particular and differences in how endoscopists evaluate HPs and determine their clinical relevance.

In Austria, SC was recommended at age 50 years for both sexes at the time of this study. With regard to the group aged 50 to 59 years, we documented an ADR of 16.89% (SD 8.30%), an SDR of 20.86% (SD 12.57%), an SPADR of 2.64% (SD 3.38%), and an CRSDR of 4.39% (SD 4.63%). Interestingly, we found the highest overall detections rates for SPADR and CRSDR in the group aged younger than 50 years.

Regarding gender, we observed significant differences between men and women for conventional adenomas (27.16% (SD 15.77%) vs. 16.0% (SD 12.52%); P < 0.001) and serrated polyps, including HPs, SSLs, and TSAs (20.95% (SD 13.86%) vs. 17.32% (SD 13.93%); P < 0.001).

The strengths of the study were the large number of colonoscopies and endoscopists, as well as the fact that all colonoscopies were performed as part of the quality assurance screening program of OEGGH. Our study has some limitations. First, it was a retrospective analysis of data that were prospectively collected but not using the design of this study. The second limitation is that until 2013, SSLs and TSAs were classified as "serrated adenomas." However, all detection rates were defined in such a way that differentiating between SSAs and TSAs was unnecessary.

Conclusions

In summary, our study suggests that ADR correlates significantly with different SDRs and endoscopists with higher ADRs have significantly higher rates of serrated polyp detection. Studies evaluating the impact of artificial intelligence on the detection of serrated lesions by endoscopists with an ADR < 25% would be of great interest for the future. A study by Zessner-Spitzenberg et al. showed that proximal SDR is associated with a reduction in post-colonoscopy CRC similar to endoscopists' ADR [26]. This suggests that quality improvement in endoscopist ADR is necessary to avoid interval cancer. Also, improving detection of serrated lesions in the right colon should be emphasized. Further studies are necessary to assess whether the serrated polyp detection rate should be implemented as an independent quality parameter for screening colonoscopy.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

[1] Bray F, Ferlay J, Soerjomataram I et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018; 68: 394–424 doi:10.3322/caac.21492

[2] Arnold M, Sierra MS, Laversanne M et al. Global patterns and trends in colorectal cancer incidence and mortality. Gut 2017; 66: 683–691 doi:10.1136/gutjnl-2015-310912

[3] Zavoral M, Suchanek S, Zavada F et al. Colorectal cancer screening in Europe. World J Gastroenterol 2009; 15: 5907–5915 doi:10.3748/wjg.15.5907

[4] Baxter NN, Warren JL, Barrett MJ et al. Association between colonoscopy and colorectal cancer mortality in a US cohort according to site of cancer and colonoscopist specialty. J Clin Oncol 2012; 30: 2664–2669

[5] Brenner H, Chang-Claude J, Seiler CM et al. Protection from colorectal cancer after colonoscopy: a population-based, case-control study. Ann Intern Med 2011; 154: 22–30

[6] Kaminski MF, Regula J, Kraszewska E et al. Quality indicators for colonoscopy and the risk of interval cancer. N Engl J Med 2010; 362: 1795–1803 doi:10.1056/NEJMoa0907667

[7] Corley DA, Levin TR, Doubeni CA. Adenoma detection rate and risk of colorectal cancer and death. N Engl J Med 2014; 370: 2541 doi:10.1056/NEJMoa1309086

[8] Rex DK, Schoenfeld PS, Cohen J et al. Quality indicators for colonoscopy. Am J Gastroenterol 2015; 110: 72–90 doi:10.1016/j.gie.2014.07.058

[9] Kaminski MF, Thomas-Gibson S, Bugajski M et al. Performance measures for lower gastrointestinal endoscopy: a European Society of Gastrointestinal Endoscopy (ESGE) quality improvement initiative. United European Gastroenterol J 2017; 5: 309–334 doi:10.1177/2050640617700014

[10] Bosman FT, Carneiro F, Hruban RH et al. WHO classification of tumours of the digestive system. Geneva. World Health Organization; 2010

[11] Jass JR. Classification of colorectal cancer based on correlation of clinical, morphological and molecular features. Histopathology 2007; 50: 113–130 doi:10.1111/j.1365-2559.2006.02549.x

[12] East JE, Vieth M, Rex DK. Serrated lesions in colorectal cancer screening: detection, resection, pathology and surveillance. Gut 2015; 64: 991–1000 doi:10.1136/gutjnl-2014-309041

[13] Arain MA, Sawhney M, Sheikh S et al. CIMP Status of Interval Colon Cancers: Another Piece to the Puzzle. Am J Gastroenterol 2009; 105: 1189

[14] Snover DC. Update on the serrated pathway to colorectal carcinoma. Human Pathology 2011; 42: 1–10 doi:10.1016/j.humpath.2010.06.002

[15] Leggett B, Whitehall V. Role of the serrated pathway in colorectal cancer pathogenesis. Gastroenterology 2010; 138: 2088–2100 doi:10.1053/j.gastro.2009.12.066

[16] 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: 1315–1330

[17] Anderson JC. Pathogenesis and management of serrated polyps: Current status and future directions. Gut and Liver 2014; 8: 582–589 doi:10.5009/gnl14248

[18] JEG IJ, 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 doi:10.1136/gutjnl-2015-310784

[19] Ferlitsch M, Reinhart K, Pramhas S et al. Sex-specific prevalence of adenomas, advanced adenomas, and colorectal cancer in individuals undergoing screening colonoscopy. JAMA 2011; 306: 1352–1358 doi:10.1001/jama.2011.1362

[20] Gessl I, Waldmann E, Britto-Arias M et al. Surveillance colonoscopy in Austria: Are we following the guidelines? Endoscopy 2018; 50: 119–127 doi:10.1055/s-0043-119637

[21] Waldmann E, Gessl I, Sallinger D et al. Trends in quality of screening colonoscopy in Austria. Endoscopy 2016; 48: 1102–1109 doi:10.1055/s-0042-113185

[22] Anderson JC, Butterly LF, Weiss JE et al. Providing data for serrated polyp detection rate benchmarks: an analysis of the New Hampshire Colonoscopy Registry. Gastrointest Endosc 2017; 85: 1188–1194 doi:10.1016/j.gie.2017.01.020

[23] Schramm C, Janhsen K, Hofer JH et al. Detection of clinically relevant serrated polyps during screening colonoscopy: results from seven cooperating centers within the German colorectal screening program. Endoscopy 2018; 50: 993–1000

[24] Crockett SD, Gourevitch RA, Morris M et al. Endoscopist factors that influence serrated polyp detection: a multicenter study. Endoscopy 2018; 50: 984–992

[25] Liang J, Kalady MF, Appau K et al. Serrated polyp detection rate during screening colonoscopy. Colorectal Dis 2012; 14: 1323–1327

[26] Zessner-Spitzenberg J, Waldmann E, Jiricka L et al. Comparison of adenoma detection rate and proximal serrated polyp detection rate and their effect on post-colonoscopy colorectal cancer mortality in screening patients. Endoscopy 2023; 55: 434–441