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The size, morphology, site, and access score predicts critical outcomes of endoscopic mucosal resection in the colon

Authors

Mayenaaz Sidhu[1,*], David J. Tate[1,2,*], Lobke Desomer[1], Gregor Brown[3,4], Luke F. Hourigan[5,6], Eric Y. T. Lee[1], Alan Moss[7,8], Spiro Raftopoulos[9], Rajvinder Singh[10], Stephen J. Williams[1], Simon Zanati[3,7], Nicholas Burgess[1], Michael J. Bourke[1,2]

Institutions

1 Department of Gastroenterology and Hepatology, Westmead Hospital, Sydney, New South Wales, Australia
2 Westmead Clinical School, The University of Sydney, Sydney, New South Wales, Australia
3 Department of Gastroenterology and Hepatology, The Alfred Hospital, Melbourne, Victoria, Australia
4 Department of Gastroenterology and Hepatology, Epworth Hospital, Melbourne, Victoria, Australia
5 Department of Gastroenterology and Hepatology, Greenslopes Private Hospital, Brisbane, Queensland, Australia
6 Department of Gastroenterology and Hepatology, Princess Alexandra Hospital, Brisbane, Queensland, Australia
7 Department of Gastroenterology and Hepatology, Footscray Hospital, Melbourne, Victoria, Australia
8 Department of Medicine, Melbourne Medical School, The University of Melbourne, Melbourne, Victoria, Australia
9 Department of Gastroenterology and Hepatology, Sir Charles Gairdner Hospital, Perth, Western Australia, Australia
10 Department of Gastroenterology and Hepatology, Lyell McEwan Hospital, Adelaide, South Australia, Australia

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Corresponding author

Michael J. Bourke, MBBS, FRACP, Department of Gastroenterology and Hepatology, Westmead Hospital, Suite 106a, 151-155 Hawkesbury Road, Westmead NSW 2145, Australia
Fax: +61-2-96333958
michael@citywestgastro.com.au

ABSTRACT

Background The SMSA (size, morphology, site, access) polyp scoring system is a method of stratifying the difficulty of polypectomy through assessment of four domains. The aim of this study was to evaluate the ability of SMSA to predict critical outcomes of endoscopic mucosal resection (EMR).

Methods We retrospectively applied SMSA to a prospectively collected multicenter database of large colonic laterally spreading lesions (LSLs) ≥20 mm referred for EMR. Standard inject-and-resect EMR procedures were performed. The primary end points were correlation of SMSA level with technical success, adverse events, and endoscopic recurrence.

Results 2675 lesions in 2675 patients (52.6 % male) underwent EMR. Failed single-session EMR occurred in 124 LSLs (4.6 %) and was predicted by the SMSA score ($P<0.001$). Intraprocedural and clinically significant postendoscopic bleeding was significantly less common for SMSA 2 LSLs (odds ratio [OR] 0.36, $P<0.001$ and OR 0.23, $P<0.01$) and SMSA 3 LSLs (OR 0.41, $P<0.001$ and OR 0.60, $P=0.05$) compared with SMSA 4 lesions. Similarly, endoscopic recurrence at first surveillance was less likely among SMSA 2 (OR 0.19, $P<0.001$) and SMSA 3 (OR 0.33, $P<0.001$) lesions compared with SMSA 4 lesions. This also extended to second surveillance among SMSA 4 LSLs.

Conclusion SMSA is a simple, readily applicable, clinical score that identifies a subgroup of patients who are at increased risk of failed EMR, adverse events, and adenoma recurrence at surveillance colonoscopy. This information may be useful for improving informed consent, planning endoscopy lists, and developing quality control measures for practitioners of EMR, with potential implications for EMR benchmarking and training.

Table e 5
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* These authors contributed equally to this work.

▶ **Table 1** The SMSA scores and levels.

Size	Points	Morphology	Points	Site	Points	Access	Points
< 1 cm	1	Pedunculated	1	Left colon	1	Easy	1
1 – 1.9 cm	3	Sessile	2	Right colon	2	Difficult	2
2 – 2.9 cm	5	Flat	3				
3 – 3.9 cm	7						
> 4 cm	9						

SMSA, size, morphology, site, access; SMSA level: SMSA 1 = 4 – 5 points; SMSA 2 = 6 – 9 points; SMSA 3 = 10 – 12 points; SMSA 4 = > 12 points

Introduction

Endoscopic mucosal resection (EMR) is safer, more efficient, and less expensive than surgery, and is now accepted as the standard of care for large (≥ 20 mm) laterally spreading lesions (LSLs) in the colon [1 – 4].

Although LSLs conventionally have been evaluated primarily on lesion size alone, procedural difficulty, clinical outcomes, and complications after EMR can vary significantly and independently of LSL size [5, 6]. Scoring systems predicting outcomes, such as the risk of clinically significant postendoscopic bleeding (CSPEB) score or the Sydney EMR recurrence tool, are useful but these scores report on one-dimensional outcomes and are limited by their reliance on prior knowledge of the EMR procedure [7, 8].

In recent years, a scoring system developed by expert consensus focusing on size, morphology, access, and site – the "SMSA" polyp score [9] – has been proposed as a method of helping to grade polyps in order to define their complexity and associated level of difficulty during resection. Its major benefit is its ability to be applied prior to the EMR procedure with information from the referral letter or procedure report.

In this study, we aimed to evaluate the ability of SMSA to predict critical outcomes of EMR, specifically technical success, adverse events, and recurrence.

Methods

Consecutive patients were enrolled over a period of 106 months (June 2008 – April 2017). For patients with multiple large LSLs referred for EMR, only the largest lesion was included in the analysis because of the difficulty in ascribing adverse events to a specific lesion and correlated observations in a single patient.

Applying the SMSA polyp score

The SMSA score was applied to a prospectively collected multicenter database (seven sites across Australia) of patients referred to tertiary endoscopy facilities for EMR of large LSLs. Large LSLs were defined as nonpolypoid lesions ≥ 20 mm.

All aspects of the SMSA polyp score were collected prospectively. Data were regrouped retrospectively into the four domains of the SMSA score: lesion size, morphology, site, and access. For each domain, points were allocated and then totaled in order to grade the LSL into one of four SMSA levels (levels 1 – 4). No lesions in the study cohort were classified as SMSA 1 because in order to qualify as SMSA 1, the maximum total points for an individual lesion must be less than 6 (▶ **Table1**). As all lesions in the study cohort were ≥ 20 mm and sessile, the minimum possible SMSA polyp score was 9 (size – 5 points, morphology – 2 points, site – 1 point, access – 1 point).

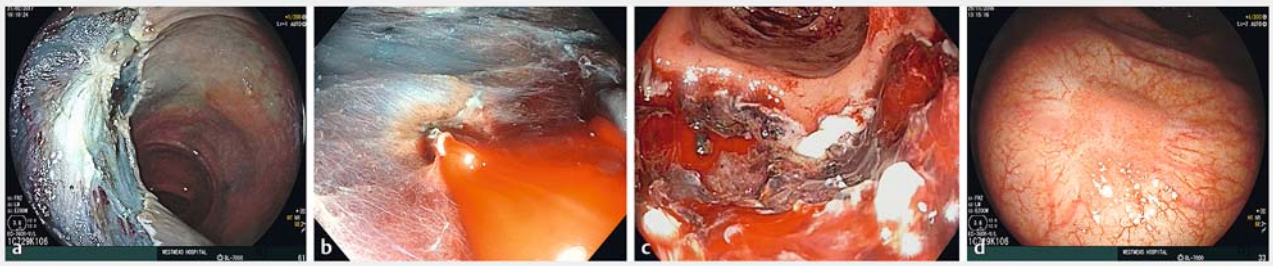
Size and morphology were recorded by the individual endoscopist performing EMR. Lesion size was approximated relative to an open snare of known dimensions placed adjacent to the lesion. Site was defined as the right colon if the lesion was located proximal to and including the splenic flexure, and left colon if it was distal to the splenic flexure. Access was defined as difficult if the referring endoscopist had significant difficulty in positioning the scope to enable resection or if the lesion location was deemed challenging (e. g. peri-appendiceal, peri-diverticular or involvement of the ileocecal valve).

EMR procedure

All EMR procedures were performed by senior endoscopists with extensive EMR experience or by an advanced endoscopy fellow under their direct supervision. Written informed consent was obtained from all patients. Split-dose bowel preparation was used. Intravenous sedation was with a combination of fentanyl, midazolam, and propofol. Insufflation of the colon was initially with air but changed to carbon dioxide in August 2010 once the benefits had been understood [10].

Colonoscopy was performed using Olympus 180 or 190 series, high definition, variable-stiffness colonoscopes (180/190 PCF/CF; Olympus, Tokyo, Japan). A standardized and previously described inject-and-resect EMR technique was used [11]. Most cases used a microprocessor-controlled electrosurgical generator (Endocut effect 3, VIO 300D; Erbe Elektromedizin, Tübingen, Germany) with fractionated current. The submucosal injectate comprised normal saline until 2010, when it was replaced with succinylated gelatin (Gelofusine; B. Braun Australia Pty. Ltd., Bella Vista, Australia) [12]. The fluid was dyed with indigo carmine blue (80 mg/500 mL solution), and epinephrine was added to achieve a final concentration of 1:100 000. Occasionally, methylene blue was used as an alternative when indigo carmine was not available.

Procedure time was defined as the total duration of the EMR procedure in minutes from the first snare resection. Technical success was determined at completion of the endoscopic pro-



▶ **Fig. 1** Endoscopic mucosal resection (EMR) adverse events. **a** Type III deep mural injury according to the Sydney classification. **b** Intraprocedural bleeding – transected artery. **c** Clinically significant postendoscopic bleeding – multifocal bleeding from the post-EMR defect. **d** Recurrence – endoscopic recurrence demonstrated by Kudo pit pattern III within the area of the post-EMR scar.

cedure and was defined as complete removal of all macroscopically visible polyp tissue.

Study outcomes

The primary outcome of the study was the ability of the SMSA score to predict technical success, adverse events, and endoscopic recurrence during follow-up examinations.

Adverse events

All patients were contacted by the study nurse 2 weeks postprocedure to assess for any adverse events related to their EMR procedure. Intraprocedural bleeding was defined as significant oozing or pulsatile bleeding requiring endoscopic control, and was treated with snare-tip soft coagulation (Soft Coagulation, 80 W Effect 4; Erbe Electromedizin) [13].

CSPEB was defined as bleeding after the completion of EMR and discharge from the endoscopy unit, resulting in presentation to the emergency department, hospitalization, or re-intervention within 14 days [14]. Delayed perforation was defined as a perforation occurring after the completion of the EMR procedure. Deep mural injury (DMI) was defined according to the Sydney DMI classification [15] as injury to the mucosa with a visible target sign or actual hole corresponding to DMI type III/IV. Examples of the endoscopic appearance of adverse events are shown in ▶ **Fig. 1**.

Follow-up

Follow-up data were collected from patients eligible for surveillance colonoscopy 1 (SC1) at a planned interval of 4 – 6 months. Time to longest follow-up and any associated recurrence after SC1 were recorded if available. SC2 was performed at a planned interval of 12 months (i. e. 18 months after the original EMR).

EMR scar assessment

Recurrence was defined as the endoscopic appearance of residual or recurrent adenoma at an EMR scar unless otherwise stated. A standardized imaging protocol was used to assess the post-EMR scar for recurrence [16]. If no visible residual adenoma was detected, biopsies were performed for histology. Any suspected recurrence was biopsied and then treated endoscopically.

Statistical analysis

All data were analyzed using IBM SPSS statistics version 22.0 (IBM Corp. Armonk, New York, USA). Categorical variables were described using frequencies and percentages. Mean, median, and interquartile ranges (IQR) were calculated for continuous data. Statistical significance was set at a threshold of 0.05, and comparison between different groups and outcomes was performed using the chi-squared or Fisher's exact test and binary logistic regression. Odds ratios (ORs) with 95 % confidence intervals (CIs) were used to compare categorical outcomes of interest between the groups with reference to SMSA 4 LSLs.

Results

A total of 2947 lesions were referred for EMR (▶ **Fig. 2**). A total of 272 lesions were excluded: 148 multiple lesions in the same patient, 83 nonattempted lesions with suspected submucosal invasive cancer, and 41 for technical reasons (involvement of the ileocecal valve, appendix or difficult access).

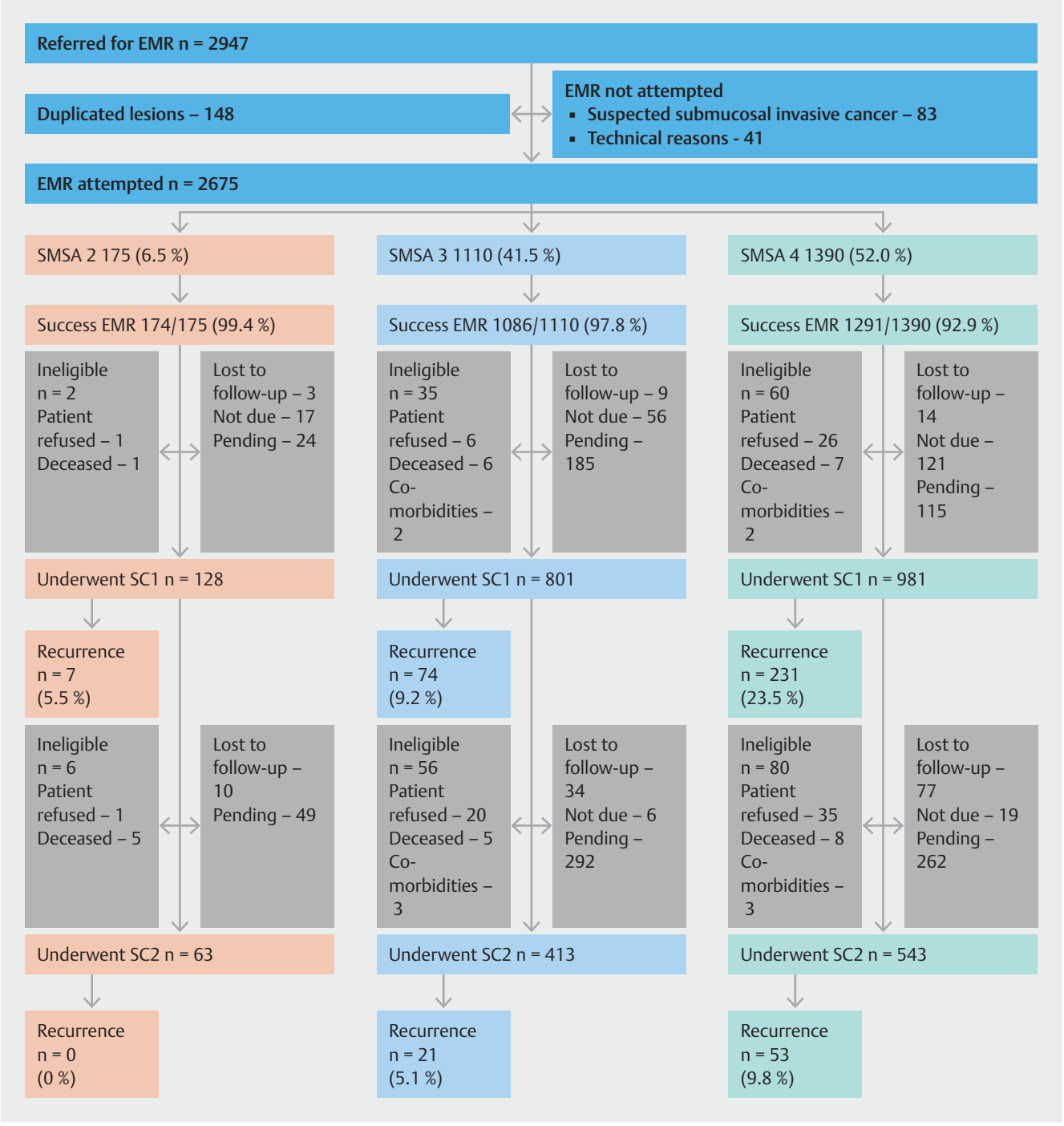
A total of 2675 lesions in 2675 patients underwent EMR. The mean age of patients was 67.3 years and 52.6 % were male. A total of 1743 LSLs (65.2 %) were located in the right colon. The median size of lesions was 35 mm (IQR 25 – 45 mm). Distribution of lesions as per SMSA (▶ **Fig. 2**, ▶ **Table 2**) was as follows: SMSA 2 – 175 (6.5 %); SMSA 3 – 1110 (41.5 %); and SMSA 4 – 1390 (52.0 %).

On assessment of morphology, Paris 0-IIa/Is lesions were most commonly noted among SMSA 4 LSLs (37.0 %). SMSA 4 LSLs were also significantly more likely to be granular compared with other SMSA groups (67.2 %). En bloc resection was most common among SMSA 2 LSLs (44.0 %). On histopathology review, tubulovillous adenomas were most common among SMSA 4 LSLs (63.1 %).

For detailed analysis of patient, lesion, and procedural features by SMSA score see ▶ **Table 3**.

Procedure

Technical success at EMR was achieved in 174/175 (99.4 %) SMSA 2 LSLs, 1086/1110 (97.8 %) SMSA 3 LSLs, and 1291/1390 (92.9 %) SMSA 4 LSLs (▶ **Table 4**). Successful EMR was more likely among SMSA 2 LSLs (OR 13.34, 95 %CI 1.85 – 96.27; P =



▶ **Fig. 2** Study design and follow-up. EMR, endoscopic mucosal resection; SMSA, size, morphology, site, and access; SC1/2, surveillance colonoscopy 1/2.

0.01) and SMSA 3 LSLs (OR 3.47, 95 %CI 2.20 – 5.46; $P<0.001$) compared with SMSA 4 LSLs. Procedure duration was longest among SMSA 4 LSLs (median time 30 minutes, IQR 20 – 45 minutes).

Intraprocedural adverse events

Intraprocedural bleeding was significantly less common among SMSA 2 LSLs (OR 0.36, 95 %CI 0.22 – 0.58; $P<0.001$) and SMSA 3 LSLs (OR 0.41, 95 %CI 0.34 – 0.54; $P<0.001$) compared with SMSA 4 lesions. Deep injury was observed with highest frequency in the post-EMR defect of SMSA 4 LSLs (31/1390).

Post-EMR adverse events

CSPEB was also significantly less likely for SMSA 2 LSLs (OR 0.23, 95 %CI 0.07 – 0.74; $P=0.01$) and SMSA 3 LSLs (OR 0.60, 95 %CI 0.42 – 0.86; $P=0.05$) compared with SMSA 4 lesions. Referral for surgery at 2 weeks after the index procedure was also less common in SMSA 3 LSLs compared with SMSA 4 lesions

▶ **Table 2** Lesion distribution by SMSA score.

SMSA	Size, mm					Morphology			Site		Access	
	<10	10–19	20–29	30–39	≥40	Ped	Sessile	Flat	Left	Right	Easy	Difficult
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	175	0	0	0	175	0	175	0	175	0
3	0	0	667	443	0	0	1087	23	213	897	859	251
4	0	0	10	283	1097	0	1329	61	544	846	702	688
Total	0	0	852	726	1097	0	2591	84	932	1743	1736	939

SMSA, size, morphology, site, access; Ped, pedunculated.

▶ **Table 3** Patient demographic details and lesion characteristics.

	SMSA 2 n = 175	SMSA 3 n = 1110	SMSA 4 n = 1390	Total n = 2675	*P* value
Patients					
Age, mean (SD), years	66.3 (11.2)	67.0 (11.8)	67.77 (11.9)		0.116
Sex, n (%)					0.307
▪ Male	99 (56.6)	567 (51.1)	740 (53.2)	1406 (52.6)	
▪ Female	76 (43.4)	543 (48.9)	650 (46.8)	1269 (47.4)	
Lesions					
Size, median (range), mm	20 (20–28)	26 (15–35)	45 (20–180)		<0.001
Paris, n (%)					<0.001
▪ 0-Is	64 (36.6)	214 (19.3)	248 (17.8)	526 (19.7)	
▪ 0-IIa	69 (39.4)	680 (61.3)	501 (36.0)	1250 (46.7)	
▪ 0-IIa/Is	28 (16.0)	124 (11.2)	514 (37.0)	666 (24.9)	
▪ Others (IIb, IIc, etc.)	14 (8.0)	92 (8.3)	127 (9.1)	233 (8.7)	
Morphology, n (%)[1]					<0.001
▪ Granular	94 (53.7)	564 (50.8)	934 (67.2)	1592 (59.5)	
▪ Nongranular	59 (33.7)	329 (29.6)	253 (18.2)	641 (24.0)	
▪ Mixed	6 (3.4)	52 (4.7)	121 (8.7)	179 (6.7)	
▪ Unable to classify	12 (6.9)	70 (6.3)	40 (2.9)	122 (4.6)	
Location, right colon, n (%)[2]	0	897 (80.8)	846 (60.9)	1743 (65.2)	
En bloc, n (%)	77 (44.0)	253 (22.8)	37 (2.7)	367 (13.7)	<0.001
Histopathology, n (%)					<0.001
▪ Tubular adenoma	57 (32.6)	297 (26.8)	270 (19.4)	624 (23.3)	
▪ Tubulovillous adenoma	83 (47.4)	483 (43.5)	877 (63.1)	1443 (53.9)	
▪ Sessile serrated adenoma	14 (8.0)	243 (21.9)	110 (7.9)	370 (13.8)	
▪ Other	21 (12.0)	87 (7.8)	133 (9.6)	238 (8.9)	
Submucosal invasive cancer, n (%)	21 (12.0)	47 (4.2)	122 (8.8)	190 (7.1)	<0.001

SMSA, size, morphology, site, access.
[1] Sessile morphology not included.
[2] Proximal to and including hepatic flexure.

▶ **Table 4** Outcomes after endoscopic mucosal resection at the initial procedure, 2 weeks, and subsequent surveillance procedures.

	SMSA 2	SMSA 3	SMSA 4	Total	*P* value	SMSA 2 vs. SMSA 4, OR (95%CI)	*P* value	SMSA 3 vs. SMSA 4, OR (95%CI)	*P* value
Total count, n (%)	175 (6.5)	1110 (41.5)	1390 (52.0)	2675					
Technical success at EMR, n (%)	174 (99.4)	1086 (97.8)	1291 (92.9)	2551 (95.4)	<0.001	13.34 (1.85 – 96.27)	0.01	3.47 (2.20 – 5.46)	<0.001
IPB, n (%)	20 (11.4)	144 (13.0)	368 (26.5)	532 (19.9)	<0.001	0.36 (0.22 – 0.58)	<0.001	0.41 (0.34 – 0.54)	<0.001
Deep injury[1], n (%)	4 (2.3)	16 (1.4)	31 (2.2)	51 (1.9)	0.34				
CSPEB, n (%)	3 (1.7)	48 (4.3)	97 (7.0)	148 (5.5)	<0.001	0.23 (0.07 – 0.74)	0.01	0.60 (0.42 – 0.86)	0.05
Delayed perforation, n (%)	0 (0)	3 (0.3)	8 (0.6)	11 (0.4)	0.40				
Surgery at 2 weeks, n (%)	21 (12.0)	71 (6.4)	157 (11.3)	249 (9.3)	<0.001	1.01 (0.61 – 1.65)	0.98	0.53 (0.40 – 0.71)	<0.001
Underwent SC1, n (%)[2]	128/172 (74.4)	801/1051 (76.2)	981/1231 (79.7)	1910/2454 (77.8)					
Recurrence at SC1, n (%)[2]	7 (5.5)	74 (9.2)	231 (23.5)	312 (16.3)	<0.001	0.19 (0.09 – 0.41)	<0.001	0.33 (0.25 – 0.44)	<0.001
Histologic recurrence SC1, n/N (%)[3]	2/42 (4.8)	44/333 (13.2)	150/498 (30.1)	196/874 (22.4)	<0.001				
Surgery at SC1, n (%)[2]	1 (0.8)	6 (0.7)	19 (1.9)	26 (1.4)	0.08				
Underwent SC2, n (%)[2]	63/122 (51.6)	413/745 (55.4)	543/901 (60.3)	1019/1768 (57.6)					
Recurrence at SC2 (%)[2]	0 (0)	21 (5.1)	53 (9.8)	74 (7.3)	0.002			0.50 (0.30 – 0.84)	0.08
Surgery at SC2, n (%)[2]	0 (0)	0 (0)	3 (0.6)	3 (0.3)	0.40				

SMSA, size, morphology, site, access; EMR, endoscopic mucosal resection; IPB, intraprocedural bleeding; CSPEB, clinically significant postendoscopic bleeding (bleeding after EMR requiring admission to hospital or re-intervention); SC1 /2, surveillance colonoscopy1 /2; OR, odds ratio; CI, confidence interval.

[1] Target sign or actual hole corresponding to DMI type III/IV Sydney classification.

[2] Percentages refer to total eligible for SC1 /SC2.

[3] percentages refer to number of lesions with histologic data available.

(OR 0.53, 95 %CI 0.40 – 0.71; $P<0.001$). No significant difference for surgical referral was noted when comparing SMSA 2 LSLs with SMSA 4 lesions (OR 1.01, 95 %CI 0.61 – 1.65; $P=0.98$) (▶ **Table 4**).

Recurrence

A total of 1910 eligible patients (77.8 %) underwent their first surveillance colonoscopy at a median 5.1 months (IQR 4 – 6.6 months). Recurrence at SC1 was significantly less common among SMSA 2 LSLs (OR 0.19, 95 %CI 0.09 – 0.41; $P<0.001$) and SMSA 3 LSLs (OR 0.33, 95 %CI 0.25 – 0.44; $P<0.001$) compared with the SMSA 4 group (▶ **Table 4**). There was no significant difference in the rates of surgery at SC1 between the groups ($P=0.08$). A total of 1019 patients underwent a second surveillance colonoscopy at a median of 18 months (IQR 15 – 22 months). Recurrence at SC2 was observed with highest frequency for SMSA 4 LSLs (53/543). Similarly, SMSA 3 LSLs were less likely to recur at SC2 compared with SMSA 4 (OR 0.50, 95 %CI 0.30 – 0.84; $P=0.08$), with no recurrences noted among SMSA 2 LSLs. There were three referrals for surgery at SC2, which were all SMSA 4 lesions.

Discussion

Colonic LSLs are now successfully and safely treated by EMR in the vast majority of cases [17]. Traditionally, size has been described as the main factor predicting outcomes after EMR [18]. However, other factors, including morphology, location, and lesion accessibility, are now recognized to also be associated with a successful EMR procedure and subsequent outcomes [19 – 21]. For several years, practitioners of EMR have had no evidence-based scoring system with which to grade the difficulty of their procedures or to describe lesion complexity. Recently, several scoring systems have been developed to predict adverse events after EMR and recurrence [7, 8]. However, these scoring systems are uni-dimensional, pertaining to a single outcome, and have the limitation of only being assessable after the endoscopic resection.

The SMSA polyp score is a simple scoring system comprised of four variables: size, morphology, colonic site, and access to the target lesion. It was derived from expert consensus among nine experienced endoscopists from the United Kingdom using two focus group discussions and the Delphi method [9]. Its main aim is to identify factors predicting the difficulty of endoscopic polyp resection, thereby creating “levels of polypectomy” competency. The main benefit of this scoring system is its ability to be applied prior to the procedure, ideally to a well-documented referral letter or procedure report.

Our study describes the application of the SMSA polyp score to 2675 prospectively collected LSLs, from a multicenter cohort, referred for EMR. This cohort had a median lesion size of 35 mm. Over half of the lesions were assigned to the highest SMSA level of 4, and no pedunculated lesions were included. All procedural and short-term outcome data, including technical success, procedure duration, bleeding (intraprocedural bleeding and CSPEB), and deep injury, were collected prospectively. Our cohort had a high compliance rate, with over 70 % undergoing a follow-up examination. From this EMR-specific cohort, it is evident that technical success, duration, procedural adverse events (intraprocedural bleeding and CSPEB), referral for surgery at 2 weeks, and recurrence at surveillance are all correlated with the SMSA level.

Longcroft-Wheaton et al. [22] published the first validation of the SMSA polyp score. In this retrospective, single-center, non-EMR-specific study of 220 pedunculated and sessile polyps (mean size 36 mm), the authors concluded that technical success, procedural outcomes, and adverse events correlated significantly with the SMSA level. Of the 179 patients who had follow-up, endoscopic cure was strongly predicted by the SMSA polyp score. In 2017, Sansone et al. [23] described a multicenter study undertaken in two high-volume tertiary centers in the United Kingdom and Italy, which attempted to validate the SMSA polyp score. In 1668 lesions, primarily < 20 mm in size (78.8 %), which included pedunculated lesions (14.4 %) where only the index procedure was described, technical success, advanced histology, and adverse events correlated significantly with SMSA.

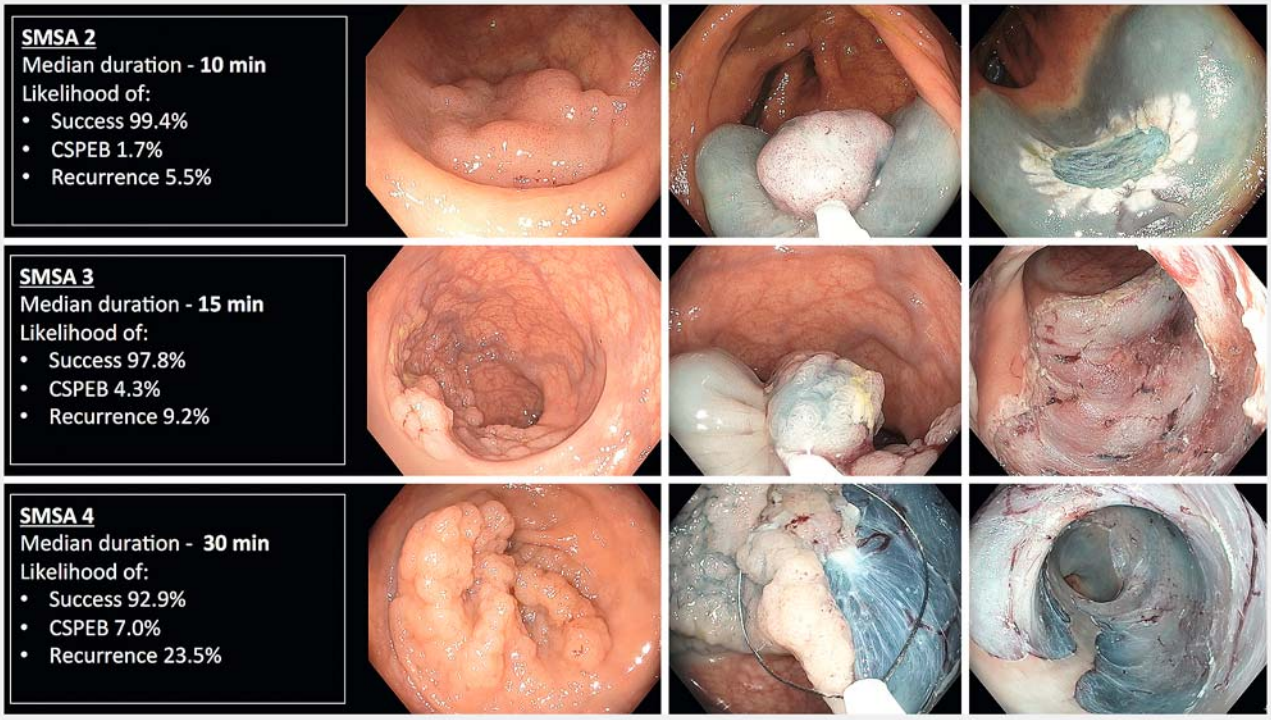
It is noted from our data that 12 % of lesions assessed as SMSA 2 were referred for surgery compared with 6.4 % of SMSA 3 lesions. This is probably due to a higher proportion of SMSA 2 lesions undergoing en bloc resection compared with SMSA 3 LSLs (44.0 % vs. 23.1 %) for suspected submucosal invasive cancer.

The clinical utility of this scoring system for EMR procedures is likely to impact positively on the interaction between the endoscopist and their patients. More detailed and precise informed consent for patients and their carers may ensue. Patients can be provided with more reliable information on the likelihood of clinical success pertinent to their specific lesion in the short and long term (▶ **Fig. 3**). Other patient-related benefits of calculating the SMSA polyp score prior to the procedure may include guidance on cessation and recommencement of antiplatelet/anticoagulant therapy in the periprocedural setting.

With the advent of widespread colorectal cancer screening programs, tertiary referral for LSL treatment is likely to increase. Endoscopy units are likely to benefit from utilizing this scoring system to assist in list planning and resource allocation. More complex lesions, for example, could be triaged to be performed by those with more experience or subspecialty training in complex EMR, as suggested by European guidelines for quality assurance in colorectal cancer screening [24]. The need for postprocedure admissions may also be more precisely assessed.

The SMSA polyp score may also be used to inform the process of training in polypectomy and EMR. It is feasible that the routine SMSA grading of lesions may be used for the development of formalized training pathways to certify trainees in advanced colonic tissue resection. Critical numbers of EMR procedures for LSLs of each SMSA level would be sequentially accumulated to allow progression through training to achieve final accreditation.

The SMSA polyp score may also allow objective benchmarks to be developed for assessing the quality of EMR procedures by



▶ **Fig. 3** Predicted outcomes relative to SMSA (size, morphology, site, and access) polyp score. CSPEB, clinically significant postendoscopic bleeding.

accounting for variations in case-mix. Such quality measures are currently lacking for EMR. Surgeons readily use well-validated scoring systems such as POSSUM and P-POSSUM [25, 26], which inform the training process and serve as a metric by which performance of individual surgical units can be compared. Such systems have been shown to improve the process of medical audits.

The SMSA polyp score is an objective tool that is applied prior to the EMR procedure. However, the level of experience of the referring endoscopist may influence assessment of lesion access in this scoring system, if applied in this context. Lesion access may be judged as "difficult" depending on lesion location (peri-appendiceal, ileocecal valve) or if the endoscopist is unable to maintain a stable position when performing EMR. Assessment of lesion access might also not be mentioned specifically by the referring endoscopist. However, we found that procedural and short-term outcomes still correlated significantly with SMSA level, even when all lesions were marked as "easy access" (see ▶ **supplementary Table e 5**, available online). Therefore, this potentially subjective variable is unlikely to impact the validity of this score.

We recognize that in an EMR-specific cohort, the SMSA polyp score has limitations. Factors such as previously attempted LSLs [27], flat/depressed LSLs [28], and LSL morphology (granular vs. nongranular) are all recognized to increase the difficulty of EMR. These are not addressed by this scoring system. This therefore gives credence to the development and validation of a modified SMSA scoring system that integrates these additional factors in order to be more specific for EMR.

Other limitations of the study include the application of the SMSA polyp score retrospectively to prospectively collected data. Although the SMSA polyp score had not been devised at the commencement of data collection, all of the domains of the score were collected prospectively in a comparable fashion. The only subjective part of the score is access, but this information was collected using a standardized definition similar to that used in previous studies. By performing a separate analysis, whereby all lesions had "easy" access and therefore scored 1, we were still able to demonstrate the ability of the SMSA score to predict important outcomes after EMR. We also note that the SMSA polyp score was not derived for LSLs ≥ 20 mm; as a result, our data primarily lie at the more complex end of the spectrum, with no lesions graded as SMSA 1. Despite this, the study has demonstrated the ability of this scoring system to predict outcomes in this complex patient cohort.

Conclusion

The SMSA polyp score is a simple, readily applicable, clinical score that identifies a subgroup of patients who are at increased risk of failed EMR, adverse events, and adenoma recurrence at surveillance colonoscopy. This information may be useful for improving informed consent, planning endoscopy lists, and developing quality control measures for practitioners of EMR. Moreover, SMSA could also have a major impact on EMR benchmarking and training.

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Competing interests

None

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