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Endoscopic Mucosal Resection of Non-pedunculated Colorectal Polyps ≥20mm: Outcome in a Self-taught Skills Environment

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ABSTRACT

Background & Aims: Endoscopic mucosal resection (EMR) of non-pedunculated colorectal polyps ≥20mm is technically demanding and should preferentially be performed by specialist endoscopists in referral centres. Little is known about the outcome in institutions establishing this competency. Here, we report the learning curve on 100 consecutive large non-pedunculated polyps resected by a single endoscopist with self-taught acquisition of skills.
Methods: We analysed data on 100 non-supervised EMR procedures performed at our academic endoscopy centre (2016-2021), representing a single endoscopist's learning curve beginning with the first polyp ≥20 mm.
Results: The median polyp size was 30 mm (20-70mm), and 61% of all polyps were ≥30 mm. Predominant polyp morphology was 0-Is (34%) or 0-IIa (47%), and most polyps developed in the ascending colon (36%). In total, 20% of polyps showed high-grade intraepithelial neoplasia, and 8% included pT1 carcinoma. Adenoma recurrence rate after piecemeal resection was 21%. All but one recurrent adenoma were treated endoscopically. Deep mural injury, intra-procedural bleeding and post-procedural bleeding were detected and managed endoscopically in 3%, 21%, and 4% of procedures, respectively. Overall, surgery could be avoided in 91% of all and 98% of non-malignant polyps. Results for the first 50 polyps did not differ from results for the following polyps.
Conclusions: Structured training is advisable to acquire advanced EMR skills. Our data show that autonomous acquisition of skills after finishing a training course represents an acceptable alternative with good results in the setting of an open error culture. Continuous review of outcome parameters and complication rate is mandatory during the learning process.

Key words: colorectal adenoma – colorectal carcinoma – endoscopic mucosal resection – learning curve.

Abbreviations: ASS: acetylsalicylic acid; CRC: colorectal cancer; DOAK: direct oral anticoagulants; IEN: intraepithelial neoplasia; EMR: endoscopic mucosal resection; ESD: endoscopic submucosal dissection; TTS: through-the-scope.

INTRODUCTION

Endoscopic therapy of neoplastic colorectal polyps (classic adenomas as well as serrated lesions), known as precursor lesions for colorectal cancer (CRC), disrupts the adenoma-carcinoma sequence and thereby prevents CRC development and reduces CRC-mortality [1]. Colorectal polyps that are challenging to remove safely by endoscopy are called "complex polyps". One of the main characteristics that makes polyp removal complex is a size of ≥20 mm with a linear increase of difficulty with size. These large polyps account for about 2% of all polyps [2]. Polyps ≥30 mm are called "giant polyps". Besides the size, sessile morphology, location (e.g., cecum, near anatomical structures, narrow or tortuous segments) distribution (e.g., more than one third of circumference, behind a fold, crossing two haustral folds, wrapping around folds) and emergence in a diseased colon (e.g., diverticulosis, stricture, scarring after previous biopsy or resection attempt, inflammatory bowel disease) are features that define complex polyps [3].

Endoscopic mucosal resection (EMR) is the standard technique used for removal of non-pedunculated polyps. Endoscopic resection of complex polyps is technically demanding with an increased risk of complications and incomplete resection [3]. Thus, EMR for advanced or complex

polyps should preferentially be performed by experienced endoscopists in referral centres to improve outcome and avoid unnecessary surgery for benign polyps [4].

Since most data on EMR outcome come from specialized referral centres, little is known about the outcome of EMR for large polyps at institutions establishing this competency. In fact, data on the EMR learning curve are scarce [5-8]. Thus, we report on the first 100 consecutive large non-pedunculated polyps resected by a single endoscopist with self-taught acquisition of skills.

METHODS

The retrospective study was approved by the local Ethics Committee (Ethikkommission der Ärztekammer des Saarlandes 254/20).

Study Design

We analysed data on 100 consecutive EMR procedures for complex non-pedunculated polyps ≥20 mm performed by a single endoscopist at an academic endoscopy centre beginning with the first polyp ≥20 mm treated by the endoscopist. At our endoscopy unit more than 5.000 gastrointestinal endoscopies are performed annually. The endoscopist who performed the procedures (M.C.) had an experience of about 500 colonoscopies and 50 polypectomies/endoscopic mucosal resections of smaller polyps before starting with EMR for complex polyps in his third year of endoscopy training. Training was complemented by theoretical (including lesion assessment, resection techniques and equipment, complication management) and practical (ex vivo animal models) advice in a two-day course for interventional colonoscopy. Thereafter, the acquisition of skills was primarily self-taught during the consecutive procedures, which were performed without direct supervision. Discussion of procedure outcomes and complications with the head of the department and optimization of procedures was carried out after each procedure for the first ten resections, then after every fifth procedure for the first 50, and thereafter after each ten procedures.

Endoscopic mucosal resection procedures were performed between 2016 and 2021 (2016: 8 procedures; 2017: 17 procedures; 2018: 15 procedures; 2019: 17 procedures; 2020: 13 procedures; 2021: 30 procedures). Endoscopies were performed with Olympus scopes (CF-140, CF160, CF 180, CF 190) and ERBE electrosurgical units (VIO300 and VIO3, Endo CUT Q mode, Erbe, Tübingen Germany). A monofil 40x20mm snare with integrated injection needle ("Skorpio-Snare", MTW, Wesel, Germany) and a small 10 mm braided hybrid snare ("CrossSnare", medwork, Höchstadt/Aich, Germany) were used for all procedures. For submucosal injection different solutions were used (normal saline, normal saline + epinephrine 1:10.000, normal saline + indigo carmine, normal saline + indigo carmine + epinephrine 1:10.000, glycerol 10% solution + indigo carmine + epinephrine 1:10.000). For clip-closure of resection defects, closure of small perforations or bleeding control 11 mm as well as 16 mm clips ("Reliance", Keysurgical, Eden Prairie, MN, USA) were used. Coagulation of bleeding vessels or coagulation of resection markings was done with the polypectomy snare tip (FORCED COAGULATION mode, Erbe, Tübingen, Germany) or using argon plasma coagulation (PULSED APC, Erbe, Tübingen, Germany). Procedures were carried out after standard bowel preparation.

RESULTS

Characteristics of Patients and Polyps

The median polyp size was 30 mm with a range of 20-70 mm (mean 34±13 mm). Overall, 61% of polyps were giant polyps ≥30 mm. Most of the polyps had 0-Is (34%) or 0-IIa (47%) morphology. The predominant site of polyp development was the ascending colon (36%). Serrated polyps accounted for 16% of polyps. In total, 20% of polyps showed high-grade intraepithelial neoplasia (IEN), and 8% included pT1 carcinoma. Of the 26 conventional adenomas with 0-IIa non-granular morphology three included pT1 carcinoma (11.5%). Of the six 0-IIa + 0-Is lesions three showed high-grade IEN (50%) and two (33.3%) were carcinomas with deep submucosal invasion. Table I provides the complete characteristics of patients and polyps; data are presented separately for the polyps 1-50 and 51-100. Fig. 1 shows representative images of four polyps before and after resection.

Need for Surgery

In the described 6-year period, endoscopic resection was not attempted in only one patient with a benign polyp, and the patient was primarily sent for surgical resection. This was a 50-year-old male patient with a circular 0-IIb polyp spanning about 8cm.

Surgery for not completely removable adenomas was necessary in two patients (one in the first and second half of patients, respectively). One was a 60 mm 0-Is+IIa lesion with high-grade IEN and a non-lift region, and the other one was a sessile lumen-occluding 70 mm polyp originating from the ileocecal region with high-grade IEN and repeated recurrence behind the ileocecal valve.

There were eight patients with pT1 carcinoma. One patient with deep submucosal invasion was sent for surgery because of endoscopically visible tumour remnants. Five patients underwent surgery because of lymphovascular invasion (n=2), deep submucosal invasion ≥sm2 (n=2), or poor tumour differentiation (n=1). Except for the patient with endoscopically visible tumour remnants, no residual disease or lymph node metastases were observed in surgical specimens. One patient with a poorly differentiated tumour (no residual tumour in an endoscopic control after 4 months) and one with deep invasion (no control) refused surgery.

Complications

Intraprocedural bleeding events occurred in 21% of patients [6 acetylsalicylic acid (ASS), 2 direct oral anticoagulants (DOAK), 1 cirrhosis and the remaining without blood thinning medicine or impaired coagulation]. Only one was a severe spurting bleeding, whereas the majority were mild oozing bleeding events. None of the patients experienced a clinically significant drop of red blood cell count. Endoscopic bleeding control using coagulation or clips was possible in all cases. Significant post-procedural bleeding (median drop of red blood cell count of 3 mg/dl) with need for prolonged

Table I. Characteristics of resected polyps

	0-50	51-100	Total
Gender (m/f)	26/24	33/17	59/41
Age (median/range)	69 (30-85)	68 (40-85)	68 (30-85)
Polyp size (median/range)	33 (20-70)	30 (20-70)	30 (20-70)
20-29mm	17	22	39
≥ 30mm	33	28	61
Additional features			
ICV involvement/ periappendiceal	8	3	11
Supra-anal localization	2	2	4
Lumen occluding polyp	1	4	5
Clam shell morphology	14	17	31
Previous treatment attempt	3	1	4
>1/3 circumference involved	4	4	8
> 2 mucosal folds involved	13	5	18
Paris classification			
0-Is	15	17	32
0-IIa granular	10	3	13
0-IIa non-granular	18	16	34
0-IIb	2	9	11
0-Is + 0-IIa	3	3	6
0-IIa + 0-IIc	2	2	4
Localization			
Cecum	13	7	20
Ascending colon	15	21	36
Transverse colon	4	2	6
Descending colon	2	6	8
Sigmoid colon	5	5	10
Rectum	11	9	20
Histopathology			
Cancer	3	5	8
Tubulovillous HGIN	9	7	16
Tubulovillous LGIEN	17	11	28
Tubular LGIEN	15	12	27
Tubular HGIEN	0	4	4
Serrated polyp (SSA,TSA)	5	11	16
Colitis associated dysplasia	1		1

ICV: ileocecal valve; HGIEN: high-grade intraepithelial neoplasia; LGIEN: low-grade intraepithelial neoplasia; SSA: sessile serrated adenoma, TSA: traditional serrated adenoma.

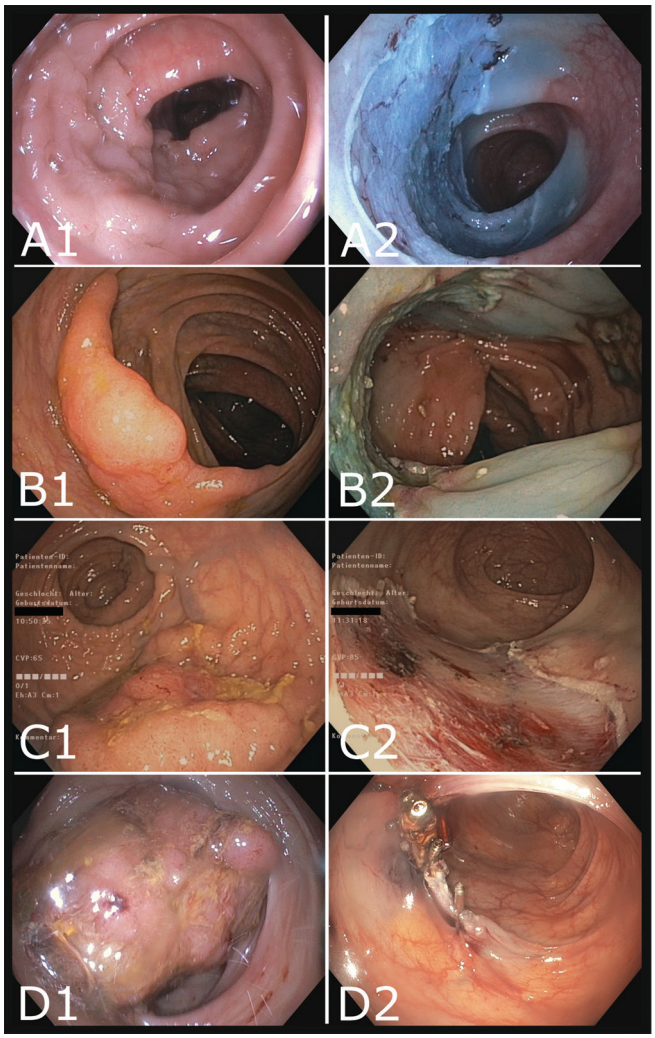

Fig. 1. Representative polyp images. Image pairs before (1) and after resection (2) of four polyps are shown. A: Patient 78; semicircular 70 mm, 0-IIa non-granular polyp spanning 3 mucosal folds, tubular adenoma low-grade intraepithelial neoplasia; B: Patient 28; clam-shell 35mm, 0-IIa non-granular, pTis G3; C: Patient 38; supra-anal 55mm, 0-IIa/Is, tradional serrated adenoma low-grade intraepithelial neoplasia; D: Patient 68; lumen filling 60mm, 0-Is, tubulovillous adenoma high-grade intraepithelial neoplasia.

hospital stay (n=1) or re-admission (n=3) was observed in 4% of patients. All of them were managed endoscopically, and only one patient needed blood transfusion. Re-bleeding events occurred at days 1 (60 mm 0-Is, sigmoid colon; ASS), 5 (30 mm, 0-IIa/Is, ascending colon; DOAK), 8 (30 mm, 0-IIa/Is, ascending colon; DOAK), and 9 (60 mm, 0-Is, descending colon; ASS).

Deep mural injury was detected during endoscopy in three patients (scarred tissue because of previous treatment or ulcerative colitis in one case each and not completely removable adenoma with high-grade IEN in another case). All of them were type IV injuries less than 5mm in size and immediately managed using through-the-scope (TTS) clips without need for surgery. Endoscopic procedures were completed after clip closure. Post-polypectomy electrocoagulation syndrome occurred in five patients. Table II summarizes outcome parameters and complications. Fig. 2 shows representative images for intraprocedural (panel A) and postprocedural (panel B) bleeding, deep mural injury (panel C), and adenoma recurrence (C4).

Outcome

For patients with expected complete initial piecemeal resection of polyps (n=80), endoscopic follow-up data were available in 79% of cases (n=63). Residual adenomatous tissue was observed in 13 cases (21%). In 12 of 13 cases, mostly small remnants were removed completely by endoscopic resection.

Table II. Endoscopic procedure characteristics, outcome and complications

	0-50	51-100	Total
En-bloc resection, n (%)	5 (10)	11 (22)	16 (32)
Duration of hospital stay (days), median (range)	1 (1-7)	1 (0-7)	1 (0-7)
Prophylactic clip closure, n (%)	14 (28)	15 (30)	29 (29)
Intra-procedural bleeding, n (%)	10 (20)	12 (24)	22 (22)
Mild oozing bleeding	10	10	20
Severe spurting bleeding	0	1	1
Through-the-scope clip	11	8	19
Coagulation	11	16	27
Post-procedural bleeding, n (%)	1 (2)	3 (6)	4 (4)
Post-polypectomy syndrome, n (%)	3 (6)	2 (4)	5 (5)
Deep mural injury, n (%)	2 (4)	1 (2)	3 (3)
Endoscopic clip closure	4 (100)	1 (100)	5 (100)
Piecemeal resection (follow-up indication)	42	38	80
Follow-up endoscopy performed, n (%)	38 (90)	25 (66)	63 (79)
Adenoma recurrence or remnants, n (%)	5 (13)	8 (32)	13 (21)
Endoscopic resection recurrence/remnants, n (%)	5 (100)	7 (88)	
Surgery n (%)	4 (8)	5 (10)	9 (9)
Carcinoma	2 (4)	4 (8)	6 (6)
Not resectable adenoma	1 (2)	1 (2)	2 (2)
Confirmed complete endoscopic resection			
Adenomas and carcinomas, n (%)	45/46 (98)	34/36 (94)	79/82 (96)
Adenomas and carcinomas, n (%)	42/43 (98)	31/32 (97)	73/75 (97)

Results are given as absolute number or median (range).

A single patient underwent surgery because of repeated recurrence.

For the whole dataset, any information on resection completeness (histologically confirmed en-bloc resection, follow-up endoscopy after initial piecemeal-resection or resection of remnants, histopathology of surgical specimens) was available for 82 polyps. Of these polyps, complete endoscopic resection was confirmed in 96% (n=79).

There were no statistically significant differences ($p>0.05$; Fisher exact test) for outcome parameters (bleeding events, perforation, completeness of resection) between polyps 1-50 and 51-100.

DISCUSSION

Due to its high efficacy, lower adverse events, and lower costs, EMR has become the standard procedure for the management of complex non-pedunculated polyps and can avoid the need for surgery in most patients [3]. However, there is a limited number of endoscopists who can appropriately manage complex polyps [9], so that there is a need for centralisation of such procedures [3]. Consequently, published data on outcome of EMR of large non-pedunculated polyps mostly come from high-volume centres. On the other hand, the centralisation of EMR skills poses the risk of referral to the local surgeon instead of admission to an EMR expert elsewhere. To the best of our knowledge, this is the first paper reporting outcome parameters during the learning curve of EMR without procedures being supervised by an experienced EMR specialist outside a referral centre. There is only one other report presenting outcomes in a newly established EMR service [5]. Specific training programs to gain experience in EMR of complex polyps will be easy to implement in specialized centres with a high caseload and the opportunity to attend a relevant number of procedures [7].

Adenoma recurrence of 10-20% must be expected in high volume centers [10, 11]. In our series, the recurrence rate after expected complete initial piecemeal resection was 21%. All but one recurrent adenomas were managed endoscopically. In experienced hands EMR for lesions ≥20 mm is technically successful in >95% of cases, and surgery can be avoided in >90% [12]. In our cohort, initial complete polyp removal was expected in 97% of polyps. For the patients with reliable information on resection completeness (n=82), complete endoscopic resection was confirmed in 96% of cases (n=79). Surgery could be avoided in 91% of patients in the whole cohort and in 98% of non-malignant polyps. Thus, the overall procedure effectiveness was at least as high as reported by specialized referral centers [13]. However, it can be speculated that the difficulty of resections (e.g., higher rate of pre-treated polyps, more features defining complex polyps) might be higher in these selected centers. In order to reduce the recurrence rate and the need for surgery due to incomplete resection it could be proposed to send patients with polyps with a high risk for incomplete resection (e.g. previous treatment attempt or involvement of more than 1/3 of circumference) to expert centers during the initial period (e.g. first 100 polyps). According to current guidelines endoscopic submucosal

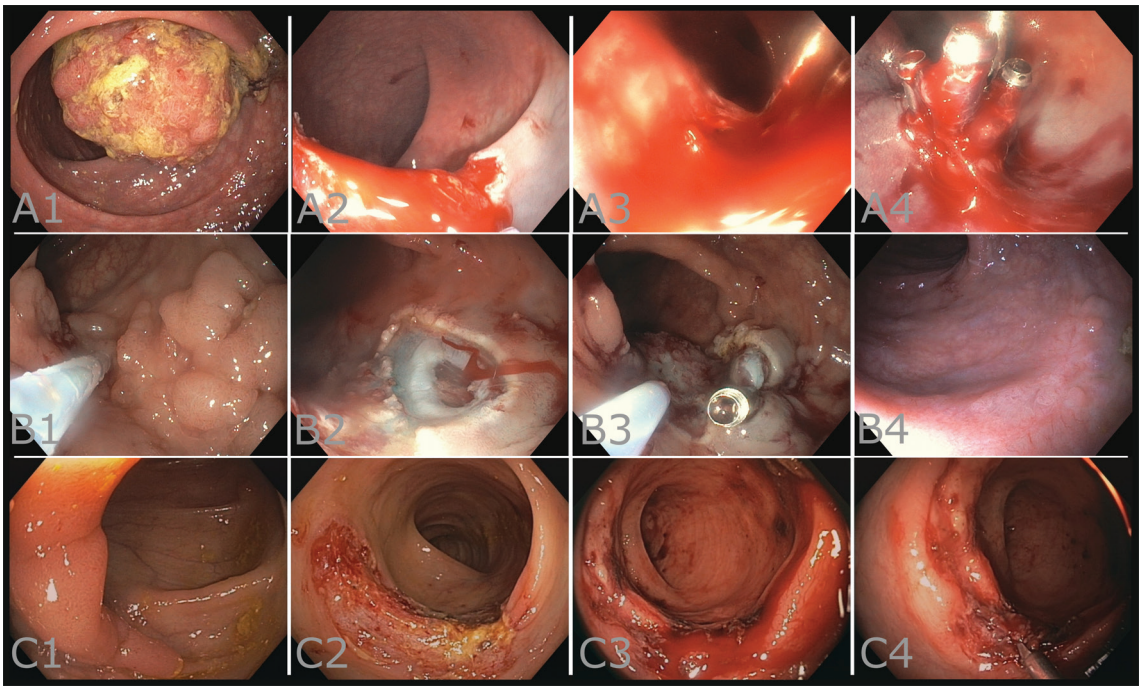

Fig. 2. Complications of endoscopic mucosal resection of large polyps. A: Patient 73: intraprocedural spurting bleeding (2, 3) after resection of a 60mm 0-Is polyp (1, tubulovillous adenoma low-grade intraepithelial neoplasia) with bleeding control using TTS clips (4). B: Patient 86: deep mural injury (2) after resection of a 40mm recurrent 0-IIa polyp (1). Resection was completed after clip-closure (3). Small remnants (4) were completely removed in a control colonoscopy. C: Patient 42: postprocedural bleeding (3) after resection of a 30 mm clam-shell 0-IIa polyp (1, 2) on day 5 under DOAK with bleeding control using TTS clips. DOAK: direct oral anticoagulants; TTS: through-the-scope.

dissection (ESD) should be considered for en-bloc resection of polyps larger than 20mm with suspicion of limited submucosal invasion (demarcated depressed area with irregular surface pattern or a large protruding or bulky component) [14], especially for rectal polyps. Interestingly, in our series surgery would have been indicated even after resection of the malignant polyps (n=8) by ESD due to deep submucosal invasion, poor tumor differentiation or lymphovascular invasion.

Deep mural injury was observed and treated in 3% of patients. There was no need for surgery, and no additional complications occurred. This is in the range of the reported 2-3% deep mural injuries in other cohorts [10, 15]. Postpolypectomy electrocoagulation syndrome was detected in 5% of patients, and a frequency of up to 7% has been reported in the literature, depending on polyp size [16].

In our series, intra-procedural bleeding was observed in 21% of patients. All bleeding events could be managed endoscopically by coagulation and/or clip closure. Nevertheless, the intraprocedural bleeding rate was substantially higher than described in the literature (about 11%) [10]. Antiplatelet agents were not stopped in our study even when large polyps were removed, maybe in part explaining the relatively high bleeding rate. Moreover, we here consequently counted every bleeding occurring during initial EMR irrespective of clinical significance as adverse event. The more clinically relevant post-procedural bleedings resulting in readmission or longer hospital stay were observed in 4% of patients only. This frequency is comparable with or lower than in previous studies [10, 17]. The main limitations of our study are its retrospective nature, the limited study population and the single operator design.

Interestingly, the results for the first 50 polyps did not differ from results for the following polyps, and even for the first 20 polyps outcome parameters were acceptable (one deep mural injury, 13% recurrence rate, one patient referred to surgery for non-resectable adenoma). In previous studies it was expected that between 60 and 100 EMRs were needed to achieve a plateau for relevant outcomes [6, 7]. However, our data indicate that acceptable results can be achieved earlier, and learning curves, even for relatively complex procedures, may vary interindividual. Since this is a single operator study, our results must be reproduced in further studies. Structured training and supervised procedures are advisable to acquire EMR skills, but outside specialized high-volume centers this is not always possible and learning curves have to be generated for individual endoscopists.

CONCLUSIONS

Our data show that the self-taught acquisition of skills after participating a training course including theoretical and practical training can be an acceptable alternative in the setting of a well-organized unit with open error culture and a multidisciplinary team for complication management. A continuous and unconcealed review of outcome parameters and complication rate prevents an unfavorable outcome for patients during learning process.

Conflicts of interest: None to declare.

Authors' contribution: M.C. performed the endoscopies, managed the patients clinically, collected data, drafted the manuscript. M.K. and F.L.

supervised the clinical management of patients and critically revised the manuscript. All authors approved the final version of the paper.

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