Long-Term Outcome and Surveillance Colonoscopy after Successful Endoscopic Treatment of Large Sessile Colorectal Polyps

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Purpose: Although there is a consensus about the need for surveillance colonoscopy after endoscopic resection, the interval remains controversial for large sessile colorectal polyps. The aim of this study was to evaluate the long-term outcome and the adequate surveillance colonoscopy interval required for sessile and flat colorectal polyps larger than 20 mm.

Materials and Methods: A total of 204 patients with large sessile and flat polyps who received endoscopic treatment from May 2005 to November 2011 in a tertiary referral center were included.

Results: The mean age was 65.1 years and 62.7% of the patients were male. The mean follow-up duration was 44.2 months and the median tumor size was 25 mm. One hundred and ten patients (53.9%) received a short interval surveillance colonoscopy (median interval of 6.3 months with range of 1–11 months) and 94 patients (46.1%) received a long interval surveillance colonoscopy (median interval of 13.6 months with range of 12–66 months). There were 14 patients (6.9%) who had local recurrence at the surveillance colonoscopy. Using multivariate regression analysis, a polyp size greater than 40 mm was shown to be independent risk factor for local recurrence. However, piecemeal resection and surveillance colonoscopy interval did not significantly influence local recurrence.

Conclusion: Endoscopic treatment of large sessile colorectal polyps shows a favorable long-term outcome. Further prospective study is mandatory to define an adequate interval of surveillance colonoscopy.

Key Words: Colorectal neoplasm, gastrointestinal endoscopy, colonoscopy

INTRODUCTION

Endoscopic mucosal resection (EMR) is regarded as a safe and effective treatment for large sessile colorectal polyps (20 mm or more),[1] nevertheless, it remains challenging because of techni-

cal difficulties, the high risk of complications, and the potential of coexisting malignancies or local recurrence following the procedure.[2-5] A recent multicenter study showed favorable outcome success rate of 89.2% for a single session EMR; complications were observed in 7.7% of cases, including post-procedure pain in 2.1%, serositis in 1.5%, bleeding in 2.9% of patients, and perforation in 1.3% of patients.[6]

Regardless of the EMR technical advances, which have resulted in these favorable results, the long-term outcomes have not been elucidated, especially for large sessile colorectal polyps. The large colorectal polyp local recurrence rate following EMR has been reported to be between 5% and 45%,[2,3,7] although it is difficult to compare the results from these different studies because of a wide variation in the polyp size, EMR method, and follow-up interval. A recent multicenter study reported a 20.4% of local recurrence or residual tumor presence detected using

surveillance colonoscopy.[6] In regard to the technical aspects of resection, en bloc resection of lesions is recommended because it allows for a more accurate histological assessment and reduces the risk of local recurrence.[8,9] However, in cases where difficult locations or large polyp sizes prevent en bloc resection, endoscopic piecemeal mucosal resection (EPMR) is recommended.[10] EPMR is regarded as a significant risk factor for local recurrence, especially in cases where 5 or more neoplasm specimens are removed.[11] Thus, in cases of EPMR, short interval follow-up colonoscopy is recommended, irrespective of the tumor size or macroscopic features.[11]

According to several current guidelines,[12-15] a repeat colonoscopy is recommended after a short interval (2–6 months) because of high rate of local recurrence and residual tumor presence, especially in patients with large sessile adenomas removed by piecemeal resection. However, this advice is based on expert opinion; there is no definitive evidence for short interval colonoscopy in such high-risk adenoma cases. Therefore, a consensus needs to be reached regarding the best surveillance colonoscopy interval following EMR for large sessile colorectal polyps. The aim of this study was to evaluate the long-term outcomes and elucidate the best surveillance colonoscopy interval following EMR of large sessile colorectal polyps.

MATERIALS AND METHODS

Patients and study protocol

Our colonoscopy cohort included 331 consecutive patients who received endoscopic treatment for colorectal polyps larger than 20 mm from May 2005 to November 2011 at Yonsei University College of Medicine, Seoul, Korea. Patients were included if the following polyp criteria were met: 1) sessile polyp (defined as a lesion in which the base is attached to the colon wall) or flat polyp (defined as a lesion with a thickness less than half of the maximum width); 2) equal to or greater than 20 mm in size; and 3) adenoma, carcinoma *in situ*, or intramucosal cancer indicated in the final pathological report following endoscopic resection.[16] We excluded patients with colorectal tumors with stalks, colorectal cancers, carcinoids, a non-neoplastic histology, or patients without a follow-up colonoscopy. Among the 331 consecutive patients, a total of 127 patients were excluded for the following reasons: pedunculated type (n=28), colorectal cancer (n=73), carcinoid (n=5), non-neoplastic histology (n=4), and no record of follow-up colonoscopy (n=17). Finally, 204 patients with sessile and flat-type colorectal polyps larger than 20 mm were included in the study (Fig. 1). Clinical, endoscopic, and demographic data were extracted from computerized clinical information system and reviewed retrospectively. The study was approved by the Institutional Review Board of our hospital. All study procedures were conducted in accordance with the International Conference on Harmonisation Good Clinical Practices and the Declaration of Helsinki and its amendments.

Procedures

Colonoscopies were performed after bowel preparation with 4 L polyethylene glycol solution (Colyte; Taejun, Seoul, Korea or Colyte-F or Colonlyte; Dreampharma, Seoul, Korea), by using a single-channel high definition colonoscope (CF Q240L, CF Q240I, CF H260AI, CF Q260AI, or PCF Q260AI; Olympus Optical Co., Tokyo, Japan) and a high-frequency generator with an automatically controlled system (VIO300; ERBE Elektromedizin GmbH, Tubingen, Germany). A translucent cap (D-201-13404 or D-201-14304; Olympus, Optical Co., Ltd., Tokyo, Japan) was mounted on the tip of the colonoscope to control the depth of the mucosal incision and to maintain a satisfactory view during the submucosal dissection.[17] Procedures were performed with a patient in a left lateral position under monitored anesthesia sedation. All procedures were performed by 4 experienced gastroenterologists. The endoscopic treatments, including EMR or endoscopic submucosal dissection (ESD), were decided according to the characteristics of the lesion and the preference of operators. EMR was performed using a snare after injecting a solution (normal saline, indigo carmine 0.04%, with or without 1:100000 dilution of epinephrine) into the submucosa.[18] Sequential submucosal injection and snare polypectomies were performed for tumor remnants.[11] For EMR or snare polypectomies, RotaSnare® (Oval shape, 15/25/35 mm sized; manufactured by Medi-Globe GmbH) was used. ESD was performed with a flex knife (Flex Knife; KD-630L, Olympus, Optical Co., Ltd.) or a dual knife (Dual Knife; KD-650L, Olympus, Optical Co., Ltd.). After spraying and injecting 0.4% indigo carmine dye solution into the submucosa beneath the lesion, a circumferential incision was made with a flex knife set to approximately 2 mm in length. After an additional injection beneath the lesion, the submucosal layer was dissected directly using the flex knife set to approximately 1 mm in length or the dual knife[19] to lift it away from the muscularis propria sufficiently. If a residual lesion was detected endoscopically, additional EMR was performed. Resections were defined as follows; en bloc resection was a single piece resection and piecemeal resection was a multiple fragment resection.[20] We did not routinely apply argon plasma coagulation or hot biopsy when the post-procedure site was clean. We applied hot biopsy only when the remnant lesion was suspected endoscopically.

Pathological evaluation

Specimens were collected using a basket or by aspiration into the suction channel. For the retrieval of entire sessile polyps located in the right colon, the colonoscope was withdrawn and reinserted as many times as necessary. All specimens were cut into 2–2.5 mm slices and examined microscopically for differentiation, lymphatic invasion, vascular involvement, depth of invasion, the lateral (mucosal) resection margin, and the basal (submucosal) resection margin. The extension of tumor cells to the resected margin was evaluated and graded as complete resection when the lateral and basal resection margins were free

of tumor (en bloc resection is essential), incomplete resection when the tumor extended into the lateral or basal margins, or not evaluable when the margins were not evaluable as a result of the artificial effects of coagulation necrosis or multipiece resection.[21] We defined negative margin involvement as instances where both lateral mucosal margins of a specimen were free of neoplastic cells. All tumors had negative basal margins. Furthermore, 2 grades of dysplasia (high and low) were recognized. The terms "carcinoma *in situ*" and "intramucosal adenocarcinoma" were both described as high-grade dysplasia.[22]

Definition and follow-up

Right-sided colon tumors were defined as those arising from the cecum to the transverse colon. Left-sided colon tumors were defined as those arising from the splenic flexure down to and including the rectosigmoid junction. Rectal tumors were defined as those arising distal to the rectosigmoid junction down to the anus (excluding squamous cell carcinoma).[23,24]

Postprocedural bleeding (PPB) was divided into immediate PPB (IPPB) and delayed (DPPB). IPPB was defined as bleeding observed immediately after polypectomy and required hemostatic procedures because the bleeding continued for over 60 s. DPPB was defined as bleeding that occurred at the polypectomy site within 30 days of the procedure and required hospitalization or treatment.[25] Other delayed adverse events of each patients were collected at the out-paitent clinics.

Patients were followed-up with colonoscopy to evaluate recurrence and residual tumor presence. The interval of surveillance colonoscopy was decided according to the previous guidelines[26] and recommendations of our institution. Prior to 2009,

however, surveillance colonoscopy was usually recommended after a short interval of less than 12 months. After 2009, surveillance colonoscopy was recommended 12 months after initial treatment, even in cases of piecemeal resection or ESD. If a polyp was detected in follow-up examinations, it was resected if possible. Local recurrence was defined as the presence of adenomatous or carcinomatous tissue on follow-up, confirmed by histology, at the site of prior endoscopic treatment.[27] When the local recurrence was suspected, endoscopical mucosal resection was initially tried. If endoscopical treatment was not sufficient, additional surgical treatment was applied.

Statistical analysis

Descriptive statistics are provided for the binary and continuous variables using the incidence frequency (%) and mean±standard deviation [or median (and range) values]. The chi-square test and Fisher's exact test were used to compare binary variables, and the two-sample t-test was used to compare continuous variables. Multivariate logistic regression analysis, adjusted by confounding factors, was performed to discern the contribution of variable factors to inter-group differences in local recurrence (no recurrence vs. recurrence). Two-sided p-values were calculated and significance was accepted at the 5% level. All of the statistical analyses were performed with Predictive Analytics SoftWare for Windows, version 18.0.0 (SPSS Inc., Chicago, IL, USA).
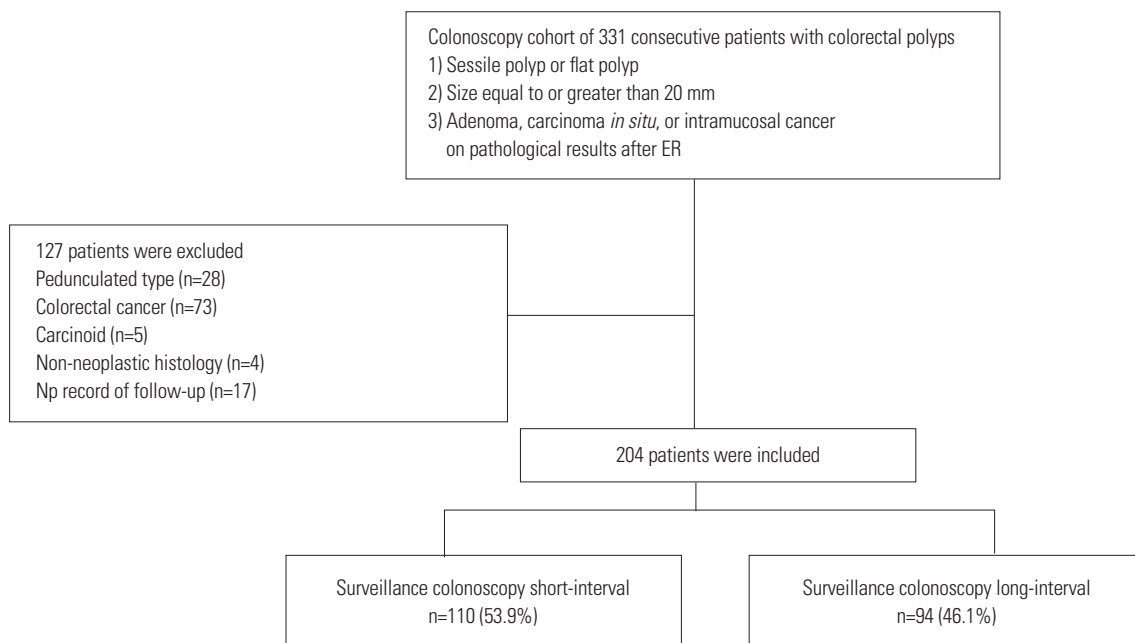
Fig. 1. Flow chart of patients throughout the study. We excluded colorectal tumors with stalks, colorectal cancers, carcinoids, tumors with a non-neoplastic histology, or patients without follow-up colonoscopy. Among the 331 consecutive patients, a total of 127 patients were excluded for the following reasons: pedunculated type (n=28), colorectal cancer (n=73), carcinoid (n=5), non-neoplastic histology (n=4), and no record of follow-up colonoscopy (n=17).

RESULTS

Patient characteristics and clinical outcomes at surveillance colonoscopy

The baseline clinical, endoscopic, and pathological characteristics are summarized in Table 1. Among the 204 patients, there were 128 (62.7%) men and the mean age was 65.1 years. The mean follow-up duration was 44.2±29.5 months. There were 144 flat (70.6%) and 60 sessile polyps (29.4%). The median tumor size was 25 mm. Among the 204 patients, 194 (95.1%) patients were treated with EMR and 10 patients (4.9%) were treated with ESD. The en bloc resection rate was 62.3%, and 77 patients (37.7%) received piecemeal resections. A negative resection margin was observed in 167 cases (81.9%), and 37 cases (18.1%) had a positive lateral margin. Low-grade dysplasia was observed in 100 cases (49%), and high-grade dysplasia was observed in 104 cases (51%). IPPB occurred in 65 patients (31.9%); 59 cases of these occurred during EMR and 6 occurred during ESD. All bleeding was successfully treated using endoscopic hemostasis. There was no case of DPPB. Perforations developed in 4 patients (2.0%); all of these patients were in the EMR group and were successfully treated with clipping.

The median surveillance colonoscopy interval was 9.4 months (1–66 months). A short interval surveillance colonoscopy, with a median of 6.3 months and range of 1–11 months, occurred in 110 patients (53.9%), and 94 patients (46.1%) received a long interval surveillance colonoscopy with a median of 13.6 months and range of 12–66 months. Piecemeal resection patients tended to receive short interval colonoscopies compared to en bloc resection patients (66.2% vs. 46.5%, respectively; $p=0.006$). There were no significant differences in the colonoscopy interval for patients with different treatment methods ($p=0.112$), margin statuses ($p=0.150$), or histologies ($p=0.068$).

During the surveillance colonoscopy, 14 local recurrences (6.9%) were detected. The mean follow-up duration was 47.6±25.3 months in 14 patients with recurrence and 43.9±29.9 months in 190 patients without recurrence ($p=0.606$). Further details of the patients with local recurrence are given in Table 2. Of the local recurrence patients, 7 were located on the right side of the colon. There were 4 patients with sessile-type and 10 patients with flat-type polyps. Three patients developed local recurrences even after an initial en bloc resection with negative resection margin. Mean time to recurrence was 28.4 months (22.7 months with range of 4–54 months in short surveillance interval group vs. 42.8 months with range of 12–82 months in long surveillance interval group, $p=0.240$). Mean size of recurrent lesion was 14.6 mm (11.7 mm in short surveillance interval group vs. 21.8 mm in long surveillance interval group, $p=0.054$). There were 11 patients who were successfully treated with a second endoscopic resection, and 3 patients received surgery.

Risk factors for local recurrence

The potential risk factors for local recurrence are shown in Ta-

ble 3. In addition, we also assessed the effect of the surveillance colonoscopy interval on local recurrence. Using multivariate analysis, a polyp size greater than 40 mm was shown to be a significant risk factor for the detection of local recurrence at surveillance colonoscopy [40–50 mm vs. 20–30 mm, odds ratio (OR) 14.22 with 95% confidence interval (CI) 2.10–96.17; $p=0.006$; >50 mm vs. 20–30 mm, OR 24.25 with 95% CI 3.32–176.88; $p=0.002$]. However, location, tumor morphology, the resection method,

Table 1. Baseline Characteristics of Enrolled Patients

Characteristics	n=204
Follow-up duration (months)	44.2±29.5
Age (yrs)	65.1±8.2
Sex (male)	128 (62.7%)
Morphology	
Flat	144 (70.6%)
Sessile	60 (29.4%)
Size (range, mm)	
20–29	131 (64.2%)
30–39	40 (19.6%)
40–49	21 (10.3%)
≥50	12 (5.9%)
Site	
Right side	95 (46.6%)
Left side	57 (27.9%)
Rectum	52 (25.5%)
Treatment method	
EMR	194 (95.1%)
ESD	10 (4.9%)
Resection	
En bloc	127 (62.3%)
Piecemeal	77 (37.7%)
Resection margin	
Negative	167 (81.9%)
Positive	37 (18.1%)
Histological grade	
LGD	100 (49.0%)
HGD	104 (51.0%)
Complication	
Perforation	4 (2.0%)
Bleeding	65 (31.9%)
Surveillance colonoscopy	
Short interval*	110 (53.9%)
Long interval†	94 (46.1%)
Local recurrence	
Negative	190 (93.1%)
Positive	14 (6.9%)

EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; LGD, low-grade dysplasia; HGD, high-grade dysplasia.
Categorical variables are presented as n (%) and continuous variables are presented as mean±standard deviation.
*Surveillance colonoscopy within 12 months, †Surveillance colonoscopy after 12 months.

Table 2. Characteristics of Surveillance-Detected Local Recurrences

	Age	Sex	Initial size (mm)	Initial location	Morphology	Resection	Resection margin	Initial histology and grade	Initial treatment method	1st endoscopic surveillance interval	Time to recurrence (month)	Recurrent lesion size (mm)	Recurrent histology and grade	Additional treatment methods
1	69	Male	20	Left (SC)	Flat	Piecemeal	Negative	TVA with HGD	EMR	Short	6	5	TA	Removal with biopsy forceps
2	50	Male	50	Right (cecum)	Sessile	En bloc	Negative	TVA with LGD	EMR	Short	11	5	TA	Removal with biopsy forceps
3	57	Male	40	Rectum	Flat	Piecemeal	Positive	CIS	EMR	Short	6	25	CIS	EMR
4	62	Male	70	Rectum	Flat	Piecemeal	Positive	TVA with HGD	EMR	Long	12	25	TVA with HGD	LAR
5	75	Male	25	Right (cecum)	Sessile	En bloc	Negative	CIS	EMR	Short	4	5	TA	Removal with biopsy forceps
6	58	Female	35	Right (AC)	Flat	Piecemeal	Negative	TA with LGD	EMR	Short	6	5	TA	Removal with biopsy forceps
7	67	Female	30	Right (TC)	Flat	En bloc	Negative	TA with LGD	EMR	Short	5	5	TA	Removal with biopsy forceps
8	58	Female	70	Right (AC)	Flat	En bloc	Positive	IM cancer	EMR	Short	29	9	TVA with LGD	Polypectomy
9	81	Female	40	Right (AC)	Flat	Piecemeal	Negative	TVA with HGD	ESD	Short	52	8	TA	EMR
10	70	Male	20	Right (cecum)	Sessile	Piecemeal	Negative	TA with LGD	EMR	Long	28	10	IS	RHC
11	45	Female	33	Rectum	Sessile	En bloc	Positive	TA with HGD	EMR	Long	82	12	TA with HGD	EMR
12	63	Female	60	Right (cecum)	Flat	Piecemeal	Positive	TVA with HGD	EMR	Short	54	10	TA	EMR
13	52	Male	60	Left (RSJ)	Flat	Piecemeal	Positive	TVA with HGD	EMR	Short	54	40	TVA with HGD	ESD
14	54	Female	30	Left (SC)	Sessile	Piecemeal	Positive	CIS	EMR	Long	49	40	IS	LAR

TVA, tubulovillous; HGD, high grade dysplasia; CIS, carcinoma *in situ*; IM, intramucosal cancer; TA, tubular adenoma; LGD, low grade dysplasia; IS, invasive adenocarcinoma; EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; SC, sigmoid colon; AC, ascending colon; TC, transverse colon; LAR, low anterior resection; RHC, right hemicolectomy; RSJ, rectosigmoid junction.

resection status, margin status, and tumor grade were not associated with local recurrence. Furthermore, the surveillance colonoscopy interval had no effect on the rate of local recurrence.

DISCUSSION

The present study has shown that the endoscopic resection of large flat and sessile colorectal polyps generally has a favorable outcome with 6.9% of local recurrence. Polyp larger than 40 mm was an independent risk factor for local recurrence.

EMR is an effective and safe method for the treatment of various colorectal neoplasms.[28] Recently, EMR has become the preferred treatment method for large colorectal polyps around the world. This might be due to the favorable outcomes of EMR and low complication rates which have previously been reported. A recent large prospective study of 799 EMR-treated colorectal lesions larger than 20 mm indicated that 98.8% of patients were adenoma-free and did not require surgery 16 months after successful EMR.[29] The major complication rates were reported as 5.1–7.9%.[6,30,31] Another recent study reported a 7.9% major complication rate, with 6.3% rate of major bleeding and 1.6% rate of perforation.[30] Most bleeding is intra-procedural minor bleeding and is easily managed by endoscopic hemostasis. Although perforation is a serious complication and sometimes requires surgical management, it can be successfully treated with

Table 3. Univariate and Multivariate Regression Analysis of the Factors Associated with Local Recurrence

	No recurrence (n=190), n (%)	Recurrence (n=14), n (%)	Univariate p value	Multivariate Odds ratio (95% CI)	p value
Age [median (range), yrs]	65 (44–82)	60 (45–81)	0.184	0.97 (0.90–1.05)	0.490
Sex			0.392		0.608
Male	121 (63.7)	7 (50.0)		1	
Female	69 (36.3)	7 (50.0)		1.39 (0.39–4.97)	
Size (mm)			0.001		
20–29	128 (67.4)	3 (21.4)		1	
30–39	36 (18.9)	4 (28.6)		5.22 (0.99–27.46)	0.051
40–49	18 (9.5)	3 (21.4)		14.22 (2.10–96.17)	0.006
≥50	8 (4.2)	4 (28.6)		24.25 (3.32–176.88)	0.002
Site*			0.773		
Right	87 (45.8)	8 (57.1)		1	
Left	54 (28.4)	3 (21.4)		0.32 (0.07–1.54)	0.155
Rectum	49 (25.8)	3 (21.4)		0.29 (0.51–1.66)	0.165
Morphology			1.000		0.708
Flat	134 (70.5)	10 (71.4)		1	
Sessile	56 (29.5)	4 (28.6)		1.32 (0.31–5.58)	
Method			0.517		0.544
EMR	181 (95.3)	13 (92.9)		1	
ESD	9 (4.7)	1 (7.1)		2.14 (0.18–24.74)	
Resection			0.395		0.423
En bloc	120 (63.2)	7 (50.0)		1	
Piecemeal	70 (36.8)	7 (50.0)		1.70 (0.46–6.27)	
Margin			0.289		0.373
Negative	157 (82.6)	10 (71.4)		1	
Positive	33 (17.4)	4 (28.6)		2.01 (0.43–9.34)	
Grade			0.588		0.840
LGD	92 (48.4)	8 (57.1)		1	
HGD	98 (51.6)	6 (42.9)		0.86 (0.20–3.68)	
Interval†			0.266		0.213
Short	100 (52.6)	10 (71.4)		1	
Long	90 (47.4)	4 (28.6)		0.42 (0.11–1.65)	

EMR, endoscopic mucosal resection; ESD, endoscopic submucosal dissection; LGD, low-grade dysplasia; HGD, high grade dysplasia; CI, confidence interval.
*Right-sided colon adenomas were defined as those arising from the cecum to the transverse colon. Left-sided colon adenomas were defined as those arising from the splenic flexure down to and including the rectosigmoid junction. Rectal adenomas were defined as those arising distal to the rectosigmoid junction and down to the anus, †Interval refers to the period between the baseline colonoscopy with endoscopic resection and the first surveillance colonoscopy.

clipping if it is detected during the procedure. In the present study, perforations were detected in 4 patients during the procedure, and these were managed with clipping and medical treatment, thus avoiding surgery. Thus, some operator experience is necessary in order to achieve favorable EMR outcomes with large colorectal polyps, and this can be related to the surveillance colonoscopy interval in practice.

Generally, the recommended adequate surveillance colonoscopy interval is based on the risk of metachronous neoplasms, as predicted by the clinical and histological findings of the index colonoscopy.[26,32,33] However, for large colorectal polyps, the surveillance colonoscopy interval is decided according to the risk of tumor remnants or recurrence. The local recurrence rate after EMR has been reported, ranging from 5% to 45%.[2,3,7] The risk of tumor remnants or recurrence is strongly related to technical factors, such as en bloc resection, the therapeutic method, and the endoscopist's experience.[34-37] The en bloc resection rate is reported to be 40−70% for large colorectal polyps.[2,9,17] Previous studies have shown that the local recurrence rate after piecemeal resection is significantly higher than en bloc resection, irrespective of the tumor size or macroscopic features.[38] Several current guidelines, recommended a repeat colonoscopy after a short interval (2−6 months) in large sessile and flat colorectal polyps treated with en bloc resection because of the difficulty of complete removal.[12-15] In view of this, some authors preferentially recommend ESD to achieve en bloc resection. In a large prospective cohort study, Saito, et al.[39] recently demonstrated that ESD is a feasible technique for treating large superficial colorectal tumors because it provides a higher en bloc resection rate. In this study, a total of 145 lesions were treated with ESD and 228 lesions treated with conventional EMR; there were only 3 cases (2%) of local recurrence in the ESD group, but 14% local recurrence in the EMR group. It is evident that ESD achieved a higher en bloc resection rate than EMR.[7] However, ESD needs more operator experience and has a higher complication rate than EMR.[7] Thus, ESD cannot be simply applied at primary hospitals treating large colorectal polyps. Furthermore, the present study showed that proper endoscopic treatments, including piecemeal resections, can achieve low rates of local recurrence.

In our study, among the 4 recurred cases in the long interval surveillance colonoscopy group, 3 (75.0%) patients underwent salvage surgeries, possibly implying a possibility that the recurrent lesions were not detected early enough for endoscopic salvage treatment. However, among the 4 recurred cases, only 2 cases were detected in the 1st surveillance colonoscopy. There were several studies to imply that a short surveillance colonoscopy interval could miss tumor local recurrence because of limited regrowth time. In a study from Japan, 572 colorectal tumors were followed-up 3 and 6 months after endoscopic resection, and 28 of the 34 lesions with local recurrence were detected at the first follow-up colonoscopy, while the remaining 6 lesions were detected at the second or a subsequent colonos-

copy.[38] A recent study with follow-up colonoscopy at 3−6 months and 12 months showed a 16.4% rate of late recurrence detection.[30] The residual or recurred tumors were treated effectively at follow-up colonoscopy. Thus, it seems reasonable to extend the surveillance colonoscopy interval up to 12 months to allow time for regrowth and reduce the colonoscopy burden. In the present study, among 14 recurred patients, 6 cases (42.9%) were detected in the 2nd or 3rd colonoscopy. Therefore, the interval of a second or third surveillance would also be very important to detect recurred lesions. Consequently, a study of the adequate follow-up interval for the 2nd or 3rd surveillance colonoscopy seems to be mandatory.

The limitations of our study include its retrospective design, and that a number of the practitioners were subject to potential bias. The limited sample size also hindered additional analyses of major interest, such as a finer stratification of the time since endoscopic resection and the separate classification of polyps by individual prognostic factors, such as the number of synchronous lesions and morphological type (e.g., granular or non-granular type laterally spreading tumors), all of which have been found to be strongly related to adenomatous or carcinomatous recurrence after endoscopic resection. A finer stratification of both the time interval and lesion type would be highly desirable so that a clearer safe surveillance period could be delineated for different types of polyp. Another drawback of this study is the single-center study design, which may limit the application of our results to general colonoscopy practice settings. Therefore, further multicenter long term studies are needed in order to confirm our findings.

In conclusion, endoscopic treatment is safe and effective with a favorable long-term outcome for large sessile and flat colorectal polyps. Further prospective study is mandatory to define an adequate interval of surveillance colonoscopy.

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REFERENCES

1. Luigiano C, Consolo P, Scaffidi MG, Strangio G, Giacobbe G, Alibrandi A, et al. Endoscopic mucosal resection for large and giant sessile and flat colorectal polyps: a single-center experience with long-term follow-up. Endoscopy 2009;41:829-35.
2. Conio M, Repici A, Demarquay JF, Blanchi S, Dumas R, Filiberti R. EMR of large sessile colorectal polyps. Gastrointest Endosc 2004;60:234-41.
3. Fukami N, Lee JH. Endoscopic treatment of large sessile and flat colorectal lesions. Curr Opin Gastroenterol 2006;22:54-9.
4. Brooker JC, Saunders BP, Shah SG, Thapar CJ, Suzuki N, Williams CB. Treatment with argon plasma coagulation reduces recurrence after piecemeal resection of large sessile colonic polyps: a randomized trial and recommendations. Gastrointest Endosc 2002;55:371-5.
5. Jang HW, Park SJ, Cheon JH, Kim TI, Kim WH, Hong SP. Does

magnifying narrow-band imaging or magnifying chromoendoscopy help experienced endoscopists assess invasion depth of large sessile and flat polyps? Dig Dis Sci 2014;59:1520-8.

6. Moss A, Bourke MJ, Williams SJ, Hourigan LF, Brown G, Tam W, et al. Endoscopic mucosal resection outcomes and prediction of submucosal cancer from advanced colonic mucosal neoplasia. Gastroenterology 2011;140:1909-18.

7. Tajika M, Niwa Y, Bhatia V, Kondo S, Tanaka T, Mizuno N, et al. Comparison of endoscopic submucosal dissection and endoscopic mucosal resection for large colorectal tumors. Eur J Gastroenterol Hepatol 2011;23:1042-9.

8. Kobayashi N, Saito Y, Uraoka T, Matsuda T, Suzuki H, Fujii T. Treatment strategy for laterally spreading tumors in Japan: before and after the introduction of endoscopic submucosal dissection. J Gastroenterol Hepatol 2009;24:1387-92.

9. Lee EJ, Lee JB, Lee SH, Youk EG. Endoscopic treatment of large colorectal tumors: comparison of endoscopic mucosal resection, endoscopic mucosal resection-precutting, and endoscopic submucosal dissection. Surg Endosc 2012;26:2220-30.

10. Katsinelos P, Kountouras J, Paroutoglou G, Zavos C, Rizos C, Beltsis A. Endoscopic mucosal resection of large sessile colorectal polyps with submucosal injection of hypertonic 50 percent dextrose-epinephrine solution. Dis Colon Rectum 2006;49:1384-92.

11. Sakamoto T, Matsuda T, Otake Y, Nakajima T, Saito Y. Predictive factors of local recurrence after endoscopic piecemeal mucosal resection. J Gastroenterol 2012;47:635-40.

12. Winawer SJ, Zauber AG, Fletcher RH, Stillman JS, O'Brien MJ, Levin B, et al. Guidelines for colonoscopy surveillance after polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer and the American Cancer Society. Gastroenterology 2006;130:1872-85.

13. Bond JH. Polyp guideline: diagnosis, treatment, and surveillance for patients with colorectal polyps. Practice Parameters Committee of the American College of Gastroenterology. Am J Gastroenterol 2000;95:3053-63.

14. Davila RE, Rajan E, Baron TH, Adler DG, Egan JV, Faigel DO, et al. ASGE guideline: colorectal cancer screening and surveillance. Gastrointest Endosc 2006;63:546-57.

15. Atkin WS, Saunders BP; British Society for Gastroenterology; Association of Coloproctology for Great Britain and Ireland. Surveillance guidelines after removal of colorectal adenomatous polyps. Gut 2002;51 Suppl 5:V6-9.

16. Hurlstone DP, Sanders DS, Cross SS, Adam I, Shorthouse AJ, Brown S, et al. Colonoscopic resection of lateral spreading tumours: a prospective analysis of endoscopic mucosal resection. Gut 2004;53:1334-9.

17. Yamamoto H, Kawata H, Sunada K, Sasaki A, Nakazawa K, Miyata T, et al. Successful en-bloc resection of large superficial tumors in the stomach and colon using sodium hyaluronate and small-caliber-tip transparent hood. Endoscopy 2003;35:690-4.

18. Lee SH, Chung IK, Kim SJ, Kim JO, Ko BM, Kim WH, et al. Comparison of postpolypectomy bleeding between epinephrine and saline submucosal injection for large colon polyps by conventional polypectomy: a prospective randomized, multicenter study. World J Gastroenterol 2007;13:2973-7.

19. Ishii N, Itoh T, Horiki N, Matsuda M, Setoyama T, Suzuki S, et al. Endoscopic submucosal dissection with a combination of small-caliber-tip transparent hood and flex knife for large superficial colorectal neoplasias including ileocecal lesions. Surg Endosc 2010;24:1941-7.

20. Saito Y, Uraoka T, Yamaguchi Y, Hotta K, Sakamoto N, Ikematsu H, et al. A prospective, multicenter study of 1111 colorectal endoscopic submucosal dissections (with video). Gastrointest Endosc 2010;72:1217-25.

21. Fujishiro M, Yahagi N, Nakamura M, Kakushima N, Kodashima S, Ono S, et al. Endoscopic submucosal dissection for rectal epithelial neoplasia. Endoscopy 2006;38:493-7.

22. Rex DK, Bond JH, Winawer S, Levin TR, Burt RW, Johnson DA, et al. Quality in the technical performance of colonoscopy and the continuous quality improvement process for colonoscopy: recommendations of the U.S. Multi-Society Task Force on Colorectal Cancer. Am J Gastroenterol 2002;97:1296-308.

23. Benedix F, Kube R, Meyer F, Schmidt U, Gastinger I, Lippert H, et al. Comparison of 17,641 patients with right- and left-sided colon cancer: differences in epidemiology, perioperative course, histology, and survival. Dis Colon Rectum 2010;53:57-64.

24. Suttie SA, Shaikh I, Mullen R, Amin AI, Daniel T, Yalamarthi S. Outcome of right- and left-sided colonic and rectal cancer following surgical resection. Colorectal Dis 2011;13:884-9.

25. Consolo P, Luigiano C, Strangio G, Scaffidi MG, Giacobbe G, Di Giuseppe G, et al. Efficacy, risk factors and complications of endoscopic polypectomy: ten year experience at a single center. World J Gastroenterol 2008;14:2364-9.

26. Lieberman DA, Rex DK, Winawer SJ, Giardiello FM, Johnson DA, Levin TR, et al. Guidelines for colonoscopy surveillance after screening and polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology 2012;143:844-57.

27. Zlatanic J, Waye JD, Kim PS, Baiocco PJ, Gleim GW. Large sessile colonic adenomas: use of argon plasma coagulator to supplement piecemeal snare polypectomy. Gastrointest Endosc 1999;49:731-5.

28. He L, Deng T, Luo H. Efficacy and safety of endoscopic resection therapies for rectal carcinoid tumors: a meta-analysis. Yonsei Med J 2015;56:72-81.

29. Moss A, Williams SJ, Hourigan LF, Brown G, Tam W, Singh R, et al. Long-term adenoma recurrence following wide-field endoscopic mucosal resection (WF-EMR) for advanced colonic mucosal neoplasia is infrequent: results and risk factors in 1000 cases from the Australian Colonic EMR (ACE) study. Gut 2015;64:57-65.

30. Knabe M, Pohl J, Gerges C, Ell C, Neuhaus H, Schumacher B. Standardized long-term follow-up after endoscopic resection of large, nonpedunculated colorectal lesions: a prospective two-center study. Am J Gastroenterol 2014;109:183-9.

31. Lee S, Park SJ, Cheon JH, Kim TI, Kim WH, Kang DR, et al. Child-Pugh score is an independent risk factor for immediate bleeding after colonoscopic polypectomy in liver cirrhosis. Yonsei Med J 2014;55:1281-8.

32. Yang DH, Hong SN, Kim YH, Hong SP, Shin SJ, Kim SE, et al. Korean guidelines for postpolypectomy colonoscopy surveillance. Clin Endosc 2012;45:44-61.

33. Jang HW, Park SJ, Hong SP, Cheon JH, Kim WH, Kim TI. Risk factors for recurrent high-risk polyps after the removal of high-risk polyps at initial colonoscopy. Yonsei Med J 2015;56:1559-65.

34. Kim YJ, Kim ES, Cho KB, Park KS, Jang BK, Chung WJ, et al. Comparison of clinical outcomes among different endoscopic resection methods for treating colorectal neoplasia. Dig Dis Sci 2013;58:1727-36.

35. Carvalho R, Areia M, Brito D, Saraiva S, Alves S, Cadime AT. Endoscopic mucosal resection of large colorectal polyps: prospective evaluation of recurrence and complications. Acta Gastroenterol Belg 2013;76:225-30.

36. Probst A, Golger D, Anthuber M, Märkl B, Messmann H. Endoscopic submucosal dissection in large sessile lesions of the rectosigmoid: learning curve in a European center. Endoscopy 2012;44:660-7.

37. Wang J, Zhang XH, Ge J, Yang CM, Liu JY, Zhao SL. Endoscopic

submucosal dissection vs endoscopic mucosal resection for colorectal tumors: a meta-analysis. World J Gastroenterol 2014;20:8282-7.

38. Hotta K, Fujii T, Saito Y, Matsuda T. Local recurrence after endoscopic resection of colorectal tumors. Int J Colorectal Dis 2009;24: 225-30.

39. Saito Y, Sakamoto T, Fukunaga S, Nakajima T, Kiriyama S, Matsuda T. Endoscopic submucosal dissection (ESD) for colorectal tumors. Dig Endosc 2009;21 Suppl 1:S7-12.