BRIEF ARTICLE

Large endoscopic mucosal resection for colorectal tumors exceeding 4 cm

Philippe Ah Soune, Charles Ménard, Ezzedine Salah, Ariadne Desjeux, Jean-Charles Grimaud, Marc Barthet

Philippe Ah Soune, Charles Ménard, Ezzedine Salah, Ariadne Desjeux, Jean-Charles Grimaud, Marc Barthet, Department of Gastroenterology, Hôpital Nord, Chemin des Bourrely, 13915 Marseille cedex 20, France
Author contributions: Ah Soune P wrote the paper; Ménard C collected the data; Salah E and Desjeux A participated in writing the introduction and discussion; Grimaud JC revised the paper; Barthet M was the leading author and was involved in preparing the whole manuscript.
Correspondence to: Marc Barthet, MD, Professor, Department of Gastroenterology, Hôpital Nord, Chemin des Bourrely, 13915 Marseille cedex 20, France. marc.barthet@ap-hm.fr
Telephone: +33-491-968737 Fax: +33-491-961311
Received: August 26, 2009   Revised: October 7, 2009
Accepted: October 14, 2009
Published online: February 7, 2010

Abstract

AIM: To evaluate the feasibility and the outcome of endoscopic mucosal resection (EMR) for large colorectal tumors exceeding 4 cm (LCRT) undergoing piecemeal resection.

METHODS: From January 2005 to April 2008, 146 digestive tumors larger than 2 cm were removed with the EMR technique in our department. Of these, 34 tumors were larger than 4 cm and piecemeal resection was carried out on 26 colorectal tumors. The mean age of the patients was 71 years. The mean follow-up duration was 12 mo.

RESULTS: LCRTs were located in the rectum, left colon, transverse colon and right colon in 58%, 15%, 4% and 23% of cases, respectively. All were sessile tumors larger than 4 cm with a mean size of 4.9 cm (4-10 cm). According to the Paris classification, 34% of the tumors were type Ⅰs, 58% type Ⅱa, 4% type Ⅱb and 4% type Ⅱc. Pathological examination showed tubulous adenoma in 31%, tubulo-villous adenoma in 27%, villous adenoma in 42%, high-grade dysplasia in 38%, *in situ* carcinoma in 19% of the cases and mucosal carcinoma (m2) in 8% of the cases. The two cases (7.7%) of procedural bleeding that occurred were managed endoscopically and one small perforation was treated with clips. During follow-up, recurrence of the tumor occurred in three patients (12%), three of whom received endoscopic treatment.

CONCLUSION: EMR for tumors larger than 4 cm is a safe and effective procedure that could compete with endoscopic submucosal dissection, despite providing incomplete histological assessment.

INTRODUCTION

Endoscopic mucosal resection (EMR) allows complete and curative removal of the affected mucosa by excising through the middle or the deeper part of the submucosa following isotonic saline injection[1-3]. Thanks to a very simple technique, the endoscopic resection of superficial colorectal adenomas and tumors has been made

possible in selected patients with little or no ganglion risk. The therapeutic management of polyps larger than 3 cm, however, often relies on surgery. The frequency of degeneration is indeed increased, and piecemeal resection is carried out in 76% of cases[4]. Laparoscopic surgery has reduced the length of hospitalization, but a substantial morbidity rate of 20% and a mortality rate of 1% persist[5]. Endoscopic submucosal dissection (ESD) is a technique currently undergoing evaluation. This technique offers the advantage of a monobloc resection, enabling the analysis of the lateral margins and leading to a reduction of the risk of recurrence. However, this technique's learning curve is steep, and the morbidity associated with it is higher than that of mucosectomy[6].

This study aimed to evaluate the feasibility and the outcome of endoscopic piecemeal mucosal resection of sessile polyps of the colorectum exceeding 4 cm in size.

MATERIALS AND METHODS

Patients
Between 2005 and 2007, our department carried out 146 mucosal resections larger than 2 cm throughout the gastrointestinal tract. Of these, 34 involved parietal tumors larger than 4 cm, and 26 tumors were colorectal. These large colorectal tumors exceeding 4 cm were treated by piecemeal resection in 25 of the 26 patients. Among these, 44% were female and the mean age was 71 years (46-89 years).

Methods
The lesions were first identified by visual inspection (Figure 1A). Computed virtual chromoendoscopy with Fujinon Intelligent Color Enhancement® was used for estimating surface extension. The size of the lesions was measured and compared using open biopsy forceps. Deep tumor extension was estimated using three parameters. Polyps were classified according to the Paris morphological classification[7]. All lesions were analyzed according to Kudo's pit pattern classification[8]. Finally, endosonography was performed on all rectal lesions. Only lesions classified as T1N0 were treated endoscopically.

Certain lesions were excluded from the study and treated by surgery if they met one or more of the following criteria: (1) Type 0-Ⅲ, Paris classification; (2) Type V, Kudo's classification; (3) Endosonographic lesions > T1 or N+; and (4) Absence of lifting after submucosal injection (negative lifting sign).

A video colonoscope type Fuji 450® was used for total colonoscopy, carried out under general anesthesia. Patients received endocarditis prophylaxis according to the recommendations of the *Société Française d'Endoscopie Digestive*[9]. Mucosal resection was performed using the conventional method[10]. In order to create a detachment of the pathological mucosa, a solution containing physiological serum (0.9%) and epinephrine (dilution of 1:10 000) was injected into the submucosa by means of a 25 gauge needle inserted into the operating channel

(Figure 1B). A diathermic snare was tightened around the elevated lesion, grasping also adjacent healthy mucosal tissue (Figure 1C). Two snare types were used: large snare of 6 cm × 3 cm (Jumbo Wilson Cook®, USA) and needle snare of 5.5 cm × 2.5 cm (Wilson Cook®, USA). Removal was performed with pure cutting current in the caecum and with endocut current in the remaining colon (Figure 1D). Considering that the injection could have masked the polyp's limits, the healthy peripheral mucosa was previously marked with a bistoury in order to ensure complete polyp removal. In case of doubt as to the normality of the resection margins, a complementary treatment was performed by applying a coagulation current to the mucosectomy margins, either *via* the tip of the snare or *via* argon plasma, at a flow rate of 1 L/min and a power of 60 W (Erbe®, Tuebingen, Germany). One-time resection was attempted in all patients (Figure 1E). If the mucosectomy was considered incomplete due to the persistence of residual adenomatous tissue, a further mucosectomy was planned.
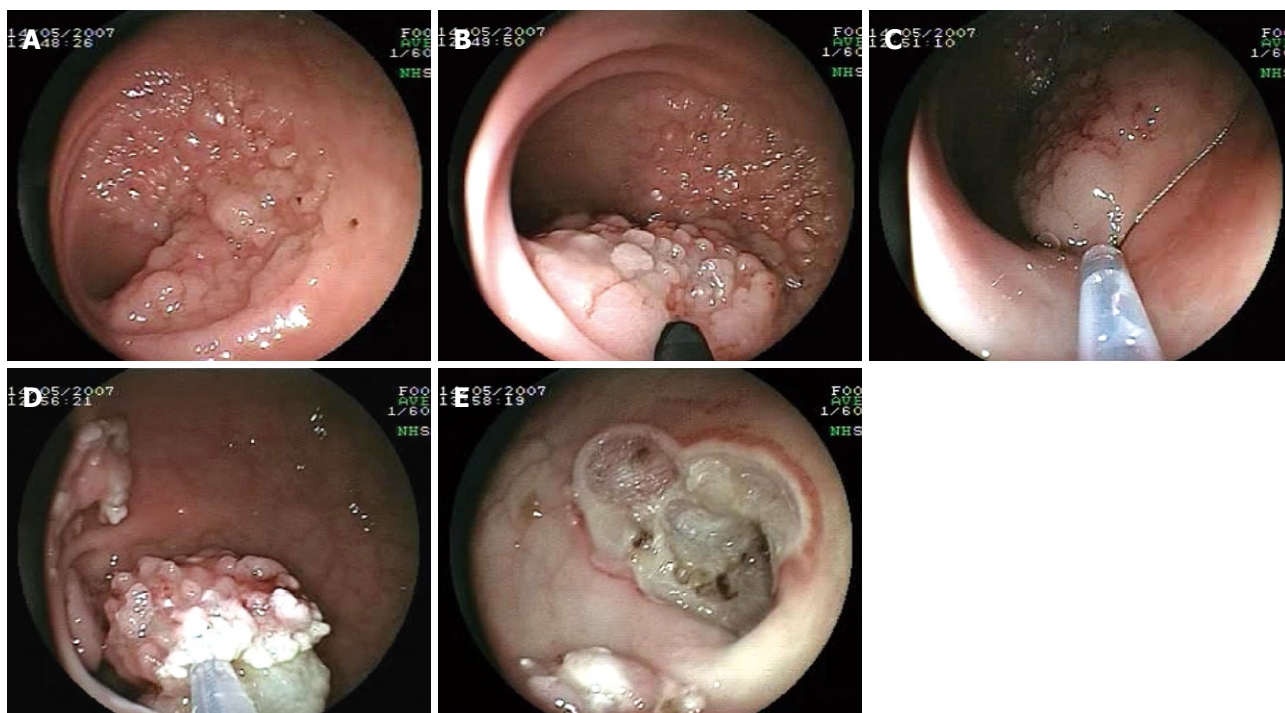
Each fragment of removed tissue was spread out and pinned on a 5 mm thick cork surface in order to avoid retraction of the polyp's base and permit improved histological assessment of the deep margins. Deep resection limits were marked with China ink and the tissue pieces were then fixed in 4% formol saline for 3 d. All fragments were routinely processed for paraffin embedding. Slices (5 μm) were stained with hematein-eosin-safran. Modified Vienna classification was used for the histological assessment according to the severity of dysplasia[11]. Lateral margins could not be evaluated due to the impossibility of displacing fragments in relation to each other. Histological assessment was carried out using the Japanese classification with deep submucosal invasion limited to 1000 μm[8].

Following mucosal resection, colonoscopic surveillance included a first early endoscopic control examination between 3 and 6 mo, and further examinations at 1 and 3 years (Figure 2). Resection was considered complete if no residual adenomatous tissue was noted following completion of mucosectomy. Local recurrence was defined as the presence (on biopsy) of adenomatous tissue in areas of previously treated mucosa at endoscopic control between 3 and 6 mo after therapy. In the case of a recurrence of small-sized tumors, an additional mucosectomy was carried out. If a lesion could not be lifted due to fibrous tissue development in the submucosa, argon plasma coagulation (APC) following multiple biopsies was performed. When the biopsy revealed recurrent cancer, the patient underwent surgery.
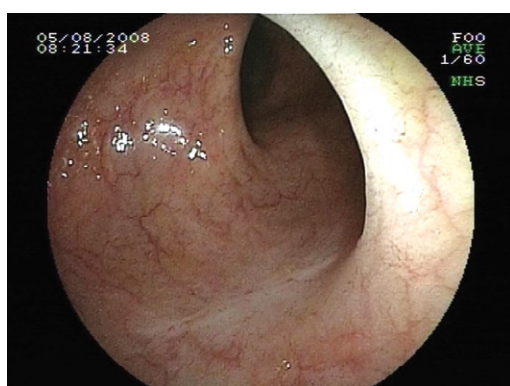
RESULTS

Lesion description and evaluation
The 26 sessile polyps were removed by piecemeal resection. The mean polyp size was 4.9 cm (4-10 cm). Lesion analysis according to the Paris classification revealed the presence of type 0- I s in 9 cases (34%), type

Figure 1 Endoscopic piecemeal mucosal resection image. A: Large lateral spreading rectal tumor (adenoma with high grade dysplasia); B: Submucosal lifting of the tumor using saline with adrenaline 1/10 000; C: Capture of the lifted part of the tumor with a needle snare; D: Piecemeal resection of the rectal tumor; E: Final aspect at the end of the resection (procedure duration 70 min).

Figure 2 One year follow-up: a scar is visible without any sign of recurrence.

0- II a in 15 cases (58%) and type 0- II b in one lesion (4%), with some mixed forms. The only lesion classified as type 0- II c (4%) showed low-grade dysplasia and two lesions classified as type 0- II a were intramucosal carcinomas. There was no ulcerated lesion of type 0-III. The most frequently identified pit pattern was pit pattern type IV in 24 cases (92%) followed by type III. The predominant location was the rectum in 15 cases (58%), and all lesions were classified as T1N0 (Table 1).

Technique

A one-time resection was performed in 23 cases (88.5%). For two lesions located in the rectum (7.7%), three sessions were necessary, and for one lesion located at the right colonic angle (3.8%), two sessions were needed. The lesions' mean size was 6.7 cm (4-10 cm). Coagulation of

Table 1 Lesion characteristics	
Lesion description and evaluation	***n* (%)**
Total number of lesions	26
Locations	
Rectum	15 (58)
Left colon	4 (15)
Transverse colon	1 (4)
Right colon	6 (23)
Size (mm)	
Mean	49
40-50	18 (65)
50-60	2 (8)
> 60	6 (27)
Paris classification	
0- I s	9 (34)
0- II a	15 (58)
0- II b	1 (4)
0- II c	1 (4)
Kudo's classification	
III (L+s)	2 (8)
IV	24 (92)
Anatomopathology	
Tubulous	8 (31)
Villous	11 (42)
Tubulovillous	7 (27)
Low-grade dysplasia	9 (35)
High-grade dysplasia	10 (38)
In situ carcinoma	5 (19)
Intramucosal carcinoma (type m2)	2 (8)
Submucosal-invading carcinoma	0

margins was performed as complementary treatment in 38.4% of cases. The mean duration of the intervention was 65 min (25-137 min).

Table 2 Lesion characteristics and treatment of recurrence

Case	Location	Size (cm)	Kudo's	Aspect	Histological type	Relapse interval time (mo)	Number of endoscopic treatments	Final treatment
1	Rectum	10	IV	0- I s	DHG	3	2	Argon plasma
2	Right colon	6	IV	0- II b	DBG	6	1	Argon plasma
3	Rectum	4	IV	0- II a + 0- II c	DBG	3	3	Surgery

Pathology

All polyps were adenomatous. The most common histological type was villous adenoma in 42% (11 cases), followed by tubular adenoma in 31% (8 cases) and finally tubulovillous adenoma with a mixed villous and tubular architecture in 27% (7 cases). In total, 35% of lesions exhibited low-grade dysplasia (9 cases), 38% high-grade dysplasia (10 cases), 19% a carcinoma *in situ* (5 cases). Two polyps (8%) were reported as intramucosal carcinoma (m2), neither of which reached the submucosa. Contrary to the lateral margins (0%), deep margin analysis was possible on all samples. Resection was performed within a safe deep margin in 100% of cases.

LEMR efficacy and follow-up

In total, 24 patients underwent endoscopic surveillance, while one patient refused to undergo control endoscopy. The mean duration of follow-up was 12 mo (3-37 mo). Three recurrences were detected (12.5%) (Table 2). All three patients had initially received a complementary treatment using APC. The median delay until recurrence diagnosis was 3 mo (3-9 mo). Two patients underwent endoscopic treatment and the remaining patient received surgical therapy. The first patient received an additional mucosectomy, followed by APC due to the absence of lifting after the injection. For the second patient, a single session of tissue destruction *via* coagulation was the immediate resort. These two endoscopically-treated recurrences were of the same histological type as the initial polyp. Following treatment of recurrences, a further endoscopic control was scheduled for 3 mo later. The third patient, who was followed-up for Crohn's disease which was surgically treated by ileorectal anastomosis, underwent rectal stump resection. After three successive endoscopic treatments, one using mucosectomy and the two others using APC, the low-grade dysplastic lesion detected at biopsy could not be eradicated. Histological examination of the surgically removed specimen revealed an infiltrating adenocarcinoma that was classified as pT2N0 with a colloid mucosal component of less than 50%. In total, endoscopic resection was effective in 96% of cases.

Complications

Intra-operative bleeding occurred in two patients but in neither patient was there any need for blood transfusion or a drop in hemoglobin levels exceeding 2 g/dL. Late postoperative bleeding, at day 6, was observed in two patients (7.7%) but no case of severe bleeding as defined in the standards of practice of the American Society for Gastrointestinal Endoscopy was noted[12]. Endoscopic injection therapy with epinephrine (diluted 1:10 000) was performed along with the deployment of hemostatic clips (Resolution® Boston Scientific, USA).

Perioperative perforation was diagnosed in one case (4%) upon visualisation of the peritoneal fat at the bottom of the resection zone. The abdominal radiography without preparation did not reveal a pneumoperitoneum because of the perforation's sub-peritoneal rectal location. The patient underwent conservative treatment with endoscopic closure of the perforation using clips, in addition to the administration of antibiotics and 48 h fasting.

Scar stenosis was observed in another patient who presented a 10 cm circumferential lesion within the upper rectum. The interval between the first colonoscopy and the diagnosis of the stenosis was 6 mo. The patient was asymptomatic and the endoscopic CRE balloon dilatation was able to traverse the stenosis.

Ten days after his examination, one patient experienced septic shock following *Staphylococcus epidermis* endocarditis. The patient had a bicuspid aortic valve, and underwent prosthetic valve replacement surgery. The microbiology did not support a bacterial translocation from the digestive tract.

DISCUSSION

This study aimed to demonstrate the efficacy of piecemeal mucosectomy in the management of large non-polypoid colorectal lesions. The success rate was 96% despite a mean lesion size of 4.9 cm. These results are comparable to those reported in the literature, which show success rates of endoscopic treatment for large polyps (those exceeding 2 cm) ranging from 83% to 100% (Table 3). Kaltenbach *et al*[13] recently described a series of 125 mucosectomy-treated colorectal plane lesions whose mean size was 16.7 mm. Of the 62 patients followed up for a mean period of 4.5 ± 1.4 years, none had developed colorectal cancer or metastasis, resulting in a success rate of 100%[13].

The Japanese Society for Cancer of the Colon and Rectum's current criteria for curative endoscopic resection are: a submucosal invasion of less than 1000 μm, moderate or well-differentiated lesion characteristics and the absence of vascular invasion[14,15]. Depending on the study reported, the presence of invasive lesions, which cross the muscular mucosa, varies from 0% to 44%, notably for sessile elevated tumors[1,16]. In our series, there was no submucosal invasion and only 2 cases (8%) with invasion of the mucosa (m2). This was

Table 3 Resection of large sessile polyps *via* fragmentation: recurrence rates and efficacy

Author	Yr	*n*	Sessile lesions (%)	Size (cm)	Piecemeal (%)	Surveillance	Relapse (%)	Endoscopic efficacy (%)
Bedogni *et al*[48]	1986	66	75	≥ 3	100	3-85 mo	11	-
Walsh *et al*[49]	1992	65	100	≥ 3	100	2.8 mo	28	88
Binmoeller *et al*[50]	1996	170	73	3-6	100	> 6 mo	16	-
Kanamori *et al*[4]	1996	32	100	3-8.5	76	2.4 yr	0	100
Iishi *et al*[27]	2000	56	100	2-5	75	34 mo	39	83
Higaki *et al*[29]	2003	24	100	2-6	79	24 mo	22.2	91.3
Doniec *et al*[21]	2003	184	76	3-≥ 13	100	40 mo	3	-
Seitz *et al*[28]	2003	288	78	> 3	100	36 mo	17	-
Hurlstone *et al*[23]	2004	58	100	> 1.5	62	24 mo	17	96
Bories *et al*[51]	2006	50	100	1-> 5	55.8	17.3 mo	15	-
Katsinelos *et al*[52]	2006	59	100	≥ 2	61	> 1 yr	3.4	96.78
Arebi *et al*[31]	2007	161	100	2-> 8	100	9.2 mo	-	95.4

accounted for by the parietal extension assessment, which was based on a series of complementary examinations. On one hand, the Paris endoscopic classification allows the exclusion of ulcerated lesions[8]. On the other hand, magnified chromoendoscopy has been shown to permit a 97% diagnostic precision of deep submucosal invasion (69/71)[17]. However, another study found a specificity of only 50%[18]. Echoendoscopy with high-frequency mini probes was not used, as muscular mucosa is only visualized in 50% to 65% of cases[19,20]. Mini probes of 7.5 MHz were employed, permitting the detection of T1 cancers without separating mucosal and sub-mucosal lesions. The evaluation of extension depth is an essential step prior to resection in order to select the patients for whom endoscopic treatment will be curative with minimal lymphatic risk.

The late bleeding rate reported by Doniec *et al*[21] was only 2%. The higher late bleeding rate observed in our study (7.7%) can be explained by the 49 mm mean extension of the resection. Lesion size has been identified as an independent predictive factor of postpolypectomy delayed bleeding[22]. However, the bleeding complications of the current study and those aforementioned were effectively treated with the deployment of hemoclips and the injection of an adrenaline serum, without resorting to surgery. Perforation rates reported after the resection of polyps exceeding 2 cm have been shown to vary from 0% to 1.2%[23,24]. If the perforations are of small size (< 1 cm) and are properly diagnosed during endoscopy, they may be treated with endoscopic clip closure in 70% of cases[25]. Scar stenosis of the colon is a complication following endoscopic mucosectomy which has not yet been explained. Two factors appear to play a role: the initial lesion's extended circumferential shape, and its location in the upper rectum (where the diameter is smallest).

Local recurrence was detected in 13.4% of cases, despite APC of the area of the defect which has proved effective in preventing recurrences following piecemeal mucosal resection[26]. Previous studies have reported recurrence rates ranging from 0% to 39% for lesions larger than 2 cm[22,27]. In the largest series, that of Seitz *et al*[28], 288 patients with large (> 3 cm) sessile and pediculated polyps were treated using piecemeal resection, and the recurrence rate was 17% for a mean follow-up duration of 36 mo. The mean delay for diagnosis of recurrence was 5 mo. We followed the recommendations of Higaki concerning postpolypectomy surveillance[29]. Most recurrences occur within the first 6 mo. Our own experience and published data encourage close endoscopic control between 3 and 6 mo, and at 1 year, in cases of piecemeal resection. Patients who have undergone resection of a large dysplastic or cancerous polyp require tighter endoscopic control[30]. Several risk factors for recurrence have been identified; piecemeal resection, lesion size[31], granulous appearance of the lesion, and a lesion location at the bottom of the rectum attaining the pectineal line[23,32]. Among these factors, endoscopic piecemeal procedure appears to play the most important role. In a series by Ishihara *et al*[33], 78 esophageal squamous cell carcinomas of ≥ 2 cm were treated by endoscopy. The strongest predictor for recurrence was the number of resected fragments; 0/34 in patients with monobloc resection (0%), 4/24 in those with 2 and 4 fragments (15%) and 8/17 in those with more than 5 fragments (47%)[33]. In addition to the risk of local recurrence, piecemeal resection may prevent a good assessment of the lateral margins, with the consequence of incomplete interpretation and the risk of leaving small carcinomas around the main lesion. In a recent retrospective study by Kim *et al*[34], 44 patients who had initially received imperfect EMR for colorectal cancers were subsequently treated by either EMR or ESD. Gross incomplete resection and deep margin positivity were found to be risk factors of residual cancer. No residual cancer cells were found after supplementary surgery in all cases with positive lateral resection margins. The authors proposed the hypothesis that the application of an electrocoagulation current can destroy residual cancer cells at the resection margins[34]. Hurlstone *et al*[35] have shown that recurrence rate could be decreased from 8.7% to 0.5% with the analysis of the pit patterns of the resection margins.

If the recurrence is of small size, removal by hot forceps is a therapeutic option. If the recurrence exceeds 5 mm, a further mucosectomy session may be carried out so as to obtain a complete histological analysis of

residual tumor tissue. In our series, such a thorough histological analysis was not possible in two out of three cases. The thermal lesion provoked by the coagulation current leads to a desmoplasmic reaction in the submucosa, preventing another mucosal lifting (non lifting sign)[36]. Destruction of tumors by APC is an alternative therapeutic option. In a series of 68 recurrent colorectal adenomas following EMRP, APC treatment was effective in 90%[37]. We believe that in all cases without malignant recurrence, the best choice is to try to perform a new EMR, in order to assess the margins. However, the submucosal fibrotic scar due to thermal injury may prevent the lifting sign leading to a management by local destruction, mainly with APC treatment. Surgery remains essential in the presence of a carcinomatous recurrence whose extension depth cannot be properly assessed, and which therefore has a risk of metastatic spread[38]. In our series, one patient followed-up for Crohn's disease with ileorectal anastomosis underwent surgery. The operative specimen revealed an infiltrating cancer classified as pT2N0. A recent meta-analysis has shown that the positive predictive value of a plane low-grade dysplastic lesion, associated with chronic inflammatory bowel disease, correlated with the presence of colorectal cancer in 22% of cases[39].

The technique of large EMR for rectal tumor might be challenged by two new techniques: ESD and transanal endoscopic microsurgery (TEMS). ESD permits single-fragment resection with safe margins in 70% of cases, as has been shown in a series of 200 colorectal lesions ranging in size from 20 to 150 mm[40]. There are only a few follow-up studies, but the risk of recurrence appears low. In a study by Fujishiro *et al*[41], 35 rectal polyps were treated using the ESD method. Monobloc resection with safe margins was possible in 62.9% of cases, with a local recurrence rate of 2.8% for a mean follow-up duration of 36 mo. Initially developed for the treatment of superficial gastric tumors, the application of this technique in the colon exposes the patient to a higher risk of complications. For instance, ESD is associated with a higher risk of perforation, ranging from 5% to 14%, due to the thinness of the colonic wall[40,25]. The intra-operative bleeding risk is also significantly higher for ESD as compared to EMR (22.6% for ESD *vs* 7.6% for EMR, $P < 0.01$)[42]. The "inject and cut" mucosectomy has the advantage of being a simple technique that may be performed by the endoscopy practitioner with routinely-used equipment. In contrast, ESD practitioners require extensive training, operating initially on animals because the endoscopist's experience inversely correlates with the risk of perforation and monobloc resection rate[43,44]. The mean time required for the procedure is significantly higher and has been compared in a study by Oka *et al*[42]. The mean time for the resection of gastric lesions smaller than 1 cm was 3.5 ± 1.3 min for EMR and 58.5 ± 28.7 min for ESD ($P < 0.01$). If the lesion is larger than 2 cm, the mean time required for the procedure is 17.2 ± 9.3 min for EMR and 123.8 ± 101.4 min for ESD ($P < 0.01$)[42]. ESD is at present a non-standardized technique. It has the advantage of allowing monobloc resection of gastrointestinal tumors, which permits the assessment of lateral margins. However, the technique is difficult to learn, its complication rates are high and the time required for the procedure is long. To date, this technique cannot be proposed as a standard technique for the management of colorectal adenomas[44].

For TEMS, major complications have been reported. In a series of 288 patients, 9% of patients experienced complications; severe digestive hemorrhages, perforations, and temporary anal incontinence. Non-surgical complications accounted for the low but relevant mortality rate of 0.3%. Duration of hospitalization was approximately 2 d[45]. Hurlstone *et al*[46] have evaluated EMR as an alternative to TEMS. In 62 patients, the success rate of endoscopic treatment was 98%, with a recurrence rate of 8%. Patients were discharged the same day as the procedure in 97% of cases[46]. Another major drawback of TEMS is economic, since it necessitates a financial investment of 50 000 Euros for the purchase of the equipment[47].

In conclusion, endoscopic piecemeal resection is a safe and effective procedure. In spite of higher recurrence rates than with the ESD method, its technical simplicity, low complication rates, and lower costs are major advantages. Moreover, endoscopic management of recurrence has proven effective, with no risk of submucosal invasion in patients without chronic inflammatory colitis. A large lesion size (> 4 cm) is not a limiting factor for an endoscopic approach, provided that the risk of submucosal invasion has been carefully evaluated. However, further studies are needed to specify the time intervals required for endoscopic surveillance and to develop new techniques that would allow the histological assessment of lateral margins.

COMMENTS

Background
Large colorectal adenomatous sessile polyps are neoplastic premalignant lesions, which carry a high risk of transformation into invasive cancer. The management of these lesions is usually surgical by segmental colonic resection. The treatment of these lesions by piecemeal mucosectomy represents a mini-invasive procedure and the resection is effective for selected lesions.

Research frontiers
Endoscopic mucosectomy is a technique approved for lesions less than 2 cm because it allows *en bloc* resection. The endoscopic resection of lesions more than 4 cm involves a systematic piecemeal resection, which could result in the absence of anatomopathologic analysis of the margins and may expose the patient to the risk of recurrence.

Innovations and breakthroughs
This is an original study taking place in a single centre that describes the effectiveness and the feasibility of this technique as less risky and simpler than that of endoscopic submucosal dissection (ESD), for the management of polyps of large size (giant polyps). This study confirms that the size of the polyps should not be a contraindication for endoscopic treatment. However, the risk of deep parietal infiltration must be evaluated in a precise way because this controls the effectiveness of the treatment as well as the risk of metastatic dissemination to lymph nodes which could preclude the endoscopic resection. It is associated with a low risk of complications and recurrence.

Applications

The results of this study show that mucosectomy for large colorectal polyps is effective whatever the size of the lesions if the estimation of lymph node infiltration is rigorously evaluated by the degree of infiltration into the layers of the wall of the colon. However, new studies should be realized in order to confirm these data and to determine the degree and regularity of follow-up monitoring.

Terminology

Mucosectomy is an endoscopic technique of resection of a lesion that requires the separation of the submucosa using normal saline solution. ESD is a new method of resection, allowing the dissection of the lesion within the thickness of the submucosa or the interface between the submucosa and the muscularis propria. FICE: Technique of virtual chromoendoscopy by processing the image in a narrow spectral band.

Peer review

Great paper, well written, appeals to our audience, favor acceptance.

REFERENCES

1   **Iishi H**, Tatsuta M, Kitamura S, Narahara H, Iseki K, Ishiguro S. Endoscopic resection of large sessile colorectal polyps using a submucosal saline injection technique. *Hepatogastroenterology* 1997; **44**: 698-702

2   **Tada M**, Murakami A, Karita M, Yanai H, Okita K. Endoscopic resection of early gastric cancer. *Endoscopy* 1993; **25**: 445-450

3   **Karita M**, Tada M, Okita K, Kodama T. Endoscopic therapy for early colon cancer: the strip biopsy resection technique. *Gastrointest Endosc* 1991; **37**: 128-132

4   **Kanamori T**, Itoh M, Yokoyama Y, Tsuchida K. Injection-incision--assisted snare resection of large sessile colorectal polyps. *Gastrointest Endosc* 1996; **43**: 189-195

5   **Clinical Outcomes of Surgical Therapy Study Group**. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004; **350**: 2050-2059

6   **Kantsevoy SV**, Adler DG, Conway JD, Diehl DL, Farraye FA, Kwon R, Mamula P, Rodriguez S, Shah RJ, Wong Kee Song LM, Tierney WM. Endoscopic mucosal resection and endoscopic submucosal dissection. *Gastrointest Endosc* 2008; **68**: 11-18

7   The Paris endoscopic classification of superficial neoplastic lesions: esophagus, stomach, and colon: November 30 to December 1, 2002. *Gastrointest Endosc* 2003; **58**: S3-S43

8   **Kudo S**, Rubio CA, Teixeira CR, Kashida H, Kogure E. Pit pattern in colorectal neoplasia: endoscopic magnifying view. *Endoscopy* 2001; **33**: 367-373

9   **Barthet M**, Napoleon B, Gay G, Ponchon T, Sautereau D, Arpurt JP, Boustiere C, Boyer J, Canard JM, Dalbies PA, Escourrou J, Greff M, Lapuelle J, Laugier R, Letard JC, Marchetti B, Palazzo L, Vedrenne B. Antibiotic prophylaxis for digestive endoscopy. *Endoscopy* 2004; **36**: 1123-1125

10 **Kudo S**, Tamegai Y, Yamano H, Imai Y, Kogure E, Kashida H. Endoscopic mucosal resection of the colon: the Japanese technique. *Gastrointest Endosc Clin N Am* 2001; **11**: 519-535

11 **Dixon MF**. Gastrointestinal epithelial neoplasia: Vienna revisited. *Gut* 2002; **51**: 130-131

12 **Dominitz JA**, Eisen GM, Baron TH, Goldstein JL, Hirota WK, Jacobson BC, Johanson JF, Leighton JA, Mallery JS, Raddawi HM, Vargo JJ 2nd, Waring JP, Fanelli RD, Wheeler-Harbough J, Faigel DO. Complications of colonoscopy. *Gastrointest Endosc* 2003; **57**: 441-445

13 **Kaltenbach T**, Friedland S, Maheshwari A, Ouyang D, Rouse RV, Wren S, Soetikno R. Short- and long-term outcomes of standardized EMR of nonpolypoid (flat and depressed) colorectal lesions > or = 1 cm (with video). *Gastrointest Endosc* 2007; **65**: 857-865

14 **Kitajima K**, Fujimori T, Fujii S, Takeda J, Ohkura Y, Kawamata H, Kumamoto T, Ishiguro S, Kato Y, Shimoda T, Iwashita A, Ajioka Y, Watanabe H, Watanabe T, Muto T, Nagasako K. Correlations between lymph node metastasis and depth of submucosal invasion in submucosal invasive colorectal carcinoma: a Japanese collaborative study. *J Gastroenterol* 2004; **39**: 534-543

15 **Ueno H**, Mochizuki H, Hashiguchi Y, Shimazaki H, Aida S, Hase K, Matsukuma S, Kanai T, Kurihara H, Ozawa K, Yoshimura K, Bekku S. Risk factors for an adverse outcome in early invasive colorectal carcinoma. *Gastroenterology* 2004; **127**: 385-394

16 **Bardan E**, Bat L, Melzer E, Shemesh E, Bar-Meir S. Colonoscopic resection of large colonic polyps--a prospective study. *Isr J Med Sci* 1997; **33**: 777-780

17 **Tanaka S**, Kaltenbach T, Chayama K, Soetikno R. High-magnification colonoscopy (with videos). *Gastrointest Endosc* 2006; **64**: 604-613

18 **Hurlstone DP**, Cross SS, Adam I, Shorthouse AJ, Brown S, Sanders DS, Lobo AJ. Endoscopic morphological anticipation of submucosal invasion in flat and depressed colorectal lesions: clinical implications and subtype analysis of the kudo type V pit pattern using high-magnification-chromoscopic colonoscopy. *Colorectal Dis* 2004; **6**: 369-375

19 **Yanai H**, Tada M, Karita M, Okita K. Diagnostic utility of 20-megahertz linear endoscopic ultrasonography in early gastric cancer. *Gastrointest Endosc* 1996; **44**: 29-33

20 **Menzel J**, Domschke W. Gastrointestinal miniprobe sonography: the current status. *Am J Gastroenterol* 2000; **95**: 605-616

21 **Doniec JM**, Löhnert MS, Schniewind B, Bokelmann F, Kremer B, Grimm H. Endoscopic removal of large colorectal polyps: prevention of unnecessary surgery? *Dis Colon Rectum* 2003; **46**: 340-348

22 **Sawhney MS**, Salfiti N, Nelson DB, Lederle FA, Bond JH. Risk factors for severe delayed postpolypectomy bleeding. *Endoscopy* 2008; **40**: 115-119

23 **Hurlstone DP**, Sanders DS, Cross SS, Adam I, Shorthouse AJ, Brown S, Drew K, Lobo AJ. Colonoscopic resection of lateral spreading tumours: a prospective analysis of endoscopic mucosal resection. *Gut* 2004; **53**: 1334-1339

24 **Tanaka S**, Haruma K, Oka S, Takahashi R, Kunihiro M, Kitadai Y, Yoshihara M, Shimamoto F, Chayama K. Clinicopathologic features and endoscopic treatment of superficially spreading colorectal neoplasms larger than 20 mm. *Gastrointest Endosc* 2001; **54**: 62-66

25 **Taku K**, Sano Y, Fu KI, Saito Y, Matsuda T, Uraoka T, Yoshino T, Yamaguchi Y, Fujita M, Hattori S, Ishikawa T, Saito D, Fujii T, Kaneko E, Yoshida S. Iatrogenic perforation associated with therapeutic colonoscopy: a multicenter study in Japan. *J Gastroenterol Hepatol* 2007; **22**: 1409-1414

26 **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**: 371-375

27 **Iishi H**, Tatsuta M, Iseki K, Narahara H, Uedo N, Sakai N, Ishikawa H, Otani T, Ishiguro S. Endoscopic piecemeal resection with submucosal saline injection of large sessile colorectal polyps. *Gastrointest Endosc* 2000; **51**: 697-700

28 **Seitz U**, Bohnacker S, Seewald S, Thonke F, Soehendra N. Long-term results of endoscopic removal of large colorectal adenomas. *Endoscopy* 2003; **35**: S41-S44

29 **Higaki S**, Hashimoto S, Harada K, Nohara H, Saito Y, Gondo T, Okita K. Long-term follow-up of large flat colorectal tumors resected endoscopically. *Endoscopy* 2003; **35**: 845-849

30 **Lin OS**. Clinical update: postpolypectomy colonoscopy surveillance. *Lancet* 2007; **370**: 1674-1676

31 **Arebi N**, Swain D, Suzuki N, Fraser C, Price A, Saunders BP. Endoscopic mucosal resection of 161 cases of large sessile or flat colorectal polyps. *Scand J Gastroenterol* 2007; **42**: 859-866

32 **Tamura S**, Nakajo K, Yokoyama Y, Ohkawauchi K, Yamada

T, Higashidani Y, Miyamoto T, Ueta H, Onishi S. Evaluation of endoscopic mucosal resection for laterally spreading rectal tumors. *Endoscopy* 2004; **36**: 306-312

33 **Ishihara R**, Iishi H, Takeuchi Y, Kato M, Yamamoto S, Yamamoto S, Masuda E, Tatsumi K, Higashino K, Uedo N, Tatsuta M. Local recurrence of large squamous-cell carcinoma of the esophagus after endoscopic resection. *Gastrointest Endosc* 2008; **67**: 799-804

34 **Kim JH**, Cheon JH, Kim TI, Baik SH, Kim NK, Kim H, Kim WH. Effectiveness of radical surgery after incomplete endoscopic mucosal resection for early colorectal cancers: a clinical study investigating risk factors of residual cancer. *Dig Dis Sci* 2008; **53**: 2941-2946

35 **Hurlstone DP**, Cross SS, Brown S, Sanders DS, Lobo AJ. A prospective evaluation of high-magnification chromoscopic colonoscopy in predicting completeness of EMR. *Gastrointest Endosc* 2004; **59**: 642-650

36 **Soetikno RM**, Gotoda T, Nakanishi Y, Soehendra N. Endoscopic mucosal resection. *Gastrointest Endosc* 2003; **57**: 567-579

37 **Regula J**, Wronska E, Polkowski M, Nasierowska-Guttmejer A, Pachlewski J, Rupinski M, Butruk E. Argon plasma coagulation after piecemeal polypectomy of sessile colorectal adenomas: long-term follow-up study. *Endoscopy* 2003; **35**: 212-218

38 **Murakami S**, Tanabe S, Koizumi W, Higuchi K, Sasaki T, Tahara K, Kitamura T, Saigenji K, Shimao H, Mitomi H. Endoscopic mucosal resection (EMR) for the management of poorly differentiated adenocarcinoma of the stomach: a patient who had recurrence and died 4 years after EMR. *Gastric Cancer* 2003; **6**: 113-116

39 **Thomas T**, Abrams KA, Robinson RJ, Mayberry JF. Meta-analysis: cancer risk of low-grade dysplasia in chronic ulcerative colitis. *Aliment Pharmacol Ther* 2007; **25**: 657-668

40 **Saito Y**, Uraoka T, Matsuda T, Emura F, Ikehara H, Mashimo Y, Kikuchi T, Fu KI, Sano Y, Saito D. Endoscopic treatment of large superficial colorectal tumors: a case series of 200 endoscopic submucosal dissections (with video). *Gastrointest Endosc* 2007; **66**: 966-973

41 **Fujishiro M**, Yahagi N, Nakamura M, Kakushima N, Kodashima S, Ono S, Kobayashi K, Hashimoto T, Yamamichi N, Tateishi A, Shimizu Y, Oka M, Ogura K, Kawabe T, Ichinose M, Omata M. Endoscopic submucosal dissection for rectal epithelial neoplasia. *Endoscopy* 2006; **38**: 493-497

42 **Oka S**, Tanaka S, Kaneko I, Mouri R, Hirata M, Kawamura T, Yoshihara M, Chayama K. Advantage of endoscopic submucosal dissection compared with EMR for early gastric cancer. *Gastrointest Endosc* 2006; **64**: 877-883

43 **Gotoda T**, Friedland S, Hamanaka H, Soetikno R. A learning curve for advanced endoscopic resection. *Gastrointest Endosc* 2005; **62**: 866-867

44 **Tanaka S**, Oka S, Kaneko I, Hirata M, Mouri R, Kanao H, Yoshida S, Chayama K. Endoscopic submucosal dissection for colorectal neoplasia: possibility of standardization. *Gastrointest Endosc* 2007; **66**: 100-107

45 **Kreissler-Haag D**, Schuld J, Lindemann W, König J, Hildebrandt U, Schilling M. Complications after transanal endoscopic microsurgical resection correlate with location of rectal neoplasms. *Surg Endosc* 2008; **22**: 612-616

46 **Hurlstone DP**, Sanders DS, Cross SS, George R, Shorthouse AJ, Brown S. A prospective analysis of extended endoscopic mucosal resection for large rectal villous adenomas: an alternative technique to transanal endoscopic microsurgery. *Colorectal Dis* 2005; **7**: 339-344

47 **Maslekar S**, Pillinger SH, Sharma A, Taylor A, Monson JR. Cost analysis of transanal endoscopic microsurgery for rectal tumours. *Colorectal Dis* 2007; **9**: 229-234

48 **Bedogni G**, Bertoni G, Ricci E, Conigliaro R, Pedrazzoli C, Rossi G, Meinero M, Gardini G, Contini S. Colonoscopic excision of large and giant colorectal polyps. Technical implications and results over eight years. *Dis Colon Rectum* 1986; **29**: 831-835

49 **Walsh RM**, Ackroyd FW, Shellito PC. Endoscopic resection of large sessile colorectal polyps. *Gastrointest Endosc* 1992; **38**: 303-309

50 **Binmoeller KF**, Bohnacker S, Seifert H, Thonke F, Valdeyar H, Soehendra N. Endoscopic snare excision of "giant" colorectal polyps. *Gastrointest Endosc* 1996; **43**: 183-188

51 **Bories E**, Pesenti C, Monges G, Lelong B, Moutardier V, Delpero JR, Giovannini M. Endoscopic mucosal resection for advanced sessile adenoma and early-stage colorectal carcinoma. *Endoscopy* 2006; **38**: 231-235

52 **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**: 1384-1392