Endoscopic Mucosal Resection Outcomes and Prediction of Submucosal Cancer From Advanced Colonic Mucosal Neoplasia

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This article has an accompanying continuing medical education activity on page e13. Learning Objective: Upon completion of these questions, successful learners will be able to: distinguish between the various types of large sessile colonic lesions and assess their respective risks for containing submucosal cancer; explain to patients the likely clinical outcomes for endoscopic management of advanced colonic mucosal neoplasia; identify risk factors for successful and unsuccessful Endoscopic Mucosal Resection (EMR); and identify risk factors for recurrence following EMR.

See related article, Kaku E et al, on page 503 in CGH; see editorial on page 1867.

BACKGROUND & AIMS: Large sessile colonic polyps usually are managed surgically, with significant morbidity and potential mortality. There have been few prospective, intention-to-treat, multicenter studies of endoscopic mucosal resection (EMR). We investigated whether endoscopic criteria can predict invasive disease and direct the optimal treatment strategy. METHODS: The Australian Colonic Endoscopic (ACE) resection study group conducted a prospective, multicenter, observational study of all patients referred for EMR of sessile colorectal polyps that were 20 mm or greater in size (n = 479, mean age, 68.5 y; mean lesion size, 35.6 mm). We analyzed data on lesion characteristics and procedural, clinical, and histologic outcomes. Multiple logistic regression analysis identified independent predictors of EMR efficacy and recurrence of adenoma, based on findings from follow-up colonoscopy examinations. RESULTS: Risk factors for submucosal invasion were as follows: Paris classification 0–IIa+c morphology, nongranular surface, and Kudo pit pattern type V. The most commonly observed lesion (0–IIa granular) had a low rate of submucosal invasion (1.4%). EMR was effective at completely removing the polyp in a single session in 89.2% of patients; risk factors for lack of efficacy included a prior attempt at EMR (odds ratio [OR], 3.8; 95% confidence interval, 1.77–7.94; P = .001) and ileocecal valve involvement (OR, 3.4; 95% confidence interval, 1.20–9.52; P = .021). Independent predictors of recurrence after effective EMR were lesion size greater than 40 mm (OR, 4.37; 95% confidence interval, 2.43–7.88; P < .001) and use of argon plasma coagulation (OR, 3.51; 95% confidence interval, 1.69–7.27; P = .0017). There were no deaths from EMR; 83.7% of patients avoided surgery. CONCLUSIONS: Large sessile colonic polyps can be managed safely and effectively by endoscopy. Endoscopic assessment identifies lesions at increased risk of containing submucosal cancer. The first EMR is an important determinant of patient outcome—a previous attempt is a significant risk factor for lack of efficacy.

Keywords: Colon Cancer; Sessile Polyp; Tumor Surveillance; Screening.

Colorectal cancer will soon surpass lung cancer as the leading cause of cancer death in the United States. Colonic carcinogenesis generally follows a well-defined pathway of gradual progression from adenoma to carcinoma, presenting opportunities for screening and intervention. Colonoscopy and polypectomy are effective at reducing the incidence of colorectal cancer. The majority of colon polyps are small or pedunculated and easily removed. Sessile or nonpolyloid adenomas are increasingly detected and have a stronger association with carcinoma. However, large sessile lesions are challenging to remove endoscopically, and surgery is the primary man—

Abbreviations used in this paper: APC, argon plasma coagulation; EMR, endoscopic mucosal resection; SD, standard deviation; SMIC, submucosal invasive cancer.
Surgery is associated with significant morbidity, mortality, and cost, especially in older patients with comorbid illness.

Endoscopic mucosal resection (EMR) is a minimally invasive technique for removal of large sessile polyps. It is performed via colonoscopy conducted under conscious sedation as an ambulatory procedure. It has high success rates and minimal morbidity and mortality, but outcome studies have limitations including single-center or retrospective designs, nonstandardized technique, and lack of comprehensive follow-up evaluation.

The term sessile polyp is used to describe a range of lesions that vary in size, morphology, and likelihood of containing submucosal invasive cancer (SMIC). Increasing lesion size often is presumed to correlate with increasing risk of adenocarcinoma. However, lesion morphology described using simple endoscopic criteria may be more informative and better able to direct treatment strategies.

We aimed to determine the safety, efficacy, and predictors of success for EMR of large sessile colorectal polyps. The usefulness of endoscopic criteria to stratify for the risk of SMIC also was assessed.

**Materials and Methods**

**Study Design, Setting, and Patients**

A prospective observational study of all patients referred for EMR of sessile colorectal polyps sized 20 mm or larger was conducted at 7 Australian academic endoscopy units. Institutional review board approval was obtained at each center. Consecutive patients were enrolled from July 2008 to May 2010.

All lesions were identified at a previous colonoscopy by the referring nationally accredited consultant endoscopist. Referral to the tertiary center followed an established clinical pathway. On the day of the procedure, the investigators met with patients and obtained written informed consent. There were no exclusion criteria.

Detailed data sheets for each patient were completed by the investigators at each site at 3 time points: (1) immediately after the procedure to describe immediate EMR outcomes, (2) at 14 days after the procedure to detail complications and histology outcomes, and (3) at the time of follow-up colonoscopy performed 4–12 months after the original procedure. Data storage and analysis were centralized.

**Lesion Classification**

Lesions were assessed by white-light colonoscopy (Q180PCF/CF; Olympus, Tokyo, Japan) without cap attachment. Lesions were classified by 3 criteria: (1) Paris classification of lesion morphology (Figure 1), (2) surface features being granular, nongranular, mixed, or unable to classify, and (3) Kudo pit patterns I–V. Pit patterns I (round) and II (stellar) indicate nonneoplastic (eg, hyperplastic) histology. Pit patterns III (tubular) and IV (branch or gyrus-like) indicate neoplasia (usually tubular or tubulovillous adenoma). Pit pattern V (irregular nonstructured) suggests advanced neoplasia with possible submucosal invasion. Narrow-band imaging ( Olympus) was used at the discretion of the endoscopist to assist with pit pattern classification.

Lesion location, size, and ease of access and positioning for EMR also were recorded. Difficulty access was defined as the endoscopist's subjective experience of encountering significant difficulty reaching the lesion. Difficult position was defined as the endoscopist having significant difficulty in positioning the lesion in a stable and suitable position relative to the scope tip to enable EMR. Ideally, the polyp is positioned at 5–6 o’clock, although this was not mandated because some lesions are more suitable for resection in an alternative position. Lesion size was measured using snares of known dimensions.

Lesions with features strongly suggestive of submucosal invasion were not attempted for EMR, and the lesion was examined by biopsy. The referring endoscopist was contacted and surgical management was suggested.
EMR Procedure

All EMR procedures were performed as ambulatory procedures by one of the investigators or a senior therapeutic endoscopy fellow under direct supervision. All clinical investigators were gastroenterologists with significant prior colonic EMR experience after training in high-volume tertiary referral centers in Australia or overseas.

Split-dose bowel preparation was used, but was not otherwise standardized. The most common preparation was a combination of 2 sachets of a sodium picosulfate/magnesium oxide/citrate preparation (each sachet, 15.5 g) (Picoprep; Pharmatel Fresenius Kabi, Sydney, Australia) and 1 L of polyethylene glycol as a split preparation. The final sachet of picosulfate was consumed 4–5 hours before admission. The quality of bowel preparation was recorded locally for each procedure, but was not included in the central database. Intravenous sedation was performed using a combination of midazolam, fentanyl, or propofol. Colonic insufflation was with air.

EMR is a modification of conventional snare polypectomy. A solution (usually normal saline dyed with methylene blue or indigo carmine) is pre-injected into the submucosa beneath the lesion. This elevates the mucosal layer containing the lesion on a submucosal fluid cushion, and provides a safety zone for snare resection. The lesions were removed by sequential inject and resect EMR technique that we have described previously in detail (Figures 2 and 3). Complete snare excision was the goal in each case. Minor residual not amenable to snare excision was treated with diathermy with the snare tip set at “soft coagulation” (ERBE, VIO 300, effect 4–6, 80 W) or argon plasma coagulation (at 20–40 W and 0.5–1 L flow depending on the lesion location). Visible vessels in the EMR defect that were not bleeding were not routinely treated prophylactically. Excised tissue was retrieved for histologic analysis.

Detailed data were recorded including lesion characteristics, technical aspects, completeness of resection, use of additional therapeutic modalities (eg, argon plasma or soft coagulation) to destroy residual polyp, duration, and complications.

Patients were observed for a minimum of 4 hours after EMR and then discharged on a clear fluid diet overnight with postprocedural instructions.

Follow-up Evaluation

Early complications were documented at day 14 by structured telephone interview. Patients with com-

Figure 2. Example of successful EMR of a large granular lesion. (A) An 80-mm sized Paris 0–IIa granular lesion of the ascending colon. (B) This lesion was resected by sequential inject and resect EMR. The submucosa at resected areas appears blue because of methylene blue dye in the submucosal injection solution. The first resection was performed at the proximal and lateral margins, with a small amount (1–2 mm) of normal tissue at the margin included in the resection. (C) Sequential resections in continuity have removed the proximal aspect of the lesion. (D) The distal (anal) aspect of the lesion is now resected, commencing at the lateral margin. Snare placement is shown, again including a small margin of normal tissue. When closed, the tip of the snare is in continuity with the previous resection margin. (E) Approximately one quarter of the lesion remains, with no mucosal islands evident in the resected area. (F) Successful EMR is achieved. The lesion was entirely resected, resulting in a wide and clean mucosal defect; histology: tubulovillous adenoma with predominantly low-grade dysplasia and focal high-grade dysplasia.
plete endoscopic excision and without SMIC underwent colonoscopic surveillance at intervals of 4 months and then 12 months with photographic documentation and biopsy of the scar. For smaller lesions (20–25 mm) in which en bloc or 2-piece excision was achieved, 12-month surveillance alone could be performed at the discretion of the treating endoscopist. If the follow-up colonoscopy detected adenoma, this was resected.

Patients with SMIC in an EMR specimen were referred for surgery. Patients who declined surgery because of advanced age, comorbidities, or a low risk of nodal involvement (well-differentiated lesion with superficial submucosal involvement only and no lymphovascular involvement in EMR specimen) underwent colonoscopic surveillance as described earlier with biopsy specimens from the EMR scar.

Complications and Definitions

Postprocedure bleeding was defined as bleeding resulting in any of the following: (1) presentation to the emergency department, (2) hospital admission, or (3) repeat colonoscopy for hemostasis therapy. Immediate perforation was defined as a full-thickness defect in the colonic wall. Closure with endoscopic clips was performed and surgical consultation was obtained.

Statistical Analysis

Results for continuous variables were summarized using mean (standard deviation [SD]) or median (interquartile range) for skewed data. Frequencies (%) were used to summarize categoric variables. The Student t test was used to compare the distribution of continuous variables by outcome. The Pearson χ² or the Fisher exact test was used to test for association between categoric variables and outcome. Relative risks and their 95% confidence intervals were used to quantify the level of association. Two-tailed tests with a significance level of 5% were used throughout. All analyses were exploratory and no adjustment was made for multiple comparisons. Multiple logistic regression with backward stepwise variable selection was used to identify the independent predictors of outcomes of interest. Candidate variables for inclusion in a model included any variable significant at a P value of .1 or less on univariable analysis. If more than one lesion meeting inclusion criteria was resected during the study period, only the largest lesion was included in the analysis. When analyzing risk factors for recurrence of adenoma at follow-up evaluation, the continuous variables of lesion size and number of pieces resected were grouped into tertiles.

Statistical analyses were performed using SPSS 17 (SPSS, Inc, Chicago, IL).

Results

Patient and Lesion Characteristics

Over a 23-month period, 479 patients (53% men; mean age, 68.5 y; range, 34–91 y) with 514 lesions were enrolled. A total of 453 patients had 1 lesion, 22 patients had 2 lesions, and 4 patients had up to 5 lesions. A total of 192 patients (40.1%) had an American Society of Anesthesiology score of 1; 229 patients (47.8%) had a score of 2; and 58 patients (12.1%) had a score of 3. The median number of patients treated at each center was 45 (interquartile range, 18–81). The mean lesion size was 35.6 mm (range, 20–100 mm; SD, 16.1 mm). The median lesion size was 30 mm (interquartile range, 25–40 mm).

Lesion characteristics are detailed in Table 1. The majority of lesions (54.7%) were located in the right colon. Flat lesions (Paris classification 0–IIa) and granular surface morphology were most prevalent. Most lesions (59.1%) were easy to reach and in favorable positions for resection. A previous attempt at resection by the referring endoscopist had occurred in 53 cases (11.1%).

Histology findings were 267 tubulovillous adenomas, 130 tubular adenomas, 53 sessile serrated lesions, 11 villous adenomas, 7 hyperplastic lesions, and 11 cases with mixed histology (6 tubulovillous adenoma plus sessile serrated lesion, 3 adenoma plus lipoma, and 2 adenoma plus carcinoid).

Predictors of Submucosal Invasion (Adenocarcinoma)

Thirty-three patients had SMIC proven histologically (30 in the EMR specimen and 3 in surgical speci-
mens for which EMR was not attempted). Risk factors for SMIC were as follows: Paris 0–IIa +c classification, non-granular surface morphology, or Pit pattern V (Table 1). The presence of multiple risk factors magnified the SMIC risk, being 46.2% in 0–IIa +c nongranular lesions (6 of 13 cases), and 55.5% (5 of 9 cases) when type V pit pattern also was present. The 0–IIa nongranular lesions were of intermediate risk at 12.8% (6 of 47). In contrast, the most prevalent 0–IIa granular lesion had a 1.4% rate (2 of 139 cases) of SMIC. Lesion size was not a risk factor for SMIC (SMIC present, 35.3 mm; SD, 12.6 mm; SMIC absent, 35.6 mm; SD, 16.4 mm; \( P = .877 \)).

### Technical Aspects

EMR was attempted in 464 of 479 patients (96.9%). It was not attempted in 15 patients because of suspected SMIC in 6 and a technically unsuitable lesion for EMR in 9. These patients were referred for surgery. The mean and median number of endoscopic resections per lesion was 4.3 (SD, 3.8) and 4.0 (interquartile range, 2.0–6.0).

The mean procedure duration for all cases was 25.3 minutes (SD, 21.6 min). The mean procedure duration increased as lesion size increased: 12 (SD, 9) minutes for lesions sized 20–29 mm; 22 (SD, 14) minutes for lesions sized 30–39 mm; 30 (SD, 18) minutes for lesions sized 40–49 mm; 37 (SD, 20) minutes for lesions sized 50–59 mm; 46 (SD, 25) minutes for lesions sized 60–69 mm; and 76 (SD, 32) minutes for lesions sized 70 mm or larger.

Complete excision was achieved in 414 of 464 lesions (89.2%). Of the 50 unsuccessful cases, 25 were referred for surgery, including 8 with SMIC in the EMR specimens. The remaining 25 underwent a second attempt at EMR. Of these, 16 were successful. Of the 9 unsuccessful, 4 were referred for surgery at that point, and 5 were planned for a third attempt at endoscopic treatment.

### Risk Factors for EMR Failure

In multiple logistic regression analysis, independent predictors of failure to achieve complete single-session excision were a previous attempt at removal

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| Table 1. Lesion Characteristics and Percentage With Submucosal Invasion (Adenocarcinoma) |
|---------------------------------|-----------------|-----------------|-----------------|
| Lesion location                 | n = 479         | % of total cohort |
| Rectum                          | 76              | 15.9            |
| Sigmoid colon                   | 56              | 11.7            |
| Descending colon                | 20              | 4.2             |
| Splenic flexure                 | 6               | 1.3             |
| Transverse colon                | 59              | 12.3            |
| Hepatic flexure                 | 42              | 8.8             |
| Ascending colon                 | 103             | 21.5            |
| Cecum only                      | 84              | 17.5            |
| Cecum with ileocecal valve       | 25              | 5.2             |
| Cecum with appendix orifice      | 8               | 1.7             |

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<th>n (%) with SMI</th>
<th>P value</th>
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by the referring endoscopist, involvement of the ileocecal valve, and difficult position. A previous attempt created technical difficulty as a result of submucosal fibrosis, with nonlifting of the lesion with submucosal injection, consequent failed snare excision, and the need for additional treatment modality (fulguration with thermal or argon plasma coagulation) (Table 2, Table 3, and Figure 4).

**Complications**

Thirty-seven patients (7.7%) were admitted to the hospital after the procedure for complications.

**Postprocedure pain.** Ten patients (2.1%) were admitted for one night with nonspecific abdominal pain that resolved by the following day.

**Serositis.** Serositis was defined by postprocedural abdominal pain without perforation but with signs of inflammation including localized peritonism, fever, or leukocytosis. Seven patients (1.5%) were treated with an-
tibiotics for suspected serositis and stayed for 3–5 days with full recovery.

**Bleeding.** Fourteen patients (2.9%) were admitted for bleeding (11 presented within 24 hours, 2 presented between 24–48 hours, and 1 presented on day 10). Seven patients were managed conservatively. Six patients underwent repeat colonoscopy with 4 patients requiring hemostatic clip or coagulation application with successful hemostasis achieved. One patient presented to a peripheral hospital at 48 hours and required an extended right hemicolectomy.

**Perforation.** Six patients (1.3%) had a perforation. Three involved en bloc resection of 20–25 mm sized 0–IIa, 0–IIa+c, or 0–IIa+Is lesions, in which inspection of the EMR defect immediately revealed the perforation. These 3 patients had successful closure of the perforation with clips, had reassuring computed tomography scans, and were managed conservatively with full recovery. Two of these 3 patients had no pain and therefore were discharged the same day with close clinical follow-up evaluation on a clear fluid diet with no further sequelae. The third patient had some mild persisting abdominal pain and was admitted overnight and discharged feeling well the next day.

In the fourth case, the perforation occurred during the final resection of a 45-mm Paris 0–IIa laterally spreading tumor of the descending colon that was removed in 6 pieces. The perforation was recognized immediately and clipped closed, but the patient remained symptomatic. A diagnostic laparoscopy revealed complete closure of the defect with no peritoneal soiling and no peritonitis. The patient was admitted to the hospital and managed conservatively, making a full recovery and being discharged on day 9.

In the fifth case, a perforation was not apparent at the conclusion of EMR of a 25-mm Paris 0–IIa lesion at the hepatic flexure. After the procedure the patient developed abdominal distention and pain. Repeat colonoscopy was undertaken immediately and the perforation was identified, however, significant edema at the EMR site meant that clip placement was not possible. The patient underwent surgery and was discharged on day 14.

In the sixth case, the lesion was a 30-mm 0–IIa+c non-granular lesion of the ascending colon that was attempted previously. It lifted poorly with submucosal injection, and piecemeal resection was undertaken cautiously. Two areas of deep resection, possibly into the muscularis propria, but not believed to represent complete perforation, were noted. Two clips were applied. A small central area of adenoma could not be resected. The patient was asymptomatic at the conclusion of the procedure, but subsequently developed clinical signs of a perforation. This patient proceeded directly to surgery because of the low likelihood that the lesion would ever be able to be completely resected endoscopically. The patient recovered well and was discharged on day 8.

**Follow-up Colonoscopy**

To date, 328 of 414 (79.2%) successful EMR patients have undergone follow-up colonoscopy (243 at 4 months, 41 at 12 months, and 44 at an interval of 4–12 months). Sixty-seven patients (20.4%) had recurrent or residual adenoma present.

Multiple logistic regression analysis found that independent predictors of recurrence were large lesion size (>40 mm) and use of argon plasma coagulation (APC) during EMR (Table 3). The presence of high-grade dysplasia in the EMR specimens or 6 or more resections being required to excise the lesion were significant on univariable analysis only (Table 2).

The recurrent/residual adenoma was unifocal, diminutive, and easily resected or ablated in 60 of 67 patients and thus a subsequent colonoscopy was scheduled for 12 months. In 7 patients, the recurrent/residual adenoma was not amenable to complete endoscopic resection. In 4 very large lesions, although not apparent at the initial intervention, residual adenoma extended in an inaccessible fashion into the appendiceal orifice in 2 patients and ileum and ileocecal valve in 2 patients. One patient had SMIC detected in the excision specimens of the residual adenoma and 2

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**Figure 4.** A previous attempt at resection causes submucosal fibrosis and increases the risk of EMR failure. (A) Attempted submucosal injection results in the jet sign, where the fluid sprays back into the lumen at high pressure as it is injected. Submucosal fibrosis has obliterated the submucosal space, resulting in the jet sign, and nonlifting of the lesion. (B and C) Submucosal fibrosis is visible endoscopically during EMR. The white tissue bands are fibrotic deposits caused by electrocautery during the previous resection. (D) Fibrosis is visible histologically with H&E staining of the EMR specimen.
had inaccessible recurrent adenoma at the hepatic flexure. These patients were referred for surgery.

**Surgical Outcomes**

Seventy-eight patients (16.3%) were referred for surgery (lesion technically unsuitable for EMR in 9 patients, suspected adenocarcinoma in 6 patients [SMIC was detected in the surgical specimen in 3 patients], failed EMR in 21 patients, failed EMR plus SMIC in EMR specimens in 8 patients, SMIC in EMR specimens in 21 patients, perforation in 3 patients [managed with laparoscopy in 1 patient and laparotomy in 2 patients], bleeding in 1 patient, recurrent/residual adenoma at follow-up evaluation that was unresectable by EMR in 7 patients, and advanced synchronous lesions in other locations in the colon in 2 patients), of whom 69 patients proceeded with surgery. Seven patients did not proceed because of comorbidities or advanced age. One patient had low-risk SMIC in the EMR specimen with clear lateral and deep margins and declined surgical referral.

**Deaths in Cohort**

There were no deaths caused by EMR. One patient with compensated cirrhosis (Child–Pugh A) had a 0–Is + 0–IIa granular rectal lesion fully excised by EMR. Low-risk SMIC was detected in one of the EMR specimens. The study endoscopist advised against surgery because of lesion location, favorable histology, and patient comorbidities. However, the patient opted for surgery based on the advice of both his referring gastroenterologist and surgeon. The surgery was technically successful, and no residual adenoma or carcinoma was present in the surgical specimen at either the EMR site or regional lymph nodes. Perioperative hepatic decompensation developed, resulting in death 10 days after surgery.

**Discussion**

This multicenter study shows that EMR is a safe and effective therapy for large sessile polyps. It is an alternative to surgery, which is the traditional standard and remains commonplace. However, these lesions frequently are detected in older patients with comorbidities that increase surgical risk. Surgery is associated with up to a 5% mortality risk. In our cohort, the mean age was 68.5 years, and American Society of Anesthesiology scores of 2 and 3 were present in 47.8% and 12.1%, respectively. There were no deaths as a result of EMR. A single surgical death occurred. The less invasive endoscopic approach has significant advantages if effective.

The application of endoscopic treatment is limited by the difficulty in determining which lesions are likely to be confined to the mucosa and therefore suitable for EMR, and which are likely to harbor SMIC, for which EMR likely would not be curative. Predicting an increased risk of submucosal invasion on the basis of a lesion's endoscopic appearance is now feasible for all endoscopists as a result of concomitant advances including the following: (1) standardized definitions of polyp descriptors (Paris classification, granularity, pit pattern); (2) higher definition endoscopes providing sufficient visual resolution to enable accurate classification with white-light endoscopy alone; and (3) evidence from Japanese studies that these classifications can stratify for the risk of invasion. Flattened lesions with a depressed component (Paris 0–IIa+c), with a non-granular surface, or with an advanced pit pattern have a significantly higher risk of containing adenocarcinoma. These lesions optimally should be removed en bloc (in a single piece). En bloc resection provides the patient with the best chance of a curative resection (if low-risk SMIC is present), and enables the pathologist to assess the margins accurately. This is critical because well-differentiated lesions with superficial submucosal invasion (<1000 μm) and no lymphovascular involvement on histologic assessment likely are cured by endoscopic resection. Depending on local expertise, options for en bloc removal may include EMR (limited to lesions sized 20–25 mm), endoscopic submucosal dissection, or surgery.

However, the prevalence of SMIC in the lesions encountered was low overall at only 6.9%. Ultimately, in this multicenter intention-to-treat study, EMR succeeded in 84%. This technique also is efficient with a mean procedure duration of 25 minutes. Furthermore, our data suggest that the EMR procedure duration may be predicted based on a lesion’s maximum dimension. Each increase in lesion size of approximately 10 mm results in an increase in EMR duration of approximately 8–10 minutes. This is likely because most lesions are approximately circular in shape, and therefore the surface area for resection increases proportionally to the square power of half the maximal lesion dimension (surface area, πr²). This knowledge may be of benefit when scheduling procedures for EMR of previously identified lesions. A primary strategy of colonoscopy and EMR should be the standard of care. Cases unsuitable for EMR or when EMR is unsuccessful may still be referred for surgery.

Standard assessment should take into account lesion characteristics, size, location, and position. We found that risk factors for failure were lesions in a difficult position for EMR, involvement of the ileocecal valve, and a previous attempt by the referring endoscopist. Although success rates were 91.0% for a treatment-naïve lesion, this decreased to 74.5% for a previously attempted lesion, primarily owing to submucosal fibrosis that greatly increased the technical difficulty at a subsequent attempt. The submucosal fibrosis is induced by the electrocautery injury that occurs at the first attempt. As a result, the likelihood of a lesion failing to lift with submucosal injection increased more than 6-fold. Furthermore, the likelihood of an incomplete excision with snare alone and need for additional therapeutic modality more than doubles. Referral to an expert center always should be considered to achieve success at the initial attempt.
lesions with a mean size of 35 mm is within the range of death in our cohort resulted from surgery for a rectal lesion. The single potential morbidity (including requirement for stoma or pouch formation in some cases) and mortality. The approach is justified because surgery is attended by serious endoscopic complications such as perforation or major bleeding, and a more aggressive endoscopic approach is justified because surgery is attended by serious potential morbidity (including requirement for stoma or pouch formation in some cases) and mortality. The single death in our cohort resulted from surgery for a rectal lesion.

The recurrence rate of 20% in this large cohort of lesions with a mean size of 35 mm is within the range of 0%-55% reported in the literature. Our technique focused on meticulous attention to attempt complete snare excision, including resection of a small margin (1–2 mm) of normal tissue, to minimize the likelihood of recurrence from the edge of the lesion. The edges of the lesion were not routinely prophylactically treated with APC to prevent recurrence. A study of 21 patients in 2002 with substantially smaller lesions (mean size, 26 mm) suggested a role for APC to reduce recurrence even when a lesion was believed to be fully excised by piecemeal EMR. However, the contemporary endoscopes used in the present study confer a significantly greater ability to accurately distinguish between adenoma and normal mucosa, thereby facilitating complete snare resection.

When the lesion cannot be fully excised with snare alone, the traditional practice is to resort to an ablative modality such as APC or thermal coagulation to treat the residual adenoma. We have identified the use of APC as a risk factor for recurrence or residual adenoma at follow-up colonoscopy. Our data suggest that nonexcisional therapies cannot be relied on to achieve a successful outcome. Increased lesion size also was associated with a higher rate of recurrence, likely owing to undetected microscopic foci of adenoma at the margin of each snare resection overlap. These risk factors may be useful for guiding the timing of follow-up colonoscopy. Guidelines recommend follow-up colonoscopy at 3–6 months after piecemeal EMR of large lesions, however, the optimal timing is not yet known. Endoscopic follow-up evaluation potentially could be delayed for lesions at lower risk of recurrence.

Although the phenomenon of “late recurrence” after a previous endoscopic and biopsy-negative 3- to 6-month follow-up colonoscopy is recognized, it is relatively rare, reported in only 2% of cases. Because almost 80% of eligible patients have undergone follow-up colonoscopy and biopsy in our study to date, even as we continue to follow up the cohort long term (≥12 months), it is unlikely that the recurrence rate will differ significantly from the presently reported rate.

The perforation rate of 1.3% in the present study is a reminder that EMR does carry a significantly higher perforation risk than standard diagnostic colonoscopy. This should be emphasized in the process of obtaining informed consent. However, surgery for perforation was uncommon. Only 2 patients (0.4%) required partial colectomy as a result of perforation, and 1 patient had a diagnostic laparoscopy that was normal. The majority of perforations may be detected during the procedure and closed endoscopically with good clinical outcomes. After extensive EMR, nonspecific abdominal pain is not infrequent. Patients must be clinically examined for signs of peritonism that may suggest serositis or perforation. Serositis is characterized by signs of inflammation including localized peritonism, fever, or leukocytosis. Where endoscopically unrecognized perforation has occurred, the signs usually are progressive, but presentation may be delayed. Persisting pain requires radiologic assessment, preferably with computed tomography, and surgical review. Other common causes of pain include the following: (1) excessive transmural fluid injection, where generally no localizing signs are found and the pain usually resolves with simple analgesia, and (2) air-induced distention of the colon and small bowel. When the ileocecal valve is incompetent, endoscopic decompression of the colon will not be beneficial. Therefore, carbon dioxide insufflation is advantageous for long EMR procedures.

In conclusion, EMR in a tertiary setting is a safe, efficient, and effective minimally invasive outpatient therapy for large sessile polyps or laterally spreading tumors of the colon. Regardless of size, the majority of sessile adenomas are at low risk for containing submucosal invasion, particularly the most prevalent 0–IIa granular lesions, and are suitable for EMR. Surgery can be avoided in 84% of patients with substantial clinical and fiscal gains. Paris classification, nongranular morphology, and advanced pit pattern may be used to identify lesions at high risk for SMIC, where other manage-
ment options should be considered to achieve en bloc resection. The first EMR procedure is critical in determining the outcome, with previous failed intervention strongly associated with further EMR failure.

References

Received November 16, 2010. Accepted February 18, 2011.

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Acknowledgments
Oral presentations were performed at Digestive Disease Week, New Orleans, LA, 2010; United European Gastroenterology Week and World Congress Gastroenterology, London, UK, 2009; Digestive Disease Week, Chicago, IL, 2009; and Australian Gastroenterology Week, Sydney, Australia, 2009.

Conflicts of interest
The authors disclose no conflicts.

Funding
The Cancer Institute New South Wales provided funding for a research nurse and data manager to assist with the administration of the study. There was no influence from the Institution regarding study design or conduct, data collection, management, analysis or interpretation, or preparation, review, or approval of the manuscript.