The Effect of Electrothermal Cautery-Assisted Resection of Diminutive Colonic Polyps on Histopathologic Diagnosis

Neal S. Goldstein, MD,[1] John C. Watts, MD,[1] James S. Neill, MD,[1] L. Michelle Vogel, MD,[2] Donald Barkel, MD,[2] Omar Kadro, MD,[2] Steven Priest, MD,[2] and Steven Klein, MD[2]

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Abstract

We examined diminutive colonic polyps to identify relationships between thermal electrocoagulation or resection trauma cytologic artifacts, type of thermal electrocoagulation, polyp size, and the interobserver variation among 3 pathologists. The 3 pathologists independently evaluated 119 colonic polyps 5 mm or less in maximum dimension for diagnosis and degree of thermal electrocoagulation or resection trauma cytologic artifacts. The maximum dimension of the polyps and type of thermal electrocoagulation were recorded. The average percentage of polyps in which a definitive diagnosis could not be made because of cytologic artifacts was 16.5% (range, 11.8%-19.3%). Decreasing polyp size was associated linearly with the inability to make a definitive diagnosis owing to cytologic artifacts. Polyps smaller than 2 mm significantly more often could not be definitively diagnosed by at least 1 pathologist owing to cytologic artifacts, including some polyps that were excised without thermal electrocautery. Interobserver variation increased with decreasing polyp dimension. Two millimeters seems to represent a cut point, below which the likelihood that a definitive diagnosis can be made can be increased if thermal electrocoagulation is used. This small size seems to make them especially susceptible to cytologically injurious forces.

Endoscopic biopsy and resection of colonic polyps is performed routinely as part of colon cancer prevention and screening programs. The identification of an adenoma indicates the need for a complete colonoscopy if it was found during sigmoidoscopy and future screening colonoscopies.[1-11] In general, additional colonoscopy is not recommended if only hyperplastic polyps are found.

The crucial component of these therapeutic decisions is that the pathologist is able to make a definitive diagnosis of the excised polyp. It has been our experience that the cytologic features of diminutive colonic polyps can be distorted extensively, usually by thermal electrocoagulation–induced cytologic artifacts, such that a definitive diagnosis cannot be made. Occasionally, we also have observed similar cytologic artifacts in diminutive polyps that were excised without thermal electrocautery. Factors that produce thermal artifact-type changes in colonic polyps and their effect on diagnosis have not been studied, to our knowledge. Does polyp size affect the pathologist's interpretation? Does the threshold at which these artifacts prevent a definitive diagnosis vary among pathologists? Does the type of electrical current waveform and power setting used in polyp electrocoagulation affect the ability of pathologists to make a definitive diagnosis in diminutive colonic polyps?

We examined diminutive colonic polyps to evaluate the relationships between coagulation-induced thermal artifacts, polyp size, and interobserver diagnostic variation among 3 pathologists (N.S.G., J.C.W., J.S.N.).

Materials and Methods

The studied specimens were 119 colonic polyps, each 5 mm or less in maximum dimension, that were resected

endoscopically from 101 patients who were treated at the endoscopy suite at William Beaumont Hospital, Royal Oak, MI. The first 110 polyps were resected from 95 consecutive patients during the period July 21, 1999, through September 2, 1999. An additional 9 polyps, from 6 patients, were resected during the period March 1 to March 10, 2000. The latter group of polyps was added to the study because the initial study group had too few polyps resected without thermal electrocautery for valid statistical analyses. All colonoscopies were performed by the colorectal surgeon authors of the study.

All polyps in which thermal electrocautery was used were resected in a similar manner. Colonoscopy was performed with an Olympus CF140Q (Olympus, Strongville, OH) colonoscope. The polyp was grasped, oriented, and pulled toward the lumen by a 2.2-mm cup, Microvasine Endoglide thermal electrocautery forceps (Boston Scientific, Boston, MA). Slight pulling force was applied to the polyp while electrical current (Olympus PSD IO, Olympus) was on for several seconds until a white coagulum was seen at the polyp base, and the polyp was severed from the stalk.[12] Polyps that were resected without thermal electrocautery were resected in a similar manner. After being grasped and oriented, force was gently applied until the polyp was separated from the stalk. The forceps was withdrawn from the colonoscope, and the polyp was removed from its cup. The forceps was reinserted into the colonoscope, the polyp stalk was regrasped in the tip of the cup, and thermal electrocautery was applied until a white coagulum was observed. The electrocautery current waveform and intensity settings were the individual preferences of the surgeons. The duration of applied current was not recorded.

No polyps were resected in a piecemeal fashion or using a snare. The maximum dimension of each polyp was measured by one of us (N.S.G.) using a handheld micrometer. The maximum dimension from stalk to polyp surface and across the length of the polyp's surface was measured for each polyp, and the larger dimension was used as the polyp's maximum dimension.

The polyps were evaluated independently by each pathologist for 2 parameters without knowledge of the other pathologist's diagnoses:

1. Diagnosis category: hyperplastic, adenoma, other polyp, or cannot categorize because of thermal electrocautery- or resection trauma–induced cytologic artifacts (cytologic artifacts).

2. Certainty factor of the diagnosis: able to make a definitive diagnosis, able to make a diagnosis despite marked cytologic artifacts, or unable to make a definitive diagnosis because of cytologic artifacts.

Statistical analyses used the SAS statistical program, version 6.12 (SAS Institute, Cary, NC). The kappa statistics for normal responses were used to compare the diagnoses of 2 pathologists (1 vs 2, 1 vs 3, and 2 vs 3). This test evaluates the amount of agreement in 2 categories that is greater than chance alone. Kappa statistics, using the SAS AGREE macro, were used to compare the diagnoses of the 3 pathologists. The categorical degrees of agreement for the kappa values were as follows: 0, poor; >0 to 0.2, slight; >0.2 to 0.4, fair; >0.4 to 0.6, moderate; >0.6 to 0.8, substantial; >0.8 to 1.0, excellent. Logistical regression analyses were used to compare polyp size as a continuous variable with the pathologist's diagnoses. The chi-square test was used to compare categories of pathologist's diagnoses and certainty factors.

Results

The mean and median polyp maximum dimension was 1.8 mm (range, 0.4-4.5 mm; SD, 0.85 mm). Sixty-three polyps (52.9%) were smaller than 2 mm. Eighteen polyps (15.1%) were resected without thermal electrocoagulation, 22 (18.5%) were resected using a setting of 2.5 blended thermal electrocoagulation, 25 (21.0%) were resected using a setting of 3.5 blended thermal electrocoagulation, 51 (42.9%) were resected using a setting of 3.0 cutting thermal electrocoagulation, and 3 (2.5%) were resected using a setting of 2.5 cutting thermal electrocoagulation.

Diagnosis Categories

Adenoma was the most common diagnosis among the 3 pathologists **Table 1**. The numbers of polyps within each diagnostic category were not statistically different among the 3 pathologists ($P = .856$). The average percentage of polyps in which a definitive diagnosis could not be made because of cytologic artifacts was 16.5% (range, 11.8%-19.3%). There were 29 polyps (24.4%) in which at least 1 pathologist could not make a diagnosis because of cytologic artifacts. Twenty-four (83%) of these 29 polyps were smaller than 2.0 mm in maximum dimension.

Polyp Size

Decreasing polyp size, when analyzed as a continuous variable, was associated significantly with the inability to make a diagnosis owing to cytologic artifacts by each pathologist and by any of the pathologists ($P = .022$). The mean and median polyp size in which at least 1 pathologist could not make a definitive diagnosis was 1.3 and 1.2 mm, respectively, compared with 2.2 and 2.3 mm, respectively, among polyps in which a definitive diagnosis was made by all 3 pathologists. Using 2 mm as a polyp size cut point, a definitive diagnosis could not be made by at least 1 pathologist in 24 (38%) of the 63 polyps that were smaller than 2 mm in maximum dimension compared with 5 (9%) of 56 polyps that were 2 mm or larger ($P < .01$).

Table 1
Diagnoses and Certainty Factors in 119 Cases*

	Pathologist 1	Pathologist 2	Pathologist 3
Diagnosis			
Hyperplastic polyp	37 (31.1)	45 (37.8)	39 (32.8)
Adenoma	58 (48.7)	59 (49.6)	55 (46.2)
Other polyp	1 (0.8)	1 (0.8)	3 (2.5)
Unable to make diagnosis owing to cytologic artifacts	23 (19.3)	14 (11.8)	22 (18.5)
Certainty factor			
Able to make a definitive diagnosis	77 (64.7)	80 (67.2)	83 (69.7)
Able to make a definitive diagnosis despite marked thermal electrocoagulation artifacts	19 (16.0)	25 (21.0)	16 (13.4)
Unable to make a definitive diagnosis because of thermal electrocoagulation artifacts	23 (19.3)	14 (11.8)	22 (18.5)

* Data are given as number (percentage).

Interobserver Variation

There was substantial overall diagnostic agreement (kappa = 0.745) **Table 2**. The agreement between individual pathologists was substantial or excellent. The kappa value between the pathologists increased to 0.897 when the polyps for which any of the pathologists could not make a definitive diagnosis owing to marked cytologic artifacts were excluded.

At least 2 pathologists made different diagnoses in 31 cases. One of the pathologists could not make a definitive diagnosis, while the other pathologist made a definitive diagnosis despite marked cytologic artifacts in 29 (94%) of these 31 cases. In 2 cases, definitive diagnosis could be made by all 3 pathologists, but different diagnoses were made. Both polyps were smaller than 1.4 mm in maximum dimension. One was diagnosed as "other polyp" by 2 pathologists and hyperplastic polyp by the third. The second was diagnosed as other polyp by 1 pathologist and as hyperplastic polyp by the other 2 pathologists. There were no discrepant tubular adenoma vs hyperplastic polyp cases among the polyps in which all 3 pathologists could make a diagnosis.

Interobserver Variation and Polyp Size

The interpathologist diagnostic agreement significantly increased with colonic polyp size (linear regression test, $P < .01$) **Table 3**. The interpathologist diagnosis agreement was moderate for polyps smaller than 1 mm in maximum dimension, substantial for polyps 1 to less than 2 mm, and increasingly excellent for polyps 2 mm or larger.

Cytologic Artifacts and Polyp Size

A greater percentage of polyps excised by the cold-cup method were diagnosed definitively by each or all of the pathologists. At least 1 pathologist could not make a definitive diagnosis because of cytologic artifacts in 2 (11%) of 18 polyps that were excised without thermal electrocautery, compared with 27 (26.7%) of 101 polyps in which thermal electrocautery was used ($P = .320$). Among polyps smaller than 2 mm in maximum dimension, a definitive diagnosis could not be made by at least 1 pathologist because of marked cytologic artifacts in 2 (20%) of 10 polyps that were excised without thermal electrocautery (cold cup), compared with 23 (45%) of 51 polyps that were excised with thermal electrocautery ($P = .471$). A morphologic distinction between cytologic artifacts present in small polyps excised with cold cup and thermal electrocautery was not possible.

The type of thermal electrocoagulation, including blended or cutting, and current setting were not associated with the inability to make a definitive diagnosis ($P = .08$-$.41$).

Certainty Factors

The diagnostic certainty factor values among the 3 pathologists are listed in Table 1. Among the 3 pathologists, a diagnosis could be made despite cytologic artifacts for 19 (16.0%), 25 (21.0%), and 16 (13.4%) polyps, respectively, and a definitive diagnosis could not be made because of marked thermal electrocoagulation–induced cytologic artifacts in 23 (19.3%), 14 (11.8%), and 22 (18.5%) cases,

Table 2
Diagnosis Agreement Between Pathologists

Comparison of Pathologists' Decisions	Kappa	*P*	Agreement Category
1 vs 2	0.782	<.01	Substantial
1 vs 3	0.854	<.01	Excellent
2 vs 3	0.797	<.01	Substantial
1 vs 2 vs 3	0.745	<.01	Substantial

Table 3
Colonic Polyp Size and Diagnosis Agreement

Colonic Polyp Size (mm)	Number	Kappa	*P*	Agreement Category
<1	23	0.414	<.01	Moderate
1 to <2	40	0.636	<.01	Substantial
2 to <3	45	0.867	<.01	Excellent
3 to <4	8	0.923	<.01	Excellent
4 to 5	3	0.999	<.01	Excellent

respectively. The numbers of polyps within each of the certainty factor categories was not statistically different among the 3 pathologists ($P = .766$).

Polyp Size

All 3 pathologists were able to achieve a greater percentage of definitive diagnoses with increasing polyp size **Table 4**. For polyps smaller than 1 mm in maximum dimension, 43% to 48% were diagnosed definitively compared with 62% to 75% of polyps 3 to 4 mm in maximum dimension. All 3 of the 4 to 5 mm polyps were diagnosed definitively by all 3 pathologists. There were no appreciable differences in the percentages of polyps in which a definitive diagnosis could be made despite marked cytologic artifacts among the polyp size groups.

Discussion

Thermal electrocoagulation–assisted excision, using an insulated forceps, is a standard method of excising diminutive colonic polyps. It has the advantages of simultaneously excising the polyp, fulgurating any remaining adenomatous epithelium at the polyp base, and improving hemostasis by coagulating the stalk's blood vessels.[13-15] The additional destruction of mucosa at the polyp base by thermal electrocautery is important in cases of adenoma. A significantly greater percentage of small adenomatous polyps have residual adenomatous epithelium if they are excised without thermal electrocoagulation compared with those resected with thermal electrocoagulation.[12,16,17]

Thermal electrocautery is a safe procedure, and complications are rare when the hot biopsy forceps cup is used in the recommended manner.[18] Insulated metal cups allow monopolar electrical current to travel through the device's tip while preferentially sparing the excised tissue within the cup. Offsetting these advantages is the inducement by electrical current of cytologic artifacts that may substantially impede a pathologist's ability to make a definitive diagnosis. To our knowledge, the effect of thermal electrocoagulation– and resection trauma–induced cytologic artifacts on pathologic interpretation has not been addressed. We cannot overlook the observation that other authors, who have specifically addressed the complications associated with diminutive polyp resections, fail to consider significant thermal cautery artifacts that preclude a definitive diagnosis as a procedure-related complication.[18-20] In addition, we find it remarkable that all 3,371 polyps reported in the National Polyp Study could be diagnosed definitively, including the 1,270 polyps (37.67%) that were 5 mm or less in maximum dimension.[11] Other studies have reported similar percentages of definitively diagnosed colonic polyps.[21,22] Williams[23] stated that in his experience, hot biopsy removal of small polyps resulted in a high rate of specimens with interpretable histologic features (95%). One study reported that only 2 (0.19%) of 1,048 small polyps that were resected using the hot biopsy forceps technique had coagulation necrosis that prevented specific histologic diagnosis.[24] Another study reported a 5.1% (24/468 polyps) inadequate specimen rate, but it is not clear whether inadequacy was due to thermal electrocautery artifacts.[21]

We found that a definitive diagnosis could not be made by a pathologist because of thermal electrocoagulation– or resection trauma–induced cytologic artifacts in an average of 16.5% (range, 11.8%-19.3%) of polyps 5 mm or smaller in maximum dimension. Although these percentages are greater than any previously reported, we believe that they are an accurate clinicopathologic reflection of the prevalence of

Table 4
Colonic Polyp Size and Certainty Factor*

	Colonic Polyp Size (mm)				
Certainty Factor	**<1 (n = 23) (100%)**	**1 to <2 (n = 40) (100%)**	**2 to <3 (n = 45) (100%)**	**3 to <4 (n = 8) (100%)**	**4 to 5 (n = 3) (100%)**
Pathologist 1					
Definitive diagnosis	10 (43)	24 (60)	35 (78)	5 (62)	3 (100)
Diagnosis despite artifacts	4 (17)	5 (12)	8 (18)	2 (25)	0 (0)
Unable to diagnose	9 (39)	11 (28)	2 (4)	1 (12)	0 (0)
Pathologist 2					
Definitive diagnosis	11(48)	23 (58)	37 (82)	6 (75)	3 (100)
Diagnosis despite artifacts	8 (35)	10 (25)	7 (16)	0 (0)	0 (0)
Unable to diagnose	4 (17)	7 (18)	1 (2)	2 (25)	0 (0)
Pathologist 3					
Definitive diagnosis	10 (43)	26 (65)	36 (80)	6 (75)	3 (100)
Diagnosis despite artifacts	7 (30)	2 (5)	6 (13)	1 (12)	0 (0)
Unable to diagnose	6 (26)	12 (30)	3 (7)	1 (12)	0 (0)

* Data are given as number (percentage).

nondefinitive diagnoses of small colonic polyps. The differences between the results of the present study and those reported in the literature also suggest that pathologists may be making inaccurate diagnoses of small polyps that are extensively cauterized or traumatized in an attempt to provide a definitive diagnosis. Possibly, some hyperplastic or other nonadenomatous polyps are being diagnosed incorrectly as adenomas, leading unnecessarily to additional colonoscopic surveillance of the patient.

We found that decreasing polyp size was associated linearly with the inability to make a definitive diagnosis owing to cytologic artifacts. A definitive diagnosis could not be made by at least 1 pathologist in a significantly greater number of polyps that were smaller than 2 mm in maximum dimension. The interobserver variation between pathologists increased with decreasing maximum dimension of the polyp. The majority of polyps in which at least 1 pathologist was unable to make a definitive diagnosis were smaller than 2 mm in maximum dimension. Polyps that were excised with thermal electrocautery more often were not diagnosed definitively by at least 1 pathologist compared with polyps that were resected without thermal electrocoagulation. This difference, although not statistically significant, was greatest among polyps smaller than 2 mm in maximum dimension. The polyps that were excised without thermal electrocoagulation in which a definitive diagnosis was not made reflect trauma-induced changes.

These results suggest that a maximum polyp dimension of 2 mm is a cut point, below which the chances of a definitive diagnosis can be increased if thermal electrocoagulation is avoided. Although a definitive diagnosis occasionally cannot be made owing to resection-induced trauma alone, it seems that this problem can be minimized if the polyp is first resected and removed from the forceps cup without thermal electrocautery. Thermal electrocautery can be administered after the removal of the polyp.[25-27]

The physical principles underlying thermal electrocautery induction of cytologic artifacts are not well understood. We found no relationship between the severity of cytologic artifacts in a polyp and the type or power setting of electrical current applied. Electrical current density of monopolar current is a key factor in the amount of tissue destruction.[28] Temperature elevation within tissue is proportional to the square of the current density.[29] The current density and temperature are highest in the tented pseudostalk of the polyp.[28] The pseudostalk coagulates first, and with continued current application, the adjacent tissue coagulates. Currently, the recommendation is to continue to apply electrical current after the stalk has been ligated until the base of the polyp becomes white. However, this additional current may have the deleterious effect of inducing cytologic changes in the excised polyp within the biopsy cup, despite its insulation.

Polyp size in the present study was determined by measurements made after tissue processing. This measurement has been shown to be slightly smaller than the measurement made on fresh tissue immediately after excision[30-32] and probably is due to the fixation process. These differences have never been considered significant, and postfixation measurement varies less than the consistently poor colonoscopic estimation of polyp size.[30-34] Endoscopic estimation of polyp size most often is significantly overestimated compared with actual measurement after removal.[32]

We found that the overall interobserver agreement among the 3 pathologists was substantial and was excellent if limited to cases in which definitive diagnoses could be made by all 3 pathologists. The latter kappa comparison value (kappa = 0.897) is almost identical to the kappa comparison value (kappa = 0.85) obtained by the authors of one study.[35] The authors of that study compared the diagnoses of 10 selected colonic polyps made by 22 community pathologists. All of the polyps could be diagnosed definitively, suggesting that part of the selection criteria included the lack of substantial thermal electrocautery–induced cytologic artifacts. Another study found a high sensitivity among community pathologists for the identification of adenomas.[36]

In summary, 2 mm seems to represent a cut point below which the likelihood of making a definitive diagnosis can be increased if thermal electrocoagulation is not used while the polyp is retained within the forceps cup, leaving resection trauma as the sole cause of injury. The size of polyps smaller than 2 mm in maximum dimension seems to make them especially susceptible to trauma-induced cytologic changes from mechanical or electrical agents. Although a definitive diagnosis occasionally cannot be made owing to resection trauma alone in small polyps, this artifact may be reduced if the polyp is removed from the forceps cup before thermal electrocautery.

From the Departments of [1]Anatomic Pathology and [2]Colorectal Surgery, William Beaumont Hospital, Royal Oak, MI.

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Address reprint requests to Dr Goldstein: Dept of Anatomic Pathology, William Beaumont Hospital, 3601 W Thirteen Mile Rd, Royal Oak, MI 48073.

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