

# Audit of hemostatic clip use after colorectal polyp resection in an academic endoscopy unit



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## ABSTRACT

**Background and study aims** Prophylactic closure of endoscopic resection defects reduces delayed hemorrhage after resection of non-pedunculated colorectal lesions  $\geq 20$ mm that are located proximal to the splenic flexure and removed by electrocautery. The risk of delayed hemorrhage after cold (without electrocautery) resection is much lower, and prophylactic clip closure after cold resection is generally unnecessary. The aim of this study was to audit clip use after colorectal polyp resection in routine outpatient colonoscopies at two outpatient centers within an academic medical center. Patients referred for resection of known lesions were excluded.

**Patients and methods** Retrospective chart analysis was performed as part of a quality review of physician adherence to screening and post-polypectomy surveillance intervals.

**Results** Among 3784 total lesions resected cold by 29 physicians, clips were placed after cold resection on 41.7% of 12 lesions  $\geq 20$  mm, 19.3% of 207 lesions 10 to 19 mm in size, and 2.8% of 3565 lesions 1 to 9 mm in size. Three physicians placed clips after cold resection of lesions 1 to 9 mm in 18.8%, 25.5%, and 45.0% of cases. These physicians accounted for 8.1% of 1- to 9-mm resections, but 69.7% of clips placed in this size range. Electrocautery was used for 3.1% of all resections. Clip placement overall after cold resection (3.9%) was much lower than after resection with electrocautery (71.1%), but 62.4% of all clips placed were after cold resection.

**Conclusions** Audits of clip use in an endoscopy practice can reveal surprising findings, including high and variable rates of unnecessary use after cold resection. Audit can potentially reduce unnecessary costs, carbon emissions, and plastic waste.

## Introduction

Meta-analyses [1, 2], randomized controlled trials [3, 4, 5], and observational studies [6], have demonstrated that prophylactic placement of hemostatic clips is effective in preventing delayed hemorrhage for non-pedunculated colorectal lesions  $\geq 20$  mm in size, located proximal to the splenic flexure, and removed

using electrocautery. All three criteria must be met before colorectal lesions have a sufficient risk of delayed hemorrhage that allows prophylactic clip closure to be demonstrated effective from both clinical and cost perspectives [1, 2, 3, 4, 5, 6, 7, 8]. For lesions that do not meet these three criteria, there is no clear evidence that prophylactic clip placement is effective in preventing delayed hemorrhage.

Colorectal lesions can also be removed without electrocautery. This process is termed cold resection and can be performed with or without submucosal injection. Cold resection using snares has been shown to be effective for all colorectal lesions < 10 mm in size [9], as well as sessile serrated lesions of any size [10, 11], and possibly for adenomas in the 10- to 20-mm size range [12, 13, 14]. For lateral spreading adenomas  $\geq 20$  mm in size, cold resection is less effective than resection using electrocautery [15]. The principal advantage of using cold resection is a very low risk of delayed hemorrhage [16]. This may result from cold snare resection cutting through the submucosal plane at a more superficial level compared with snare resection using electrocautery. The same difference is the rationale for using electrocautery to remove lesions of any size considered to have any significant risk of invasive cancer. However, the overwhelming majority of colorectal lesions, particularly those  $\leq 10$  mm in size, can be predicted to have essentially no risk of cancer based on their endoscopic features [17]. Because the risk of delayed hemorrhage is so low after resection of colorectal lesions using cold techniques, there is no rationale for placement of prophylactic clips after cold resection. However, we have anecdotally encountered individual physicians with high rates of prophylactic clip closure after cold resection, including experts who have used prophylactic clip closure after cold resection of large lesions, and some physicians in our own group who use prophylactic clip closure after cold resection of colorectal lesions regardless of size.

Unnecessary prophylactic clip closure increases the cost of colonoscopy because hemostatic clips are expensive. Further, unnecessary clip closure adds time and inefficiency to the colonoscopy procedure and creates unnecessary carbon emissions and plastic waste. To assess the frequency of inappropriate clip closure in our own practice, we performed an audit of clip use after cold resection during routine surveillance, screening, and diagnostic colonoscopies in our academic endoscopy practice.

## Methods

We performed a retrospective audit of clip usage after colorectal polyp resection for 29 physicians performing colonoscopy in two university-based outpatient academic endoscopy units associated with Indiana University. The audit interval began in January 2023 and extended into June 2023. The principal purpose of the audit was a quality review of physician assignment of intervals for screening and post-polypectomy surveillance colonoscopy, using the 2019 US Multi-society Task Force on Colorectal Cancer recommendations [18]. A target of 100 consecutive patients undergoing routine screening, surveillance, or diagnostic colonoscopy by each physician were reviewed. Both the number of cases involving polyp resection and the number of polyp resections varied between endoscopists.

Patients were excluded if they had inflammatory bowel disease (IBD), inherited colorectal cancer syndromes, serrated polyposis syndrome, or were referred to our center for resection of a colorectal polyp.

All physicians were attending faculty members. Some physicians had fewer than 100 colonoscopies reviewed if their primary appointments were at the Veterans Administration system hospital or the safety-net hospital in our system, or if their primary clinical duties included less general endoscopy. The two outpatient centers included in the study serve primarily private practice patient populations. Physicians were grouped into the categories of advanced endoscopists, general gastroenterologists, IBD specialists, liver specialists, or motility specialists, based on how they are identified within our gastroenterology practice. The physician who performs the most endoscopic resections of large colorectal lesions at our center (DKR) was classified as a general gastroenterologist. Advanced endoscopists at our center perform primarily endoscopic ultrasound, endoscopic retrograde cholangiopancreatography, peroral endoscopic myotomy of the lower esophageal sphincter and pylorus, and endoscopic submucosal dissection.

We used the colonoscopy reports identified in an electronic report generation system database (Provation, Minneapolis, Minnesota, United States) to conduct the audit. For each colonoscopy involving polyp resection, we recorded polyp size, location, shape, method of resection, whether or not any clips had been placed post resection, and if clips were placed, the number used. Lesions were grouped into three size categories:  $\geq 20$  mm, 10 to 19 mm, and 1 to 9 mm.

## Statistical analysis

The number of colonoscopies targeted for each physician was arbitrary and selected for the quality review of appropriate use of screening and post-polypectomy surveillance intervals as a reasonable number to assess each physician's adherence to the 2019 US Multi-society Task Force on Colorectal Cancer recommendations.

In general, statistics were descriptive. We used Jeffrey's binomial procedure to calculate confidence intervals for clip use proportion. All calculations were performed using SPSS version 29. We used chi-square test or Fisher's exact test, as appropriate, to compare clip use for lesions removed by cold resection in patients on no anticoagulation compared with those on aspirin only or with those on either anticoagulation or a non-aspirin antiplatelet agent. Statistical significance was set at 0.05.

## Results

There were 29 endoscopists who performed routine screening, surveillance, and diagnostic colonoscopies during the audit interval, including four advanced endoscopists, 11 general gastroenterologists, three IBD specialists, five liver specialists (hepatologists), and six motility specialists. All 29 endoscopists removed some lesions in the 1- to 9-mm category, 25 removed at least one lesion in the 10- to 19-mm category, and 17 removed at least one lesion  $\geq 20$  mm.

► **Table 1** shows the number of lesions in each of the three size categories removed by cold resection, and the number in which one or more hemostatic clips were placed. There were 3784 total lesions evaluated in the audit, of which 3565 lesions were 1 to 9 mm in size (► **Table 1**). The table also shows the

► **Table 1** Clip use in cold resections by size.

≥ 20 mm	Physician category	Number of physicians	Number of procedures	Number of lesions	Percentage of resections with clips used (95% CI)	Range of clip use by individual physicians
	All physicians	7	11	12	41.7% (18.0%-68.8%)	0.0%-100.0%
10–19 mm	Physician Category	Number of physicians	Number of procedures	Number of lesions	Percentage of resections with clips used (95% CI)	Range of clip use by individual physicians
	All physicians	23	164	207	19.3% (14.4%-25.1%)	0.0%-100.0%
	Advanced endoscopists	3	13	17	35.3% (16.3%-58.9%)	28.6%-66.7%
	General	9	88	109	16.5% (10.5%-24.3%)	0.0%-60.0%
	IBD	3	29	41	7.3% (2.1%-18.3%)	0.0%-25.0%
	Liver	3	14	18	27.8% (11.5%-50.6%)	0.0%-30.8%
	Motility	5	20	22	36.4% (18.9%-57.1%)	0.0%-100.0%
1–9 mm	Physician category	Number of physicians	Number of procedures	Number of lesions	Percentage of resections with clips used (95% CI)	Range of clip use by individual physicians
	All physicians	29	1307	3565	2.8% (2.3%-3.4%)	0.0%-45.0%
	Advanced endoscopists	4	75	194	1.5% (0.4%-4.1%)	0.0%-3.0%
	General	11	628	1653	0.9% (0.5%-1.5%)	0.0%-6.3%
	IBD	3	192	480	1.3% (0.5%-2.6%)	0.0%-3.9%
	Liver	5	185	583	3.9% (2.6%-5.8%)	0.0%-25.5%
	Motility	6	227	655	8.2% (6.3%-10.5%)	0.0%-45.0%

CI, confidence interval; IBD, inflammatory bowel disease.

range of lesions followed by clip placement for all endoscopists, and with the breakdown by subspecialty.

Three individual physicians, including two motility specialists and one liver specialist, used clips in a large percentage of lesions after cold resection. For example, for 1- to 9-mm lesions, these three physicians placed clips in 18.8%, 25.5%, and 45.0% of lesions after cold resection. These three physicians accounted for 8.1% of all cold resections in the 1- to 9-mm size range but accounted for 62.4% of lesions 1 to 9 mm with clip placement. At the other end of the usage spectrum, there were 16 physicians who utilized clips in ≤ 1% of lesions 1 to 9 mm in size.

There were 879 lesions resected cold in patients on or resuming antiplatelet agents or anticoagulants shortly post-procedure. Of these 530 (60.3%) were using aspirin only, 192 (21.8%) were on anticoagulation alone (warfarin or direct-acting oral anticoagulant), 51 (5.8%) were on dual antiplatelet therapy, 46 (5.2%) were on non-aspirin antiplatelet therapy alone, 37 (4.2%) were on aspirin plus anticoagulation, 13 (1.5%) were on non-aspirin antiplatelet therapy plus anticoagulation, and 10 (1.1%) were on two anticoagulant medications. There were no significant differences in clip use after cold resection of lesions in patients on no blood thinners of any type

compared with those on aspirin only, either for all physicians combined or any of the physician subspecialty groups (► **Table 2**). Clip use after cold resection for all lesions was higher in patients on anticoagulation or non-aspirin antiplatelet agents compared with those on no blood thinners for all physicians combined (5.7% vs 3.5%;  $P = 0.039$ ), and among the advanced endoscopists (12.8% vs. 1.5%;  $P = 0.005$ ), but there were no significant differences between these groups of lesions among the four other physician subspecialty groups (► **Table 2**). The three physicians with the highest clip use had clip use rates after cold resection of lesions 1 to 9 mm in size in patients on no anticoagulation or antiplatelet agents (including aspirin) of 19.6%, 26.3%, and 46.2%, and each physician independently had higher clip use in these lesions compared with the other 26 physicians combined ( $P < 0.001$  for each of the three physicians).

During the audit interval, there were an additional 121 lesions removed during routine screening, surveillance, or diagnostic examinations using electrocautery. Thus, 3.1% (121 of 3905) of all colorectal lesions removed during these routine colonoscopies utilized electrocautery. For all lesions removed, the rate of clip placement for lesions removed after cold resection was 3.9% (146 of 3784), compared with 71.1% (86 of 121) of the lesions removed by electrocautery. Of the 86 lesions for

► **Table 2** Clip use after cold resection among all physicians and within physician groups when no anticoagulation or antiplatelet agent was in use, when aspirin only was in use, and when anticoagulation or an antiplatelet agent was used or resumed shortly post-procedure.

Physician category	No anticoagulation or antiplatelet agent	On aspirin only	On or resuming anticoagulation or non-aspirin antiplatelet agent
All physicians	* 102/2905 (3.5)	24/530 (4.5)	20/349 (5.7)
Advanced endoscopists	2/130 (1.5)	1/34 (2.9)	6/47 (12.8)
General	25/1420 (1.8)	3/187 (1.6)	6/159 (3.8)
IBD	7/442 (1.6)	3/53 (5.7)	1/32 (3.1)
Liver	20/434 (4.6)	3/108 (2.8)	5/59 (8.5)
Motility	48/479 (10.0)	14/148 (9.5)	2/52 (3.8)

\* Lesions clipped/all lesions in category (%).  
IBD, inflammatory bowel disease.

which clips were placed after resection with electrocautery, seven fulfilled the traditional criteria for clip closure of size  $\geq 20$  mm and location proximal to the splenic flexure. There were 57 lesions in which clip placement was used after electrocautery that were pedunculated or semi-pedunculated in shape. Four lesions involved treatment of a recurrence using electrocautery. In the remaining 18 lesions, there was no clinically evident basis for prophylactic clip closure, except that for six of these 18 lesions, the patient was scheduled for reinstitution of anticoagulation or antiplatelet agents. The average number of clips placed per lesion after electrocautery was 1.72, which was similar to the average 1.68 clips placed per lesion when clips were used after cold resection. The average number of clips placed per lesion after cold resection of lesions measuring 1 to 9 mm was 1.53. Overall, there were 246 clips used on cold resection sites, and 148 clips used on sites after use of electrocautery, so that 62.4% of all clips used in the audit were on cold resection sites.

## Discussion

In this report, we describe an audit of clip use after resection of colorectal lesions in patients undergoing routine screening, surveillance, and diagnostic colonoscopy in two outpatient endoscopy centers. Importantly, patients who were referred for resection of colorectal lesions were excluded from the study. Many of these patients referred for resection had lesions that would fulfill the standard criteria for prophylactic clip closure, including size  $\geq 20$  mm, location proximal to the splenic flexure, and removal by electrocautery.

Thus, these results reflect clip use in patients undergoing routine colonoscopy, almost entirely without preexisting knowledge of whether and what colorectal lesions were present. Several important findings were generated from the audit, which led to direct feedback to the entire group of endoscopists, and specific feedback to heavy users of clip placement after cold resection. First, specific individuals were using prophylactic clip closure more frequently than expected and more commonly than the other physicians for lesions with a negli-

ble risk of delayed post-polypectomy hemorrhage [16], and in patients not on any anticoagulation or antiplatelet agents. Available evidence suggests that clip placement after cold snare resection is not helpful even when anticoagulation is continued or resumed [19]. Each of the physicians overusing clips responded favorably to feedback and instruction about appropriate use of clips for prophylaxis and agreed to change their practice. Additional audit of their practice is expected. Second, while cold resection was overwhelmingly the most common method of resection identified during the audit ( $> 96.9\%$  of resections), and while clip use was much less common after cold resection than after resection with electrocautery, clip use after cold resection still accounted for the bulk of clip use during routine screening, surveillance, and diagnostic colonoscopies. Regarding pedunculated polyps, it is our institutional practice to place clips after resection rather than using clips or ligature devices prior to resection in order to maximize the oncologic resection margin in cases of pedunculated polyps harboring malignancy [20]. Clips generate a variable amount of waste depending on manufacturer, but in general lead to higher carbon emissions than either snares or forceps [21]. Therefore, more appropriate use of clips after cold resection could reduce endoscopy unit costs, improve the efficiency of colonoscopy for specific over-users of clips, and reduce carbon emissions and plastic waste associated with device use.

Third, the number of clips used per resection site in the audit was similar after cold resection versus resection with electrocautery. This suggests that endoscopists using clips after cold resection were often trying to close the entire cold resection site. The senior author for this study recommends that clip placement after cold resection, regardless of the lesion size, should only be utilized for instances of persistent active immediate bleeding. Prior to clip placement, simple measures such as: 1) use of the water jet to create a submucosal cushion and tamponade; 2) direct pressure on the bleeding area with the scope tip; and 3) reopening the snare and re-grasping the bleeding point and applying direct tamponade with the snare without re-transection of the submucosal defect will usually stop immediate bleeding without the need for clip placement.

If clip placement is required, only the number of clips needed to stop immediate bleeding (usually one clip) is needed, and there is no rationale for closing the entire defect. Previous reports have also noted that immediate bleeding can be prevented to some degree by squeezing the ensnared tissue for a few seconds before transection [22]. Anecdotally, this seems to create less immediate bleeding than rapid cold transection.

Limitations of the study include its retrospective nature. However, retrospective analysis can accurately identify important practice patterns, as was the case in this study. The most significant limitation is the single academic center design. Excessive clip use may or may not occur at other centers. Neither endoscopy unit in our study is an ambulatory surgery center (ASC). In an ASC, we would expect financial pressures to limit excessive hemostatic clip use. Such pressures were not present for endoscopists in this study. Our study only suggests that audit of appropriate clip use may be helpful in some settings.

## Conclusions

In summary, we found through an audit of clip usage that in an academic medical center, a significant fraction of clip usage occurred after cold transections, and significant evidence that the majority of this clip usage was inappropriate and unnecessary. This audit allowed feedback that should lead to a reduction in cost, improved efficiency for certain operators, and a reduction in carbon emissions and plastic waste associated with device use. Although this problem might be exclusive to our center, this seems unlikely. We suggest that others evaluate and report patterns of clip use in their practice, and that professional societies emphasize current concepts about appropriate use of prophylactic clips.

## Conflict of Interest

DKR: Consultant: Olympus Corporation, Boston Scientific, Braintree Laboratories, Norgine, Medtronic, Acacia Pharmaceuticals; Research Support: Olympus Corporation, Medivators, Erbe USA Inc, Braintree Laboratories; Shareholder: Satisfai Health. Krishna C. Vemulapalli is a salaried employee of Cook Research Incorporated, a Cook Group company. All other authors have no COI

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