12-28-2021

Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study

Duyen T. Dang
Henry Ford Health, ddang1@hfhs.org

Suraj Suresh
Henry Ford Health, ssuresh1@hfhs.org

Brooks Vance
Henry Ford Health

Sumit Singla
Henry Ford Health, ssingla1@hfhs.org

Siddharth Javia
Henry Ford Health

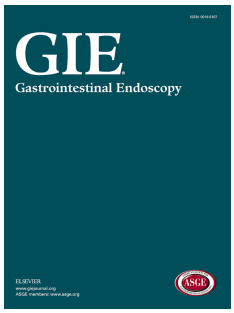
See next page for additional authors

Recommended Citation
Dang DT, Suresh S, Vance B, Singla S, Javia S, Watson A, Chathadi KV, Katakuri V, Pompa R, Stidham RW, Zuchelli T, and Piraka C. Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study. Gastrointest Endosc 2021.

Authors

Duyen T. Dang, Suraj Suresh, Brooks Vance, Sumit Singla, Siddharth Javia, Andrew Watson, Krishnavel V. Chathadi, Vinay Katakuri, Robert Pompa, Ryan W. Stidham, Tobias Zuchelli, and Cyrus Piraka

Journal Pre-proof



Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study

Duyen T. Dang, MD, Suraj Suresh, MD, Brooks Vance, MD, Sumit Singla, MD, Siddharth Javia, MD, Andrew Watson, MD, Krishnavel V. Chathadi, MD, Vinay Katukuri, MD, Robert Pompa, MD, Ryan W. Stidham, MD, Tobias Zuchelli, MD, Cyrus Piraka, MD

PII: S0016-5107(21)01932-5

DOI: https://doi.org/10.1016/j.gie.2021.12.018

Reference: YMGE 13043

To appear in: *Gastrointestinal Endoscopy*

Received Date: 27 June 2021

Accepted Date: 17 December 2021

Please cite this article as: Dang DT, Suresh S, Vance B, Singla S, Javia S, Watson A, Chathadi KV, Katukuri V, Pompa R, Stidham RW, Zuchelli T, Piraka C, Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study, *Gastrointestinal Endoscopy* (2022), doi: https://doi.org/10.1016/j.gie.2021.12.018.

Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study

[*]Duyen T. Dang, MD[1], [*]Suraj Suresh, MD[1], Brooks Vance, MD[1], Sumit Singla, MD[1], Siddharth Javia, MD[1], Andrew Watson, MD[1], Krishnavel V. Chathadi, MD[1], Vinay Katukuri, MD[1], Robert Pompa, MD[1], Ryan W. Stidham, MD[2], Tobias Zuchelli, MD[1], Cyrus Piraka, MD[1]

[1]Division of Gastroenterology, Henry Ford Hospital, Detroit, Michigan

[2]Division of Gastroenterology, Michigan Medicine, Ann Arbor, Michigan

[*]These authors contributed equally to this work

Corresponding Author: Cyrus Piraka, MD, Henry Ford Hospital, 2799 W Grand Blvd, Detroit, MI 48202; Telephone: (313) 812-9491; Email: cpiraka1@hfhs.org.

Funding: None

Conflicts of Interest: Dr. Zuchelli is a consultant for Boston Scientific. Dr. Piraka has received research funding support from US Endoscopy and Aries and is on the speakers bureau for US Endoscopy. All other authors disclosed no financial relationships relevant to this publication

Author contributions: All authors were involved in study concept and design as well as the analysis and interpretation of data. DD and SS authored the initial draft of the manuscript, and all authors critically revised the manuscript and approved the final copy.

Acknowledgements: We would like to thank Stephanie Stebens, MLIS, AHIP and Dr. Karla D. Passalacqua, Ph.D. at Henry Ford Hospital for editorial assistance and manuscript formatting.

Outcomes of cold snare piecemeal endoscopic mucosal resection for nonampullary small-bowel adenomas larger than 1 centimeter: a retrospective study

ABSTRACT

Background and Aims: Nonampullary small-bowel adenomas ≥10 mm are typically resected using cautery-based polypectomy, which is associated with significant adverse events. Studies have demonstrated the safety and efficacy of piecemeal cold snare endoscopic mucosal resection (EMR) for removing large colon polyps. Our aim was to assess the safety and efficacy of cold snare EMR for removal of large adenomas in the small bowel.

Methods: A retrospective study of patients who underwent lift and piecemeal cold snare EMR of small-bowel adenomas ≥1 cm between January 2014 and March 2019 was conducted at a tertiary care medical center. Polyp characteristics at time of index and surveillance endoscopy were collected. Primary outcomes included residual or recurrent adenoma (RRA) seen on surveillance endoscopy, polyp eradication rate, and number of endoscopic procedures required for eradication. Adverse events including immediate and delayed bleeding, perforation, stricture, pancreatitis, and postpolypectomy syndrome were assessed.

Results: Of 43 patients who underwent piecemeal cold snare EMR, 39 had follow-up endoscopy. Polyps ranged in size from 10 to 70 mm, mean 26.5 mm. RRA was found in 18 patients (46%), with increased polyp size correlating with higher recurrence ($P < 0.001$). Polyp eradication was observed in 35 patients (89%), requiring a median of 2 (range 1-6) endoscopic procedures. Only 1 patient (2.3%) had immediate postprocedural bleeding. No cases of perforation or postpolypectomy syndrome were seen.

Conclusions: Piecemeal cold snare EMR may be a feasible, safe, and efficacious technique for small-bowel polyps >10 mm. Prospective, randomized studies are needed to assess how outcomes compare with traditional cautery-based polypectomy.

Keywords: Endoscopic mucosal resection; EMR; Polypectomy; small-bowel adenoma; Piecemeal; Upper endoscopy; EGD; Adenoma recurrence; Adverse events

INTRODUCTION

Nonampullary small-bowel adenomas are infrequently seen on routine upper endoscopy but have the potential to progress to adenocarcinoma via molecular mechanisms similar to colorectal adenomas.[1, 2] As such, multiple gastrointestinal societies recommend complete resection of small-bowel adenomas when found on esophagogastroduodenoscopy. The endoscopic approaches for resection of small-bowel adenomas mirror those for colonic adenomas and are similarly dependent on adenoma size, location, morphology, and pathology. Endoscopic resection techniques include cold snare polypectomy, cold forceps polypectomy, hot and cold endoscopic mucosal resection (EMR) with or without margin ablation, and endoscopic submucosal dissection.[3] Definitive treatment of small-bowel adenomas, especially those >2 cm, typically requires repeat intervention often with a need for multiple follow-up endoscopies due to high rates of incomplete resection, with adenoma recurrence that ranges from 23% to 37% after traditional cautery-based techniques.[3-5]

The use of electrocautery during polypectomy has been considered the standard of care for resection of small-bowel and colonic polyps >10 mm.[3] This standard is based on the rationale that electrocautery facilitates transection through thick tissue, prevents bleeding by instant vascular coagulation, and thermally ablates residual unresected dysplastic tissue. However, electrocautery also induces submucosal and deeper injury and therefore can result in adverse

events such as perforation, postpolypectomy syndrome, and delayed bleeding from coagulum sloughing off and unroofing a submucosal vessel. Typically, 2 types of electrocautery are employed: coagulation current, which delivers a higher voltage and interrupted current, and cutting current, which uses lower voltage and continuous current.[6] However, the type of electrosurgical setting does not alter the risk of adverse events, resection rate, or recurrence, whether with large colon polyps, biliary sphincterotomy, or ampullectomy.[6-8] Compared with the colon, the small-bowel wall is thinner and more vascular, which leads to a higher risk of adverse events. Previous studies of standard electrocautery based EMR for small-bowel polyps have reported intraprocedural bleeding risk upward of 29.2%, delayed bleeding risk of 16.7%, and perforation rate of up to 4.3%.[9] Without electrocautery, these adverse events should be mitigated. In 2015, our group first reported that cold EMR with submucosal lifting was technically feasible for both large duodenal and colonic polyps.[10] Moreover, the cold EMR safety profile was considerably more favorable than standard electrocautery-based endoscopic resection. In a subsequent study, we reported that cold snare EMR was efficacious and safe in the eradication of colon polyps ≥1 cm, with no adverse events and similar residual polyp rates as historically reported for hot EMR.[11] The aim of this study was to evaluate the outcomes of piecemeal cold snare EMR for removal of small-bowel polyps ≥1 cm.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of the Henry Ford Health System. Patients who underwent cold snare polypectomy for resection of nonpedunculated small-bowel polyps ≥1 cm at a single tertiary care hospital from January 1, 2014 to March 31, 2019 were identified on retrospective chart review. The procedures were performed by advanced endoscopists (n = 5), with or without a fellow, over this 5-year period (CP only from January

2014 to February 2017; C.P., R.P., T.Z., S.S., and V.K. from February 2017 to March 2019). The polyps included in this study were flat, sessile, and bulky polypoid lesions; any polyp with a stalk was excluded. Patients were excluded if they received any form of coagulative therapy at the time of polyp resection. This excluded all patients undergoing ampullectomy, as our approach to ampullectomy includes hot snare resection of the ampulla.

All procedures were performed electively, with anesthesia support, using a standard adult endoscope or pediatric colonoscope (Olympus America, Center Valley, Pa, USA) in the endoscopy unit at Henry Ford Hospital. Carbon dioxide insufflation was routinely used for all cases. As part of standard complex polypectomy at our institution, all procedures used a short distal attachment cap (Olympus) to deflect intervening folds and stabilize scope position for submucosal lift and resection. All patients underwent submucosal lift with a solution of dilute epinephrine (1:60,000 to 1:500,000) mixed with saline solution and methylene blue or indigo carmine dye. Dedicated cold snares were used in all cases. An Exacto snare (US Endoscopy, Mentor, Ohio, USA) was most commonly used, with occasional use of the small Captivator II cold snare (Boston Scientific, Marlborough, Mass, USA). If en bloc resection was not feasible, piecemeal resection was typically initiated at the lateral margin of the polyp with progressive resection of overlapping tissue (transection through the submucosa underlying the prior resection site) until all visible polyp was removed, with effort made to extend lateral margins beyond the polyp edge and avoid leaving bridges of tissue at the base. Given the difficulty of removing large pieces without cautery, the polyp resection was performed by removing smaller individual segments. A high-definition endoscope was used in all cases and narrow-band imaging and near-focus imaging was commonly used to inspect the polypectomy base and margins for residual polyp tissue. Suspected residual adenomatous tissue along margins and polyp base was removed

using a cold snare and, occasionally, with large-capacity forceps. Hemostatic clips were used at the discretion of the endoscopist to treat immediate bleeding or in anticipation of the patient resuming anticoagulation. Patients did not undergo any form of thermal therapy, including the use of "hot" forceps or argon plasma coagulation (APC) at index resection. Although some data suggest that a one-week course of proton pump inhibitors (PPIs) may improve the rate of healing of iatrogenic ulcers, which are more superficial than acid induced ulcers, our protocol did not require PPI use after the procedure.[12]

Histopathology was assessed by the pathology department at Henry Ford Hospital. The size, polyp location, morphology, resection technique, total procedure time, and all adjunct therapies (including use of clips or forceps) were recorded at the time of the procedure using electronic documentation through Endoworks (Olympus America, Center Valley, Pa, USA) or ProVation MD (ProVation Medical, Minneapolis, Minn, USA). Pathology results, patient demographics, American Society of Anesthesiologists class scores, and procedure indications were accessed through the EPIC electronic medical record system (EPIC Systems, Verona, Wisc, USA).

Resection efficacy was defined by the absence of residual or recurrent adenoma (RRA) on direct endoscopic visualization and on biopsy at the time of follow-up after index polypectomy. Follow-up endoscopy was recommended at a 2- to 6-month interval after initial polypectomy, with shorter intervals recommended for larger polyps and those with advanced histology. All patients who underwent follow-up endoscopy had a visual assessment of the resection site using high-definition white light, narrow-band imaging, and near-focus imaging, and had biopsy specimens taken of the polypectomy sites to determine the presence or absence of residual or recurrent microscopic adenoma. Adverse events assessed included immediate or

delayed postprocedural bleeding, pancreatitis, development of stricture, and bowel perforation occurring within 2 weeks of the endoscopy. Electronic medical records were reviewed for assessment of postprocedural clinical course.

Statistical Analysis

All categorical variables were compared using the Fisher exact tests due to low expected cell counts. For continuous variables, univariate 2-group comparisons were performed using Wilcoxon rank sum tests due to the non-normal distributions and group comparisons were performed using Kruskal Wallis tests due to non-normal distributions. Statistical significance was set at $P < 0.05$. All analyses were performed using SAS 9.4 (SAS Institute Inc, Cary, NC, USA).

RESULTS

Population and Polyp Characteristics

Between January 1, 2014 and March 31, 2019, 43 patients underwent piecemeal cold snare polypectomy of small-bowel polyps ≥1 cm in diameter, which resulted in removal of a total of 43 polyps. At the end of the study data collection period, 39 of the 43 patients had surveillance endoscopy at 32 to 533 days from the index endoscopy, and these 39 were included in the final analysis. The remaining 4 patients did not undergo surveillance endoscopy at our institution, and therefore, follow-up data were not available for review. Tables 1 and 2 show polypectomy data stratified by polyp size and percent involvement of the small-bowel circumference, respectively. Polyps were stratified according to their sizes: 10 to 19 mm, 20 to 29 mm, and ≥30 mm. The rationale for stratification into these 3 groups was 2-fold. First, extrapolating from the literature for colon polyps, polyps within the 10 mm to 19 mm size range are considered "medium-sized," polyps ≥20 mm are considered "large," and polyps ≥30 mm are considered "giant."[13]

Furthermore, with the medium-sized colon polyps, there still exists a dichotomy between cold and hot snare resection techniques, with master endoscopist Dr Douglas Rex using cold snare for removal, and master endoscopist Dr. Evelien Dekker using hot snare.[13] Thus, we felt it was important to analyze our results within this subgroup to specifically address our experience within this dichotomy. Second, our previous data in colon adenomas showed that median polyp size was significantly greater in those with RRA (37.1 vs 19.1 mm).[11] We thus wanted to distinguish between polyps greater and less than 20 mm in size. Of the 39 patients who completed surveillance, 27 (69%) were female patients, and the median age was 66 years (range 50-93 years). The median total procedure length was 69 minutes (range 12-253 minutes). Most polyps were found in the second portion of the duodenum (27/39, 69.2%) and the median polyp size was 20 mm (range 10-70 mm; mean 26.5 mm). Two of the polyps were in the jejunum, but within reach of a pediatric colonoscope. These were included as resection within the jejunum was as challenging as in the duodenum and used the same cold snare EMR techniques.

Of the 39 polyps, 28 (71.8%) involved <50% of the circumference of the small-bowel lumen whereas 11 (28.2%) involved ≥50% of the luminal circumference. Histologic analysis revealed that most polyps were tubular adenomas (29/39, 76%) whereas the remainder were tubulovillous adenomas (10/29, 34%). Most tubulovillous adenomas were ≥30 mm in size (7/9, 78%) and 1 had features of high-grade dysplasia.

Efficacy

RRA was found at the polypectomy site in 18 out of 39 (46%) cases. When stratified by polyp size, 2 out of 16 (12.5%) polyps 10 to 19 mm, 5 out of 9 (55.6%) polyps 20 to 29 mm, and 11 out of 14 (79%) polyps ≥30 mm had RRA on surveillance endoscopy. Of polyps involving <50% of the small-bowel circumference, 10 out of 28 (35.7%) had RRA whereas 8 out of 11

(72.7%) polyps involving ≥50% of the small-bowel circumference demonstrated RRA. Polyps with RRA on follow-up had an initial mean (standard deviation) polyp size of 36.8 (17.0 mm; median 30 mm and range 12-70 mm) compared with 17.9 (9.5 mm; median 15 mm and range 10-40 mm) in polyps without RRA ($P < 0.001$). Of polyps with RRA, 11 were tubular adenomas, 7 were tubulovillous adenomas, and 1 had high-grade dysplasia. All patients with RRA underwent biopsy and repeat cold snare EMR with or without APC to remove RRA tissue. APC was used during surveillance endoscopy to eradicate polyp tissue in 13 out of 39 (33.3%) patients, where 4 out of 25 (16%) were in patients with initial polyps <30 mm and 9 out of 14 (64.2%) were in patients with initial polyps ≥30 mm. By the end of the study period, 35 out of 39 (89.4%) polyps were eradicated completely. Of the 10 to 19 mm polyps, 15 out of 16 (93.8%) were eradicated. Of polyps 20 to 29 mm, 8 out of 9 (88.9%) were eradicated. Finally, of polyps ≥30 mm, 12 (86%) were eradicated. The median number of esophagogastroduodenoscopies needed for complete adenoma eradication was 1 (range 1-2) for polyps 10 to 19 mm, 2 (range 1-6) for polyps 20 to 29 mm, and 3 (range 1-6) for polyps ≥30 mm. No patients developed interval cancer between index and surveillance endoscopy.

Safety

Of the 43 patients who underwent cold snare small-bowel EMR, only 1 (2.3%) had immediate bleeding, which was treated with placement of 2 hemoclips. This patient had a 10-mm duodenal adenoma and had stopped taking warfarin 5 days before the procedure. The patient was admitted 11 days after the procedure with delayed bleeding, was found to have an international normalized ratio of 4.6 and had a bleeding ulcer at the resection site that required placement of 2 additional clips. The patient had no residual adenoma on surveillance esophagogastroduodenoscopy 181 days later. Of the 39 patients who underwent surveillance, 3

(8%) were noted to have small-bowel strictures. All these patients had initial polyps ≥30 mm that involved >50% circumference of the small-bowel lumen. Of these 3 patients, one was asymptomatic and did not require dilation, whereas the other 2 responded to 1 dilation. One patient (3%) developed necrotizing pancreatitis after the first surveillance endoscopy in which thermal therapy was also used. This patient initially had a 60-mm tubulovillous adenoma involving the second and third portions of the duodenum, which was resected by piecemeal cold snare EMR. At the first surveillance endoscopy 4 months after surgery, there were small foci of residual adenomatous-appearing mucosa, which was treated with biopsy forceps, cold snare, and APC. The patient had abdominal pain after the procedure and developed necrotizing pancreatitis, suspected to be due to injury of the pancreatic orifice from thermal therapy. The patient died 4 months later after a complicated hospital course. No other patients had serious adverse events related to cold snare EMR. There were no perforations and no episodes of post-polypectomy syndrome.

DISCUSSION

In this study, we evaluated the safety and efficacy of cold snare EMR for resection of large (≥ 10 mm) nonpedunculated small-bowel adenomas. We are currently in the midst of a "cold snare revolution," where the utility of cold snare piecemeal resection and "cold EMR" for nonpedunculated colonic adenomas > 10 mm are being recognized as safe and efficacious.[10, 11, 14, 15] More recently, the use of cold EMR has been extended to colonic lesions >20 mm,[15] with efficacy comparable to cautery-based techniques but with considerable safety benefit. The data from this study support the notion that cold EMR is feasible and remarkably safe for adenomas > 10 mm within the more fragile small bowel.

Previous studies of standard electrocautery EMR for resection of small-bowel polyps have reported very high rates of intraprocedural and delayed bleeding, as well as a risk of perforation, which is more consequential in the small bowel than in the colon.[9] In the largest 10-year retrospective study to date, which included 166 duodenal EMRs using thermal snare technique, the median polyp size was 20 mm and complete initial mucosal resection was felt to have been achieved in 92% of cases, but recurrence was observed to be 23% at a median of 277 days.[4] In comparison, our observed RRA rate was 46%, and our sample included a larger mean polyp size of 26.6 mm. More recently, use of thermal ablation of the defect margin after thermal EMR for duodenal polyps >10 mm has been shown to result in lower recurrence rates than conventional EMR (2.3% vs 17.6%), but with intraprocedural bleeding occurring in 37%, of which 66.7% required a hospital admission.[16] Our data support the hypothesis that cold snare polypectomy is significantly safer and may be as efficacious as resection with thermal techniques. In the previously cited large retrospective study, thermal EMR–related bleeding occurred in 11% of cases.[4] Our intraprocedural and delayed bleeding rates were much lower at 2.6% and occurred only in a single patient who was on anticoagulation. One patient did develop necrotizing pancreatitis after initial surveillance endoscopy where thermal therapy was applied. It is likely that this adverse event occurred due to thermal injury of the pancreatic duct orifice from APC rather than the use of cold snare. This case highlights the potential dangers of using thermal therapies in proximity to the papilla. Although adenoma recurrence was common (46% of cases with a strong association between polyp size and rate of RRA), close to 90% of the polyps were eradicated within 2 surveillance endoscopic procedures, on average. Furthermore, there were no interval cancers, even in a patient with high-grade dysplasia.

Another potential benefit of cold EMR to consider is cost reduction. Use of cold snare may obviate the need for prophylactic clipping that would otherwise be needed to reduce the risk of delayed bleeding and perforation. Cost savings per procedure could be substantial depending on the number of clips that might be required to close a large defect. Indeed, a recent study that modeled the differences in cost between hot and cold EMR for the removal of large sessile colon polyps found that a strategy of cold EMR led to a cost savings of $955 per case over hot EMR and was most related to not needing to use clips with cold EMR.[17] Additional savings may also be found in the amount of time required to perform the procedure, as clipping a defect can be time and labor intensive. It is unclear whether there is an overall increase in the amount of time it takes to perform the polyp resection cold as compared with hot, although we have found that with more experience, the resection can be performed rather quickly, particularly as the endoscopist can forego concerns about perforation. Current studies are underway to compare the time it takes to perform a polyp resection via cold or hot EMR. One may contend that there is the potential for increased cost arising from the need for additional or earlier surveillance endoscopy when removing a 10- to 20-mm polyp piecemeal rather than en bloc. However, attempted en bloc resection of polyps with hot snare techniques may still be incomplete, and unless the pathologist confirms that the margins are all negative, there may be unrecognized residual polyp remaining, as evidenced by the reported high residual polyp rates in studies of hot EMR.[3-5] Piecemeal resection is a known risk factor for post-EMR recurrence [18]. Our data suggest that even when resected piecemeal, these smaller polyps (10-20 mm) may be completely removed with high confidence within 1 procedure, as the RRA rate was relatively low at 12.5%. Future studies are needed to help define the appropriate follow-up interval in this subset of patients. Finally, the financial and human costs associated with hospitalization for delayed bleeding are

substantial, and as it occurs more commonly with hot EMR in the small bowel, minimizing this adverse event is even more potentially consequential.

The efficacy and safety outcomes in this study were highly encouraging and suggest that electrocautery is not mandatory to achieve eradication of large small-bowel adenomas. Given the potential safety advantages, the avoidance of cautery may represent a paradigm shift in small-bowel polypectomy practice. However, for cold polypectomy to have a real impact on clinical practice, studies performed by other endoscopists in varying practice environments, ideally in the context of multicenter prospective studies, need to be done. Such studies—if they demonstrate favorable outcomes—will ultimately inform the design of methodologically rigorous randomized trials, which may define the exact role of cold snare small-bowel EMR. Future studies are important to overcome the limitations of retrospective studies, including the potential of skewing efficacy data based on the initial selection of patients for cold snare resection. Furthermore, there is always the potential for late recurrences even with typical cautery-based resection techniques, and the rate is not yet defined with this technique.

In conclusion, this study adds support to our hypothesis that piecemeal cold snare EMR of small-bowel polyps >1 cm is feasible, safe, and efficacious. However, caution must be observed when combining this technique with thermal modalities such as APC, especially in proximity to the papilla. Because piecemeal cold polypectomy represents a significant change to the standard of care for polyp management, additional observational and randomized comparative effectiveness studies are necessary to demonstrate the noninferiority of this technique for adenoma eradication and its safety advantage over hot snare EMR. In the interim, endoscopists may consider using this technique at least in high-risk scenarios, such as for patients who are at high risk of delayed hemorrhage or those who are very unlikely to tolerate an

operation to address perforation. And arguably, the significant morbidity associated with the extraordinarily high rates of delayed bleeding and perforation in the setting of hot snare small-bowel EMR would support having a low threshold to transition to the use of cold EMR for nonampullary small-bowel adenomas.

Table 1: Polypectomy data stratified by polyp size.

	All cases (N=39)	**Polyps 10-19 mm (n = 16)**	**Polyps 20-29 mm (n = 9)**	**Polyps ≥30 mm (n = 14)**	***P* value**
Sex, number (%)					0.6735
Male	12 (30.8)	6 (37.5)	3 (33.3)	3 (21.4)	
Female	27 (69.2)	10 (62.5)	6 (66.7)	11 (78.6)	
Median age, years (range)	66 (50-93)	67 (50-88)	63 (51-93)	67 (52-83)	
Mean age, years (SD)	66.8 (10.1)	68.0 (9.2)	64.7 (12.2)	66.9 (10.1)	0.4153
Median polyp size, mm (range)	20 (10-70)	12 (10-18)	20 (20-25)	40 (30-70)	
Mean polyp size, mm (SD)	26.6 (16.4)	12.7 (2.5)	22.2 (2.6)	45.4 (11.8)	<0.0001
Polyp location, number (%)					0.5648
Bulb	3 (7.7)	2 (12.5)	1 (11.1)	0	
D2	27 (69.2)	12 (75.0)	6 (66.7)	9 (64.3)	
D3	7 (17.9)	2 (12.5)	1 (11.1)	4 (28.6)	
D4	0	0	0	0	
Jejunum	2 (5.1)	0	1 (11.1)	1 (7.1)	
Polyp histology, number (%)					0.0013
Tubular adenoma	29 (74.4)	16 (100.0)	7 (77.8)	6 (42.9)	

Tubulovillous adenoma	9 (23.1)	0	2 (22.2)	7 (50.0)	
Tubulovillous adenoma with HGD	1 (2.6)	0	0	1 (7.1)	
Procedure details					
Forceps use, number (%)	8 (20.5)	2 (12.5)	3 (33.3)	3 (21.4)	0.4650
Hemostatic clips use, number (%)	2 (5.1)	2 (12.5)	1 (11.1)	0	0.4363
Median procedure length, minutes (range)	69 (12-253)	34.5 (12-73)	46.5 (24-82)	122 (36-253)	
Mean procedure length, minutes (SD)	71.7 (57.9)	35.9 (16.7)	46.5 (17.1)	127.1 (61.5)	< 0.0001
Follow-up details					
Median time to follow-up, days (range)	153 (32-533)	181 (32-406)	108 (84-533)	107 (43-183)	
Mean time to follow-up, days (SD)	152.8 (103.7)	186.3 (100.6)	186.6 (149.8)	107.1 (41.6)	0.0697
Polyps with RRA (%)	18 (46.2)	2 (12.5)	5 (55.6)	11 (78.5)	0.0012
Polyps eradicated by end of study period (%)	35 (89.4)	15 (93.8)	8 (88.9)	12 (85.7)	0.8162
Median no. of EGDs to eradicate polyp (range)	2 (1-6)	1 (1-2)	2 (1-6)	3 (1-6)	
Mean no. of EGDs to eradicate polyp (SD)	2.1 (1.6)	1.1 (0.3)	2.0 (1.7)	3.5 (1.8)	0.0003
APC use during surveillance EGD, number (%)	13 (33.3)	2 (12.5)	2 (22.2)	9 (64.2)	0.0095
Total adverse events, number (%)	5 (12.8)	1 (6.3)	0	4 (28.6)	0.1149
Stricture	3 (7.7)	0	0	3 (21.4)	0.0490

Bleeding	1 (2.6)	1 (6.3)	0	0	1.000
Pancreatitis	1 (2.6)	0	0	1 (7.1)	0.5897

Abbreviations: APC, Argon plasma coagulation; D2, second portion of the duodenum; D3, third portion of the duodenum; D4 fourth portion of the duodenum; EGD, esophagogastroduodenoscopy; HGD, high-grade dysplasia; SD, standard deviation; RRA, residual or recurrent adenoma

Table 2: Polypectomy data stratified by percent involvement of small-bowel circumference.

	All cases (N=39)	**Polyps < 50% circumference (n = 28)**	**Polyps ≥ 50% circumference (n=11)**	***P* value**
Sex, number (%)				0.4463
Male	12 (30.8)	10 (35.7)	2 (18.2)	
Female	27 (69.2)	18 (64.3)	9 (81.8)	
Median age, years (range) Mean age, years (SD)	66 (50-93) 66.8 (10.1)	65 (50-93) 67.1 (9.9)	67 (52-83) 66.0 (11.0)	 0.7675
Median polyp size, mm (range) Mean polyp size, mm (SD)	20 (10-70) 26.6 (16.4)	15 (10-40) 18.0 (7.5)	50 (35-70) 48.6 (11.0)	 <0.0001
Polyp location, number (%)				0.4799
Bulb	3 (7.7)	3 (10.7)	0	
D2	27 (69.2)	20 (71.4)	7 (63.6)	
D3	7 (17.9)	4 (14.3)	3 (27.3)	
D4	0	0	0	
Jejunum	2 (5.1)	1 (3.6)	1 (9.1)	
Polyp histology, number (%)				0.0018
Tubular adenoma	29 (74.4)	25 (89.2)	4 (36.4)	
Tubulovillous adenoma	9 (23.1)	3 (10.7)	6 (54.5)	
Tubulovillous adenoma with HGD	1 (2.6)	0	1 (9.1)	
Procedure details				
Forceps use, number (%)	8 (20.5)	6 (21.4)	2 (18.2)	1.000

Hemostatic clips use, number (%)	2 (5.1)	2 (7.1)	0	0.5123
Median procedure length, minutes (range)	69 (12-253)	42 (12-120)	123 (46-253)	
Mean procedure length, minutes (SD)	71.7 (57.9)	44.0 (24.1)	139.6 (61.2)	<0.0001
Follow-up details				
Median time to follow up, days (range)	153 (32-533)	136.5 (32-533)	105 (43-183)	
Mean time to follow up, days (SD)	152.8 (103.7)	175.2 (117.4)	107.7 (45.7)	0.0789
Polyps with RRA (%)	18 (46.2)	10 (35.7)	8 (72.7)	0.0722
Polyps eradicated by end of study period (%)	35 (89.4)	26 (92.9)	9 (81.8)	0.5619
Median no. of EGDs to eradicate polyp (range)	2 (1-6)	1 (1-6)	3 (1-6)	
Mean no. of EGDs to eradicate polyp (SD)	2.1 (1.6)	1.7 (1.4)	3.4 (1.8)	0.0087
APC use during surveillance EGD (%)	13 (33.3)	6 (21.4)	7 (63.6)	0.0221
Total adverse events, number (%)	5 (12.8)	1 (3.6)	4 (36.4)	0.0084
Stricture	3 (7.7)	0	3 (27.3)	0.0181
Bleeding	1 (2.6)	1 (3.6)	0	1.000
Pancreatitis	1 (2.6)	0	1 (9.1)	0.2821

Abbreviations: APC, Argon plasma coagulation; D2, second portion of the duodenum; D3, third portion of the duodenum; D4 fourth portion of the duodenum; EGD, esophagogastroduodenoscopy; HGD, high-grade dysplasia; SD, standard deviation; RRA, residual or recurrent adenoma

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, explain how loss to follow-up was addressed
		(*e*) Describe any sensitivity analyses
Results		

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for nonparticipation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Report numbers of outcome events or summary measures over time
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

REFERENCES

1. Wagner PL, Chen YT, Yantiss RK. Immunohistochemical and molecular features of sporadic and FAP-associated duodenal adenomas of the ampullary and nonampullary mucosa. Am J Surg Pathol 2008;32:1388-95.
2. Rubio CA. Gastric duodenal metaplasia in duodenal adenomas. J Clin Pathol 2007;60:661-3.
3. Basford PJ, Bhandari P. Endoscopic management of nonampullary duodenal polyps. Therap Adv Gastroenterol 2012;5:127-38.
4. Tomizawa Y, Ginsberg GG. Clinical outcome of EMR of sporadic, nonampullary, duodenal adenomas: a 10-year retrospective. Gastrointest Endosc 2018;87:1270-1278.
5. Abbass R, Rigaux J, Al-Kawas FH. Nonampullary duodenal polyps: characteristics and endoscopic management. Gastrointest Endosc 2010;71:754-9.
6. Pohl H, Grimm IS, Moyer MT, et al. Effects of Blended (Yellow) vs Forced Coagulation (Blue) Currents on Adverse Events, Complete Resection, or Polyp Recurrence After Polypectomy in a Large Randomized Trial. Gastroenterology 2020;159:119-128 e2.
7. Li DF, Yang MF, Chang X, et al. Endocut Versus Conventional Blended Electrosurgical Current for Endoscopic Biliary Sphincterotomy: A Meta-Analysis of Complications. Dig Dis Sci 2019;64:2088-2094.
8. Minami K, Iwasaki E, Fukuhara S, et al. Electric Endocut and Autocut Resection for Endoscopic Papillectomy: A Systematic Review. Intern Med 2019;58:2767-2772.
9. Lim CH, Cho YS. Nonampullary duodenal adenoma: Current understanding of its diagnosis, pathogenesis, and clinical management. World J Gastroenterol 2016;22:853-61.

10. Choksi N, Elmunzer BJ, Stidham RW, et al. Cold snare piecemeal resection of colonic and duodenal polyps >/=1 cm. Endosc Int Open 2015;3:E508-13.

11. Piraka C, Saeed A, Waljee AK, et al. Cold snare polypectomy for non-pedunculated colon polyps greater than 1 cm. Endosc Int Open 2017;5:E184-E189.

12. Lee SY, Kim JJ, Lee JH, et al. Healing rate of EMR-induced ulcer in relation to the duration of treatment with omeprazole. Gastrointest Endosc 2004;60:213-7.

13. Rex DK, Dekker E. How we resect colorectal polyps <20 mm in size. Gastrointest Endosc 2019;89:449-452.

14. Thoguluva Chandrasekar V, Spadaccini M, Aziz M, et al. Cold snare endoscopic resection of nonpedunculated colorectal polyps larger than 10 mm: a systematic review and pooled-analysis. Gastrointest Endosc 2019;89:929-936 e3.

15. Mangira D, Cameron K, Simons K, et al. Cold snare piecemeal endoscopic mucosal resection of large sessile colonic polyps >/=20 mm (with video). Gastrointest Endosc 2020.

16. Sidhu M, Fritzsche JA, Klein A, et al. Outcomes of thermal ablation of the defect margin after duodenal endoscopic mucosal resection (with videos). Gastrointest Endosc 2020.

17. Mehta D, Loutfy AH, Kushnir VM, et al. Cold versus hot endoscopic mucosal resection for large sessile colon polyps: a cost-effectiveness analysis. Endoscopy 2021.

18. Komeda Y, Watanabe T, Sakurai T, et al. Risk factors for local recurrence and appropriate surveillance interval after endoscopic resection. World J Gastroenterol 2019;25:1502-1512.

Acronyms and Abbreviations

APC – Argon Plasma Coagulation

D2 – Second portion of the duodenum

D2 – Third portion of the duodenum

D4 – Fourth portion of the duodenum

EGD – Esophagogastroduodenoscopy

EMR – Endoscopic mucosal resection

HGD – High grade dysplasia

RRA – Residual or recurrent adenoma

SD – Standard deviation