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Incidence of retained biopsy specimens after esophagogastroduodenoscopy and colonoscopy

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ABSTRACT

Background and study aims In gastrointestinal endoscopy, biopsies must transit through the accessory channel and cap, presenting an opportunity for loss of tissue. We sought to determine the incidence of specimen retention in the accessory channel or cap and identify procedure characteristics associated with specimen retention.

Patients and methods After completion of standard endoscopic procedures in which biopsies were obtained, the biopsy cap and accessory channel were inspected, brushed, and irrigated for any retained biopsy specimens according to a standard protocol. For controls, the same protocol was applied to procedures in which biopsies were not obtained. Specimen bottles from the recovery protocol were sent for pathological examination regardless of whether any visible tissue was present.

Results A total of 216 outpatient procedures were included: 55 esophagogastroduodenoscopies (EGDs) and 50 colonoscopies in which biopsies were obtained and 56 EGDs and 55 colonoscopies in the control group. Retained specimens were found in either the cap or channel in 50 of 105 (48%). In 20 of 105 (19%), retained specimens were found just in the cap, in six of 105 (5.7%), retained specimens were found just in the channel, while in 24 of 105 (23%), retained specimens were found in both the cap and channel. Retained specimens were more likely to be found in EGDs compared to colonoscopies (58% vs. 36%, $P = 0.031$). No retained specimens were found in the control group.

Conclusions Retained specimens are startingly common in standard gastrointestinal endoscopic procedures and could potentially change diagnoses and management. Quality improvement measures should be instituted to monitor prevalence of retained biopsies and methods to prevent them should be developed.

Introduction

Errors in tissue handling for surgical pathologic analysis could result in significant clinical consequences, but fortunately appears to be a rare occurrence. Early errors during surgical pathology sample processing may include loss or mislabeling the biopsy sample. Sandbank et al. [1] analyzed 4200 surgical procedures and found five specimens to be lost while Shalom et al. [2] showed one lost specimen out of over 7000 specimens. Gastrointestinal endoscopy procedures are among the most common procedures performed in medicine with a majority obtaining tissue samples for surgical pathology. However, surgical biopsy or specimen loss is not directly comparable to tissue loss during gastrointestinal endoscopy procedures. Tissue loss may relate to instrument design, as the biopsy material must pass through the accessory endoscope channel and cap, pro-

viding a unique opportunity for sample loss, before being secured for histologic analysis. Endoscopists have noted anecdotally that retained biopsy tissue may occasionally be found in the accessory channel and/or cap during or after the procedure completion. Furthermore, endoscopy technicians have noted retained tissue during post-procedure manual cleaning of endoscopes [3]. The loss of biopsy specimens from gastrointestinal endoscopy procedures has not been previously reported. We investigated the incidence and location of any tissue specimen retention in routine upper and lower endoscopies and identified patient or procedural characteristics associated with specimen retention.

Patients and methods

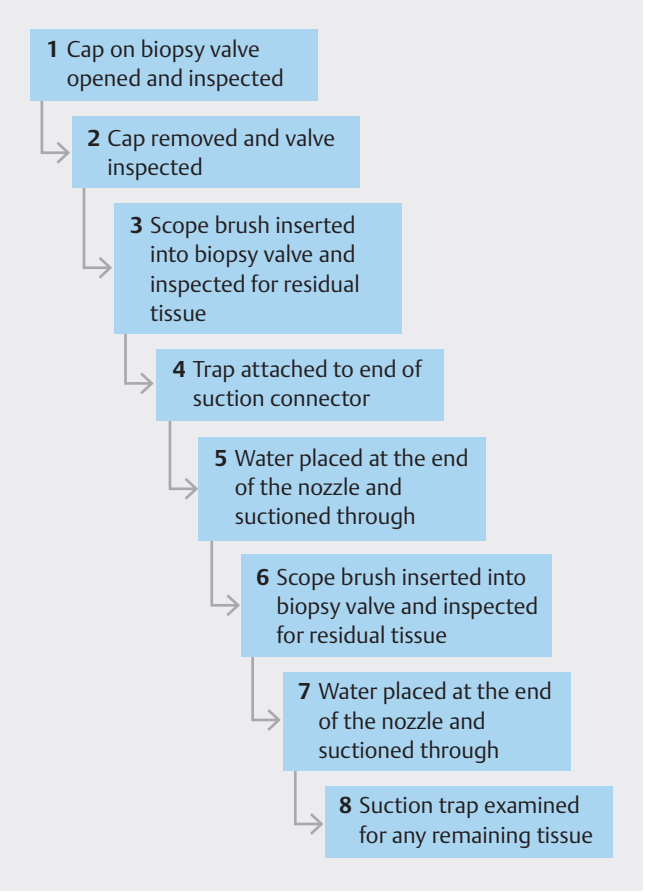
Study design

Consecutive outpatient routine upper and lower endoscopies (esophagogastroduodenoscopy [EGD], colonoscopy) at university-based outpatient endoscopy lab in which biopsies were obtained at the discretion of the performing endoscopist were included. The experimental group could include procedures where biopsies only were taken to remove polyps. Exclusion criteria included those where polyps were removed with snare (hot or cold) methods and incomplete or aborted procedures. Consecutive upper and lower endoscopies in which biopsies were not obtained were used as controls. All procedures were performed at our university hospital outpatient endoscopy lab by attending gastroenterology faculty. Nineteen different endoscopists with 2 to 21 years of experience participated in the study. No fellows participated in the study or control procedures.

No sample size calculation was performed because there were no previous data on the incidence of biopsy retention. Therefore, approximately 50 each of consecutive upper and lower endoscopies were included in the test group and compared to a similar number of consecutively collected control procedures. The study was deemed exempt from institutional review board review because there was no change in patient care and all data were de-identified.

Biopsy retention collection method

Immediately after standard endoscopic procedures (EGD and colonoscopy) (Evis Exera III GIF-HQ190, CF-HQ190, Olympus America) were performed, the rubber accessory channel cap was opened and inspected for any retained biopsy tissue. The cap was then removed and both the inside of the cap and the accessory channel opening, where the cap attaches, were carefully inspected for retained tissue. Finally, a scope brush was used to brush the accessory channel opening. Any biopsy material recovered in these steps were placed in a formalin bottle labeled “cap.” Single-use disposable biopsy forceps were used for all EGDs and colonoscopies (Radial Jaw 4 Large Capacity with Needle 2.8 mm, Boston Scientific, Natick, Massachusetts, United States (EGD) and Radial Jaw 4 Jumbo with Needle 3.2 mm, Boston Scientific, Natick, Massachusetts, United States [colonoscopy]).



▶ **Fig. 1** Flowchart of the study procedure.

Next, a suction trap was attached and water suction was applied to the accessory channel to collect any residual tissue. The scope brush was inserted into the accessory biopsy channel to dislodge residual tissue and brush bristles were inspected. The accessory channel was then suctioned again with water. Any retained biopsy material recovered in the suction trap or the scope brush was placed in a formalin bottle labeled “channel.” No bottle was generated for cases in which no residual tissue was found during these steps (▶ **Fig. 1**).

The de-identified labeled bottles were sent to pathology for analysis. Retained biopsy tissue was interpreted by one of authors (G.H.) who is a subspecialty-trained gastrointestinal pathologist and part of the institutional gastrointestinal pathology group who interprets all gastrointestinal pathologic tissue at our center. This interpretation was performed blinded to the official pathological interpretation of the case where the retained specimens were found. The same recovery process for retained biopsy specimens was performed on a control group of procedures (EGDs and colonoscopies) in which no biopsies were obtained. All biopsy channel caps, forceps and suctions traps were single use devices.

Data collection and variables

Patient and procedure data collected included: patient age, gender, procedure time, fentanyl dose, propofol dose, and location biopsied. Data collected from the official pathology interpretation included: number of specimen bottles, number of tissue specimens per bottle, and number of total specimens overall. The official pathology interpretations were compared with the official pathology interpretations from retained biopsy specimens to determine if there would be any change in diagnosis or management.

Analysis

Incidence rates for specimen retention were calculated and compared between EGD and colonoscopy procedures using the Wilcoxon rank sum test. This was done for all occurrences and then separately for retention in different locations (cap, channel, or both).

Age, gender, and procedural variables were also compared between different categories, specifically type of procedure, whether a specimen was found, and (when applicable) where the specimen was found. Numeric variables such as age are summarized with mean and standard deviation (SD), median and interquartile range (IQR) and range, and compared using the Wilcoxon rank sum test. Categorical variables, such as gender, are summarized with number (N) and percent in each category and compared using Fisher's exact test.

Univariate logistic models are used to examine the relationships between specimen retention and age, gender, and procedural variables. Upper and lower confidence limits and *P* values were calculated. Because of the high rate of specimen retention, we were limited to seven variables in the multivariate logistic analysis, where confidence limits and *P* values were given. Recursive feature selection, a backward selection algorithm based on predictor importance ranking, with 10 cross-validation as external re-sampling method was applied to subset selection. All analysis was performed in R 4.0.5 (R Foundation for Statistical Computing, Vienna, Austria) and statistical significance was determined as $P < 0.05$. The official pathology interpretations were compared with pathology interpretations from retained biopsy specimens to determine if there would be any change in diagnosis or management.

Results

A total of 216 outpatient endoscopic procedures were performed, including 105 in the experimental group (55 EGDs and 50 colonoscopies) in which biopsies were obtained as part of usual care and 111 in the control group (56 EGDs and 55 colonoscopies) in which no biopsies were obtained. There were 107 males and 109 females in the patient sample. The average age was 56.1 years (±16.8). Demographic summary data for the experimental and control groups are provided in ▶ **Table 1**.

Retained biopsy specimens were found in either the cap or channel in 50 of 105 of the experimental cases (48%). In 20 of 105 cases (19%) a retained biopsy specimen was found just in the cap, in six of 105 cases (5.7%) a retained biopsy specimen was found just in the channel, while in 24 of 105 cases (23%) a retained biopsy specimen was found in both the cap and channel (▶ **Table 2**). Restricting cases to only those in which a retained biopsy specimen was found, 88% had biopsy specimens found in the cap, 60% had biopsy specimens found in the channel, and 48% had biopsy specimens found in both the cap and channel. These categories are not mutually exclusive as a case that had a biopsy found in both the cap and channel would

▶ **Table 1** Demographic and procedure breakdown of experimental and control groups.

	Experimental N = 105	Control N = 111
Average age (SD)	53.4 ± 17.2	58.6 ± 16.0
Males	51	56
Females	54	55
EGD	55	56
Colonoscopy	50	55

SD, standard deviation; EGD, esophagogastroduodenoscopy.

▶ **Table 2** Location of retained biopsies in total and by procedure.

	Retained biopsy found any location	Retained biopsy found both cap and channel	Retained biopsy found cap only	Retained biopsy found channel only
All procedures N = 105	50 (48%)	24 (23%)	20 (19%)	6 (5.7%)
EGD N = 55	32 (58%)	16 (29%)	14 (25%)	2 (3.6%)
Colonoscopy N = 50	18 (36%)	8 (16%)	6 (12%)	4 (8%)
P value EGD vs. colonoscopy	0.031*	0.162	0.089	0.421

EGD, esophagogastroduodenoscopy.
* statistically significant with threshold *P* value of 0.05

▶ **Table 3** Demographic and procedure characteristics by whether biopsy was retained.

	Biopsy retained (N = 50)	Biopsy not retained (N = 55)	*P* value
Type of procedure			0.031*
Colon N (%)	18 (36%)	32 (64%)	
EGD N (%)	32 (58.2%)	23 (41.8%)	
Gender			0.174
Female N (%)	22 (40.7%)	32 (59.3%)	
Male N (%)	28 (54.9%)	23 (45.1%)	
Procedure time (mean, median, range)	24.9, 21, (8, 62)	25.2, 23, (5, 93)	0.757
Fentanyl (mcg) (mean, median, range)	33.3, 25, (0, 75)	31.6, 25, (0, 75)	0.868
Propofol (mg) (mean, median, range)	240.5, 210, (70, 470)	271.4, 250, (70, 1000)	0.28

EGD, esophagogastroduodenoscopy.
* statistically significant with threshold *P* value of 0.05

▶ **Table 4** Number of biopsies taken, or biopsy bottles taken by whether biopsy was retained.

	Biopsy retained (N = 50)	Biopsy not retained (N = 55)	*P* value
Number of bottles (mean, median, range)	3.1, 3, (1, 11)	2.8, 2, (1, 10)	0.611
Number of bottles > 1 N (%)			0.832
No	14 (45.2%)	17 (54.8%)	
Yes	36 (48.6%)	38 (51.4%)	
Total number of biopsies (mean, median, range)	13.5, 11, (1, 67)	11.4, 10, (1, 68)	0.379
Total number of biopsies > 5			0.832
No N (%)	14 (45.2%)	17 (54.8%)	
Yes N (%)	36 (48.6%)	38 (51.4%)	
Total number of biopsies > 10			0.437
No N (%)	23 (43.4%)	30 (56.6%)	
Yes N (%)	27 (51.9%)	25 (48.1%)	

also count as a case in which a biopsy was found in the cap. No retained biopsy specimens were found in either the cap or channel in the control group.

Comparing the procedure types, a retained biopsy specimen was found significantly more often in EGDs compared to colonoscopies (58% vs. 36%, $P = 0.031$). There was a higher percentage of EGDs than colonoscopies that had retained biopsies found in the cap only (25% vs. 12%, $P = 0.08$), while a higher percentage of colonoscopies than EGDs had retained biopsies found in the channel only (8% vs. 3.6%, $P = 0.4$), although these differences did not reach statistical significance (▶ **Table 2**).

There was no significant difference in age or gender between cases in which retained biopsy specimens were found and those in which they were not (▶ **Table 3**). Colonoscopies had a longer procedure time, lower fentanyl dose, and higher propofol dose. However, there was no statistically significant correlation between procedure time, fentanyl dose, propofol dose and whether a retained biopsy specimen was found (▶ **Table 3**).

We also analyzed the number of bottles and number of specimens sent for official pathology interpretation and found no statistically significant correlation between these factors and whether a retained biopsy specimen was found. We conducted further analysis by dividing the number of bottles and number of specimens into dichotomous variables. We compared cases with one bottle compared to more than one bottle of biopsy specimens and total number of biopsy specimens of ≤ 5 to > 5 and ≤ 10 to > 10 total specimens (▶ **Table 4**). None of these analyses yielded a significant difference in whether a retained biopsy was found. When looking at location biopsied in relation to whether a biopsy was retained, we found that there was no pattern for EGDs. For colonoscopies, there was a trend in which a

▶ **Table 5** Location of retained biopsies by whether biopsy was retained.

	Biopsy retained (N = 50)	Biopsy not retained (N = 55)	*P* value
EGD	N = 32	N = 23	
Esophagus	14 (51.9%)	13 (48.1%)	0.509
Stomach	21 (56.8%)	16 (43.2%)	0.987
Duodenum	14 (50%)	14 (50%)	0.327
Colonoscopy	N = 18	N = 32	
Cecum/terminal Ileum	10 (47.6%)	11 (52.4%)	0.329
Ascending colon/hepatic flexure	7 (41.2%)	10 (58.8%)	0.938
Transverse colon	8 (57.1%)	6 (42.9%)	0.140
Descending colon/splenic flexure	3 (21.4%)	11 (78.6%)	0.251
Rectosigmoid	4 (20%)	16 (80%)	0.070

higher proportion of procedures with biopsies taken from a more proximal location like the terminal ileum or ascending colon had retained biopsies. Conversely, in procedures during which biopsies were taken from more distal locations such as the rectosigmoid, there was a lower proportion of procedures with retained biopsies. None of these differences reached statistical significance. However, the difference between procedures that biopsied the rectosigmoid with retained biopsies and without retained biopsies approached statistical significance ($P = 0.07$) (▶ **Table 5**).

Of the 50 cases in which retained biopsy specimens were found, only five cases had a new or different pathologic diagnosis on interpretation of the retained biopsy specimens. In four cases, the additional pathologic interpretation would not have changed management of the patients. In the fifth case, intestinal mucosa suggestive of Barrett's esophagus was diagnosed on retained biopsy, which could potentially have changed the endoscopic surveillance interval for the patient (▶ **Table 6**).

Discussion

To our knowledge, there is no existing literature specifically addressing retained or lost gastrointestinal endoscopic biopsy specimens. We found the overall incidence of retained biopsies during routine EGD and colonoscopies was a startingly high 48%. In addition, we found that a small percentage of these retained biopsies could potentially impact the final pathologic diagnosis. When informally surveying our providers and endoscopy lab technicians, the anecdotal incidence of retained gastrointestinal endoscopic biopsies was estimated to be 10% to 15%. One study examining 4200 surgical procedures over a period of 5 years found a specimen loss of 0.068% [2]. Another analysis of over 21,000 surgical specimens found 91 (0.43%) of them had an identification error, which could include no label, no patient name, and wrong patient. Only 16 of the over 21,000 specimens were noted to be an empty container [4].

Another significant finding of our study is that there were more retained biopsy specimens found in EGDs compared to colonoscopies. Neither the number of biopsies taken (total and dichotomizing for ≤ 5 vs. > 5, or ≤ 10 vs. > 10 total specimens) nor number of bottles sent (total and dichotomizing for 1 vs > 1 bottles) accounted for this difference because there is no significant difference between these factors comparing EGDs and colonoscopies. One hypothesis for this difference is that it may be related to the physical structural differences between the two endoscopes. Standard EGD endoscopes have a smaller-diameter accessory channel than a standard colonoscope (2.8 cm vs. 3.7 cm, respectively) and use smaller forceps, potentially making it easier for biopsy material to dislodge. In addition, the colonoscopy accessory channel is longer, which could explain why there is a trend for retained biopsies to be found in the channel from colonoscopy and the cap from EGD (▶ **Table 2**). We also found that for colonoscopies, there was a trend that biopsies were more likely to be retained in procedures with more proximal biopsy sites (▶ **Table 5**). This could be due to increased torque or looping of the colonoscope during removal of these biopsies. As expected, there were no retained biopsy specimens found in our control group in which no biopsies were taken during the procedures. This confirms the reliability of our endoscope cleaning protocols.

In five of the 50 retained biopsy specimen cases, we found that the additional pathological interpretation differed from the official pathologic diagnosis and could have potentially changed management in one patient. We suggest that a quality goal would be to have no change in diagnosis or management from biopsy specimen retention or loss. It is certainly possible, if not likely, that with a larger sample size a more clinically significant change in diagnosis or management could occur.

Some of the limitations the study include the single-center design and analysis of a relatively small number of cases. The small sample size could have led to lack of correlation with the number of biopsies taken to incidence of retained biopsies. However, there were a reasonably large number of biopsies tak-

▶ **Table 6** Retained biopsy cases in which where additional pathologic interpretation differed from official pathological interpretation.

Official pathology interpretation	Retained specimen pathology interpretation	Diagnosis change	Management change	Comments
Esophagitis with eosinophils and parakeratosis	Squamous mucosa with focal epithelial cell injury and reactive features suggestive of reflux	Yes	No	Official pathology showing eosinophils without other reflux changes. Patient already on PPI.
Gastric antral and fundic mucosa without diagnostic abnormality	2 fragments of gastric antral mucosa with mild chronic inactive gastritis. 1 fragment of sloughed squamous cells with mixed bacteria and acellular debris	Yes	No	Mild chronic gastritis not diagnosed on official pathology
Antral and fundic mucosa with no significant abnormality. duodenal mucosa with no significant abnormality.	2 fragments of unremarkable gastric oxyntic mucosa; 1 fragment of gastric oxyntic mucosa with mild chronic inactive gastritis; 1 fragment of unremarkable duodenal mucosa; 1 fragment of partially degraded gastric oxyntic mucosa	Yes	No	Mild chronic gastritis not diagnosed not diagnosed on official pathology
Adenoma with ulcer; no high-grade dysplasia Esophageal squamous mucosa with rare intraepithelial eosinophils (up to 11 per high powered field)	Small bowel mucosa with no significant pathologic abnormality; fragment of intestinal mucosa suggestive of Barrett's esophagus	Yes	Yes	Patient with familial adenomatous polyposis and undergoing annual surveillance EGD and pouchoscopy. Both procedures performed with same upper endoscope. Biopsies taken of Grade A esophagitis and pouch and duodenal polyps. Barrett's esophagus potentially diagnosed

PPI, proton pump inhibitor, EGD, esophagogastroduodenoscopy.

en overall and we suspect that the main finding of a high incidence of retained biopsies is unlikely to change significantly with a larger sample size. In addition, the providers participating in the study knew that they were a part of a study investigating the incidence of retained biopsies, which could have influenced their behavior. However, one might expect this would lead to lower rather than higher incidence of retained specimens. Another limitation of our study is that we did not control the number of specimens obtained per pass of the biopsy forceps and there were no data in the procedure reports on whether the biopsies were taken in an anteflexed or retroflexed position.

Strengths of our study included using a control group to ensure that there were no cleaning or reprocessing errors contributing to the high incidence of retained biopsy specimens. In addition, we created a standardized method to assess and collect retained biopsy specimens. We believe this is a very simple, low-cost and replicable technique.

Our findings are novel as no previous study has examined whether biopsies can be retained in the endoscope and we found an unexpectedly high rate of retained biopsies. It is absolutely critical for accurate diagnosis that correct procurement and labeling of pathologic specimens occurs. This is especially true in procedures in which specific biopsy sites are important, such as Barrett's esophagus surveillance for which biopsies are taken at multiple levels 1-cm apart and a missing biopsy at one level could result in missing a diagnosis of dysplasia. Our results suggest that procurement of pathologic specimens may be negatively impacted by specimen retention in the endoscope channel and caps. In fact, even in our relatively small sample, we found cases in which these retained biopsies could have potentially changed diagnosis or management.

Conclusions

In conclusion, retained biopsy specimens are startingly common in standard gastrointestinal endoscopic procedures. Biopsy specimen retention appears to be more common during EGDs compared to colonoscopies. Further studies are needed to examine larger numbers of endoscopic procedures in different settings as well as different types of endoscopic procedures. Quality improvement measures should be instituted to monitor prevalence of retained biopsies and methods to prevent them should be developed.

Conflict of Interest

The authors declare that they have no conflict of interest.

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