

## Abstract

**OBJECTIVE** To compare clinical outcomes in patients with and without history of tobacco use who underwent Zenker's diverticulotomy (ZD).

**STUDY DESIGN** Single institution retrospective review.

**SETTING** Tertiary care academic hospital.

**METHODS** A retrospective review of patients who underwent ZD via an open stapler, rigid endoscopic CO2 laser, stapler or harmonic scalpel, and flexible endoscopic technique from January 2006 to December 2020 was performed. Data were abstracted for patient demographics, diverticular features, and rates of adverse events and symptomatic recurrence.

**RESULTS** Out of 424 patients, 146 (34.4%) had a history of tobacco use: 126 (29.7%) were former smokers, and 20 (4.7%) were active smokers. In univariable cross-sectional analyses, the likelihood of postoperative bleeding, perforation, emergency department visits, unplanned readmission, or recurrence did not demonstrate an association with tobacco use history even after adjustment for age, sex, and surgical approach. Similarly, in Cox Proportional Hazards regression, tobacco use was not associated with an increased risk of recurrence, even after correcting for age, sex, and type of surgery. The median time to recurrence observed in our cohort was 11.5 years amongst non-smokers, 8.7 years amongst former smokers, and 1.2 years amongst active smokers (p= 0.94).

**CONCLUSIONS** There were no significant differences in post-operative adverse events or frequency of recurrence of ZD between active, former, and non-smokers. Although underpowered and not statistically significant, median time to recurrence appears to be shorter in smokers when compared with former and non-smokers following surgery.

## Introduction

Tobacco smoking is a known cause of impaired wound healing.<sup>1</sup> It has also been shown to worsen esophageal reflux and cause delayed esophageal motility, conditions that can predispose patients to esophageal pathologies.<sup>2</sup> Smoking is associated with higher rates of laryngeal irritation following extubation under general anesthesia.<sup>3</sup> The aim of this study was to identify differences in outcomes for patients who have undergone Zenker's diverticulotomy via five surgical techniques between non-smokers, former smokers, and active smokers. We hypothesized that smoking history might lead to higher rates of post-operative complications such as perforation and affect ZD recurrence rates.

## REFERENCES

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## Methods

**RETROSPECTIVE ANALYSIS** Patients who underwent treatment for symptomatic ZD between January 2006 and December 2020

**INTERVENTION** Zenker's diverticulotomy was performed via open stapler, endoscopic laser, endoscopic stapler, endoscopic harmonic scalpel, and flexible endoscopic septum division approaches at Mayo Clinic, Rochester.

**CRITERIA** The diagnosis of ZD was established through videofluoroscopic swallowing studies (VFSS) and subsequently confirmed during surgical intervention. Patients with cricopharyngeal (CP) hypertrophy lacking a Zenker's pouch were excluded from the study.

**PARAMETERS EVALUTED** Patient demographics, diverticulum size, procedural specifics, duration of hospital stay, procedure-associated complications, and recurrence of ZD

## Results

**TABLE 1** Patient characteristics

	Smoking Status			Total (N=424)	P-value
	Non-smoker (N=278)	Former (N=126)	Active (N=20)		
Age at surgery, mean (SD)	73.3 (11.57)	74.0 (9.85)	65.8 (11.92)	73.1 (11.20)	<.01 <sup>1</sup>
Sex, n (%)					<.01 <sup>2</sup>
Male	151 (54.3%)	89 (70.6%)	11 (55.0%)	251 (59.2%)	
Female	127 (45.7%)	37 (29.4%)	9 (45.0%)	173 (40.8%)	
BMI, mean (SD)	26.9 (5.28)	27.2 (4.95)	28.0 (6.44)	27.1 (5.24)	0.72 <sup>1</sup>
Prior Zenker's procedure, n (%)	59 (21.2%)	34 (27.0%)	4 (20.0%)	97 (22.9%)	0.42 <sup>2</sup>
Pre-op swallow study size of ZD in cm, mean (SD)	2.0 (0.62)	1.9 (0.73)	2.2 (0.73)	2.0 (0.66)	0.23 <sup>1</sup>

<sup>1</sup>Kruskal-Wallis p-value; <sup>2</sup>Chi-Square p-value

**TABLE 2** Procedural outcomes

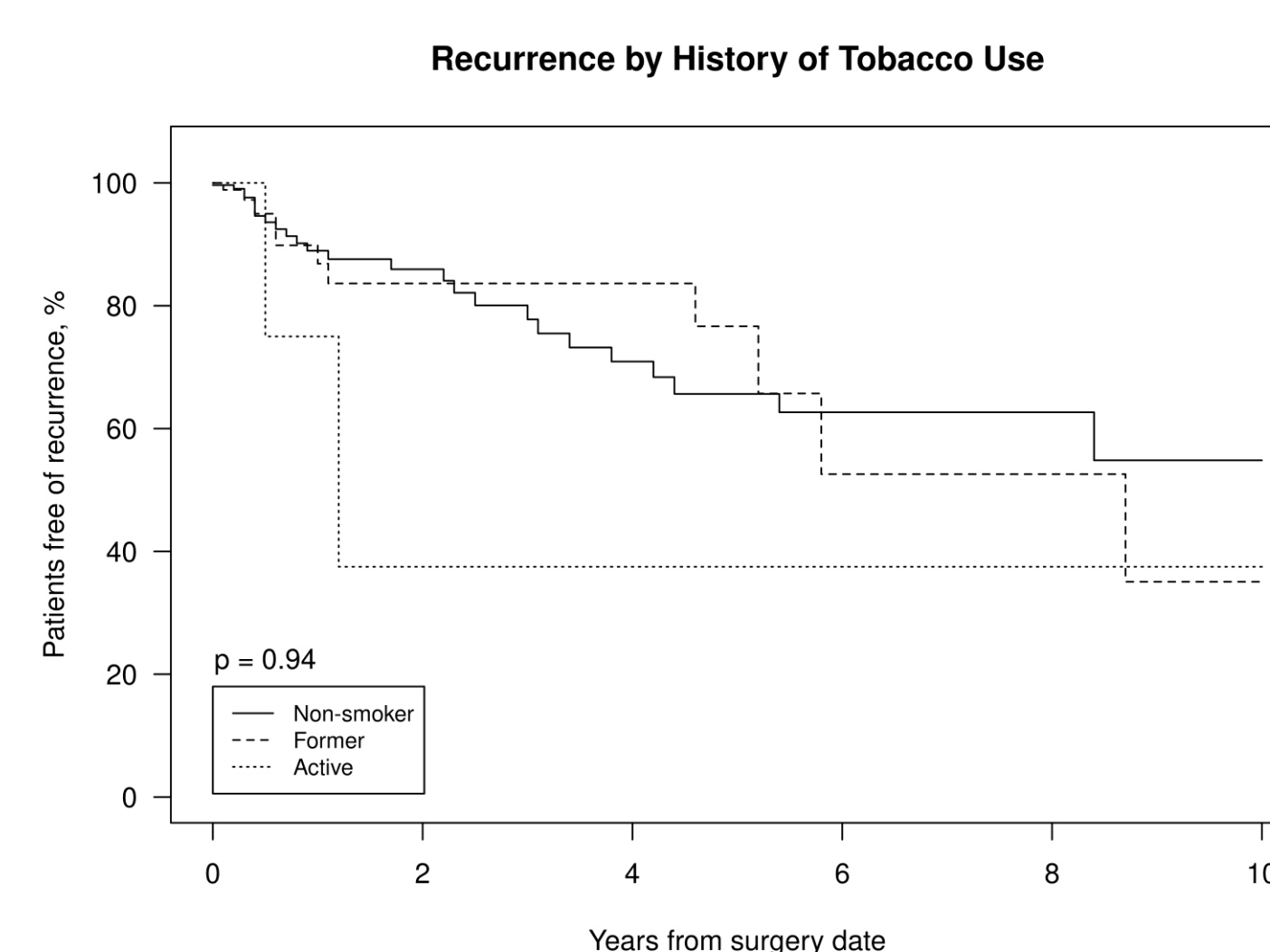
	Smoking Status			Total (N=424)	P-value
	Non-smoker (N=278)	Former (N=126)	Active (N=20)		
Total operating time in minutes, mean (SD)	61.0 (42.07)	68.3 (59.07)	55.5 (37.64)	62.9 (47.42)	0.75 <sup>1</sup>
Length of hospital stay in days, mean (SD)	1.1 (1.49)	1.1 (1.90)	0.7 (0.80)	1.1 (1.60)	0.38 <sup>1</sup>
Return to oral intake in days, mean (SD)	0.6 (1.91)	0.7 (1.98)	1.2 (3.23)	0.7 (2.01)	0.97 <sup>1</sup>
Post-operative bleeding, n (%)	2 (0.7%)	3 (2.4%)	0 (0.0%)	5 (1.2%)	0.32 <sup>2</sup>
Post-operative infection, n (%)	4 (1.4%)	0 (0.0%)	0 (0.0%)	4 (0.9%)	0.35 <sup>2</sup>
Perforation, n (%)	17 (6.1%)	6 (4.8%)	1 (5.0%)	24 (5.7%)	0.85 <sup>2</sup>
Presentation to the ED for a procedure-related adverse event, n (%)	4 (1.4%)	3 (2.4%)	0 (0.0%)	7 (1.7%)	0.66 <sup>2</sup>
Re-admitted to the hospital for a procedure-related adverse event, n (%)	6 (2.2%)	3 (2.4%)	1 (5.0%)	10 (2.4%)	0.72 <sup>2</sup>
Zenker's recurrence, n (%)	28 (10.1%)	11 (8.7%)	2 (10.0%)	41 (9.7%)	0.91 <sup>2</sup>
Additional Zenker's procedure in patients with recurrence, n (%)	15 (53.6%)	6 (54.5%)	2 (100.0%)	23 (56.1%)	0.44 <sup>2</sup>
Follow-up time, mean (SD)	461.9 (869.86)	446.9 (856.17)	331.7 (1072.51)	451.3 (874.37)	0.38 <sup>1</sup>

<sup>1</sup>Kruskal-Wallis p-value; <sup>2</sup>Chi-Square p-value

**TABLE 3** Cumulative incidence of ZD recurrence

	Smoking Status			
	Non-smoker	Former	Active	Overall
Median time to recurrence (years)	11.5	8.7	1.2	8.7
Years from surgery:				
1	11% (5-17%)	13% (2-23%)	25% (0-57%)	12% (7-17%)
2	14% (7-21%)	16% (4-27%)	63% (0-92%)	16% (9-22%)
5	34% (20-46%)	23% (4-39%)	63% (0-92%)	32% (21-41%)
10	45% (23-61%)	65% (6-87%)	63% (0-92%)	52% (29-68%)

**FIGURE 1** Kaplan-Meier plot of recurrence broken out by history of tobacco use

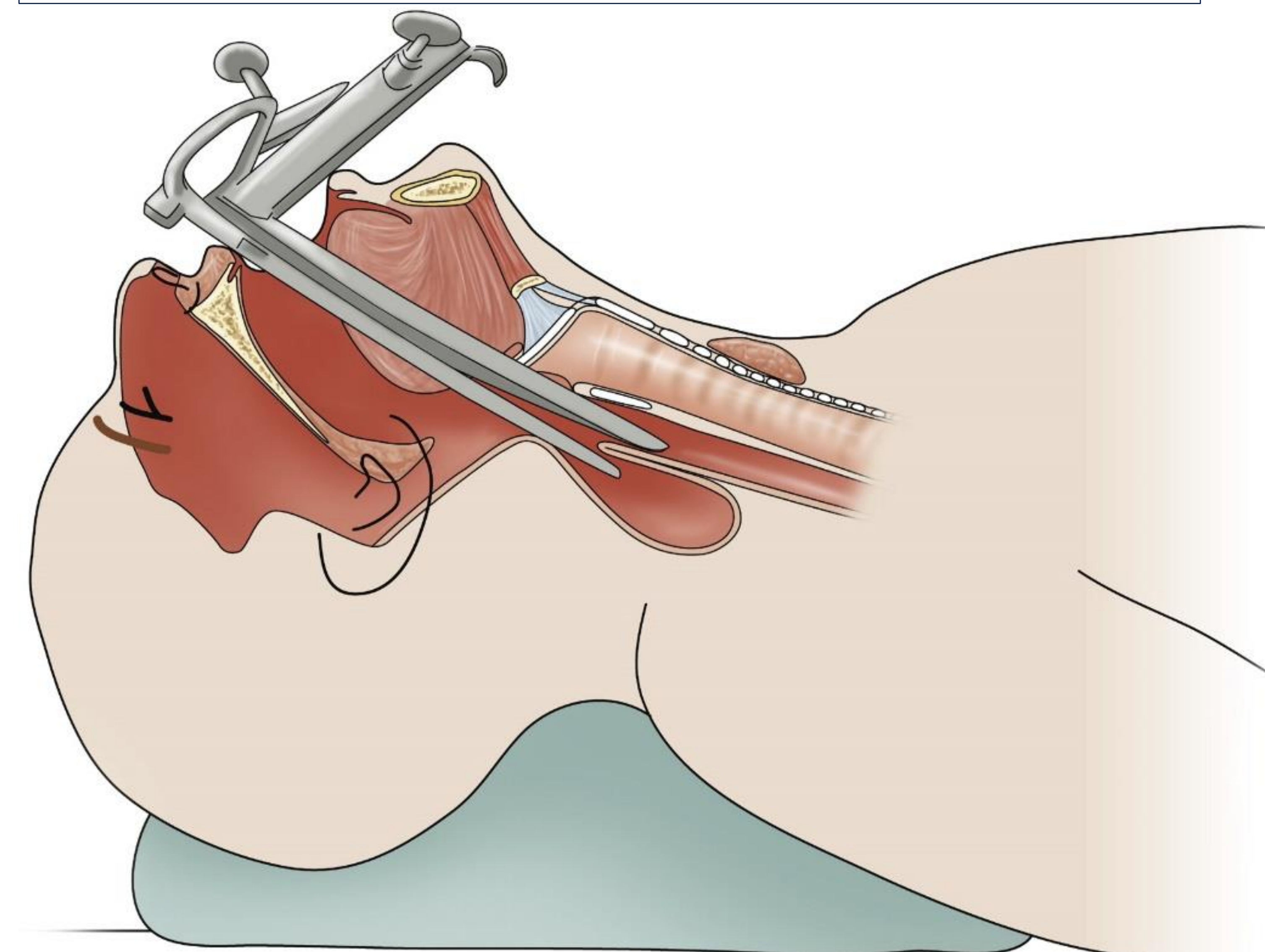


## Discussion

Active smokers underwent surgery for ZD at a younger age compared to non-smokers or former smokers (Table 1). The inflammatory effect of tobacco use and its affect on esophageal motility might accelerate the onset or symptomatic presentation of ZD, necessitating surgical intervention earlier in life.<sup>4</sup>

There was no difference in total operating time, length of hospital stay, or return to PO intake between groups (Table 2). There were also no difference postoperative bleeding, infection, perforation, and other adverse events. However, the absolute numbers, especially for active smokers, were low, potentially limiting the statistical power of the study.

Despite active smokers having a statistically similar rate of recurrence amongst its patients, the median time to recurrence was 1.2 years compared to 11.5 years and 8.7 years for the non-smoking and former smoking (Table 3, Figure 1). This finding, although based on limited observations in the active smoker group, draws attention to the detrimental effect of continued smoking on post-diverticulotomy healing.<sup>5</sup>



## Conclusions

While tobacco use may not have a significant impact on immediate post-operative results, it may affect the timeframe of ZD recurrence. We hypothesized that smoking history might lead to higher rates of post-operative complications such as perforation, but there was no significant difference between groups. We found that active smokers required operative intervention at a younger age than former and non-smokers. Though overall rate of recurrence was similar between groups, ZD recurrence occurred at an earlier time point for patients in the active smoking group. Our small sample size of patients in the active smoking group limited our statistical significance and necessitates further investigation.