

Effect of internal ligation on the occurrence of trocar site hernia after laparoscopic sleeve gastrectomy

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ABSTRACT

Aims: Nowadays, laparoscopic sleeve gastrectomy (LSG) has become the most commonly performed bariatric surgical method. One of the complications seen after LSG is trocar site hernia (TSH). The aim of this study is to identify the risk factors for TSHs after LSG and to investigate the effect of internal ligation of the trocar entry site using energy-based vessel-sealing device (LigaSure™) on preventing TSH occurrence.

Methods: The records of 841 patients who underwent LSG between January 2021 and October 2023 at Altınbaş University Faculty of Medicine Medicalpark Hospital were reviewed. A total of 244 patients were included in the study. All surgeries were performed by the same surgical team under identical conditions. In all patients, the right trocar site used to remove the stomach from the abdomen was expanded with a Kocher clamp. The right and left 12 mm trocar entry sites were ligated internally using LigaSure. The patients' age, gender, body-mass index (BMI), diabetes mellitus (DM), hypertension (HT), dyslipidemia, wound site infections, smoking status, chronic obstructive pulmonary disease (COPD), and constipation were evaluated. All patients were followed up at the 3rd, 6th, and 12th months following the LSG surgery. Physical examinations and ultrasound scans were performed to detect the presence of TSH.

Results: In the analysis of 244 patients, 150 (61.5%) were female, 94 (38.5%) were male, and their ages ranged from 18 to 72 years old. The average age was 39.28±12.27 years old. The BMI ranged from 35.1 kg/m² to 63.9 kg/m², with an average of 43.16±5.40 kg/m². HT was present in 32% of the cases, diabetes in 35.2%, dyslipidemia in 38.9%, and COPD in 6.1%. Constipation was reported in 26.6% of the patients, and 41.4% were smokers. Wound infections were seen in 2 cases (0.8%). At the 3-month follow-up, no TSHs were detected. At the 6-month post-surgical follow-up, one patient had a TSH, and one more was detected in an ultrasound scan performed after 1 year of the LSG surgery. The hernias identified were at the right trocar site, and none of them were symptomatic. There was no statistically significant correlation between gender, BMI, HT, diabetes, dyslipidemia, smoking, and the occurrence of hernia (p>0.05). The mean age of patients with a detected hernia (66.0±2.83 years) was statistically significantly higher than that of patients without hernia (39.06±12.07 years) (p:0.020; p<0.05). The hernia rate in COPD patients (13.3%) was statistically significantly higher compared to those without COPD (0%) (p: 0.004; p<0.05). Although the hernia rate in patients with constipation (3.1%) was higher than in those without constipation (0%), this difference was not statistically significant (p: 0.070; p>0.05). The hernia rate in patients with wound site infections was statistically significantly higher than in those without wound site infections (p: 0.016; p<0.05). In literature, studies report that the incidence of TSH ranges from 4% to 39%. In our study, this rate was less than 1%.

Conclusion: Advanced age, COPD, constipation, and wound site infection were identified as risk factors for TSH. Internal ligation of the trocar entry site after LSG is an effective method for reducing the rate of TSH.

Keywords: Laparoscopy, sleeve gastrectomy, trocar site hernia, wound infection

INTRODUCTION

Obesity is a chronic and complex disease characterized by excessive fat accumulation that can impair the body's health. Obesity increases the risk of type 2 diabetes, hypertension (HT), fatty liver disease, cardiovascular disease, joint disorders, sleep apnea, depression, and certain cancers.

According to the World Health Organization's 2022 data, one in eight people worldwide lives with obesity.¹

In the treatment of obesity, diet and exercise are initially recommended. However, in patients who are unable to lose

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weight despite diet and exercise while having a body-mass index (BMI) over 40 kg/m², or a BMI over 35 kg/m² with obesity-related comorbidities, bariatric surgery is indicated. Various bariatric surgical methods have been described. However, today laparoscopic sleeve gastrectomy (LSG) is the most frequently performed bariatric surgery method.

LSG is a restrictive method. The stomach is mobilized along the greater curvature, and 75-80% of the stomach is resected, forming a tube-shaped stomach.

Complications that can arise in patients after LSG are divided into early and late complications (**Table 1**). Hemorrhage is the most common early complication. Staple line leaks in the early period can be a fatal complication. Nutritional deficiencies are the most common late complications. Trocar site hernia (TSH) is a late complication that can also occur. TSH is an incisional hernia that can occur at the trocar entry sites following various laparoscopic surgeries.

Table 1. Possible complications of sleeve gastrectomy surgery	
Early complications (<30 days)	Late complications (>30 days)
Bleeding	Gastric stenosis
Staple line leaks	Nutritional deficiencies
Intraabdominal abscess	Gastroesophageal reflux
Wound site infections	
Acute pancreatitis	
Pulmonary emboli	Trocar site hernia
Thrombophlebitis	Eating disorders
Rhabdomyolysis	Mental disorders
Acute kidney insufficiency	
Partial spleen infarct	

TSH may sometimes be an overlooked complication because it usually has a slow clinical course. While it can manifest asymptotically in some patients, it can cause serious morbidity and mortality due to bowel strangulation risk in others.

In obese patients, due to the excess subcutaneous fat tissue, diagnosing TSH by inspection and physical examination is difficult. Therefore, it is recommended to evaluate the trocar site with superficial ultrasound. Various studies have used imaging methods to detect abdominal wall defects postoperatively in obese patients. In these studies, TSH was detected in up to 39% of cases.²⁻⁴ These values make TSH an important complication after bariatric surgeries, especially LSG.

Current literature supports closing trocar sites larger than 10 mm due to the risk of incisional hernia, while stating that it is unnecessary to suture the abdominal fascia when 5 mm trocars are used.

Closing the trocar entry incision in laparoscopic surgery, especially in patients with morbid obesity, is a challenging procedure. Various techniques and devices have been proposed to close trocar wounds and therefore minimize the risk of hernia formation. To date, the most suitable closure technique for closing trocar site incisions after LSG has not been clearly defined.

Our procedure for closing the trocar entry site is relatively simple, safe, less time-consuming, and cost-effective.

The aim of our study is to determine the risk factors for TSHs after LSG surgery and to investigate the preventive effect of internally ligating the trocar entry site with a Ligasure device on the development of TSH.

METHODS

The study was initiated with the approval of the Altınbaş University Health Sciences Scientific Researches Ethics Committee (Date: 14.11.2024, Decision No: 1). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The records of 841 patients who underwent LSG at Altınbaş University Faculty of Medicine Medical Park Hospital between January 2021 and October 2023 were reviewed. 244 patients were included in the study.

All surgeries were performed by the same surgical team under the same conditions. A standard LSG was applied to all patients.

Two 12 mm trocars were inserted through the right and left midclavicular lines, one 11 mm trocar through the umbilicus within the left rectus muscle, one 5 mm trocar through the epigastric region, and one 5 mm trocar through the left anterior axillary line (**Figure 1**). The right trocar region used for stomach extraction was expanded with a Kocher clamp in all patients (**Figure 2-3**). The 12 mm right and left trocar entry sites were internally ligated with an energy-based vessel-sealing device (LigaSure™) (**Figure 4**). The sealing was done circumferentially, ensuring the trocar entry site opening was 5 mm or smaller (**Figure 5-6-7**).

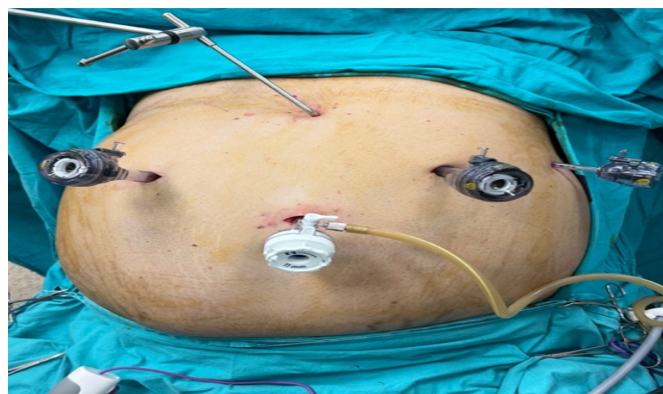


Figure 1. Trocar placement

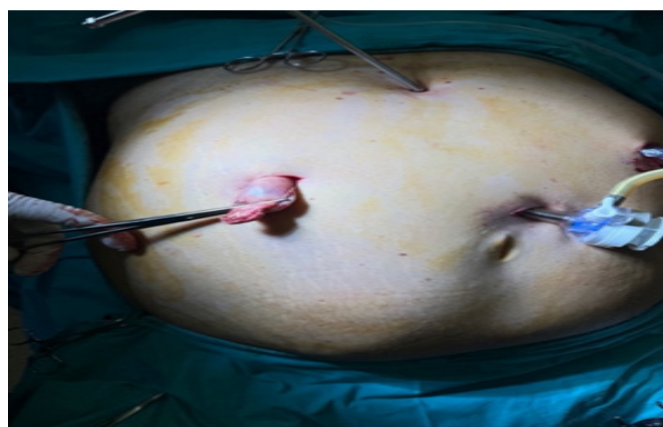


Figure 2. Right trocar used for stomach extraction

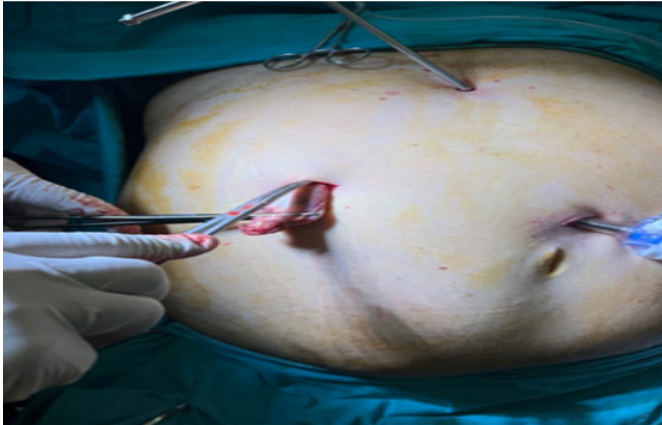


Figure 3. Right trocar used for stomach extraction

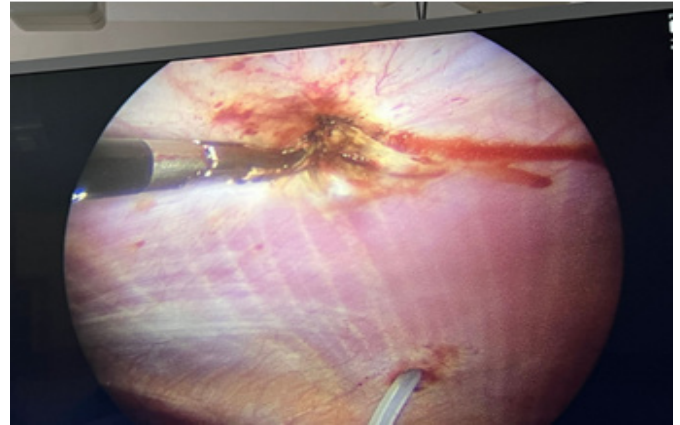


Figure 7. Internal ligation of the trocar entry site



Figure 4. Measuring trocar entry site

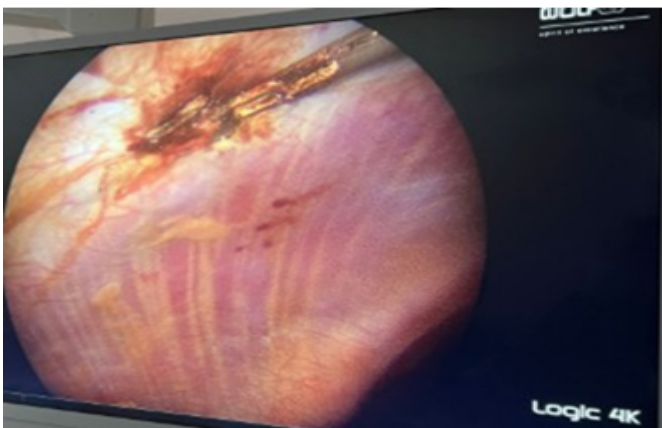


Figure 5. Internal ligation of the trocar entry site



Figure 6. Internal ligation of the trocar entry site

Patients' age, gender, BMI, diabetes mellitus (DM), HT, dyslipidemia, wound site infections, smoking, chronic obstructive pulmonary disease (COPD), and presence of constipation were evaluated.

In addition to routine follow-ups, all patients were checked at 3, 6, and 12 months post-LSG surgery for the presence of TSH through physical examination and ultrasound controls. All ultrasound checks were performed by the same radiologist.

Findings and statistical results were compared with the literature to analyze the effect of internally ligating the trocar entry site using a LigaSure device.

Statistical Analysis

The findings obtained in the study were analyzed using the IBM SPSS Statistics 22 program. The suitability of the parameters to normal distribution was evaluated using the Kolmogorov-Smirnov test, and it was determined that the parameters did not show normal distribution. Descriptive statistical methods (minimum, maximum, mean, standard deviation, median, frequency) were used in the evaluation of the study data. Mann-Whitney U test was used for comparisons of quantitative data between two groups. Fisher's Exact Chi-square test was used for the comparison of qualitative data. OR (odds ratio) was calculated for univariate risks. Significance was evaluated at the $p < 0.05$ level.

RESULTS

The study was conducted with 244 cases, including 150 (61.5%) females and 94 (38.5%) males, aged between 18 and 72 years. The mean age was 39.28 ± 12.27 years. BMI levels ranged from 35.1 kg/m^2 to 63.9 kg/m^2 , with a mean of $43.16 \pm 5.40 \text{ kg/m}^2$ (Table 2).

HT was present in 32% of the cases; diabetes in 35,2%; dyslipidemia in 38,9%; and COPD in 6.1%. Constipation was reported in 26.6% of the patients, and 41.4% were smokers. Wound infections were observed in 2 cases (0.8%).

Hernia was detected in 2 cases (0.8%) in the ultrasound performed after 1 year of the LSG surgery, with one of the detected hernias being symptomatic.

There was no statistically significant relationship between gender and hernia ($p > 0.05$).

Table 2. Distribution of the study parameters

		n	%
HT	Yes	78	32
	No	166	68
DM	Yes	86	35.2
	No	158	64.8
Dyslipidemia	Yes	95	38.9
	No	149	61.1
COPD	Yes	15	6.1
	No	229	93.9
Constipation	Yes	65	26.6
	No	179	73.4
Smoking	Yes	101	41.4
	No	143	58.6
Wound site infection	Yes	2	0.8
	No	242	99.2
Ultrasound scan 1 year later	TSH	2	0.8
	No TSH	242	99.2

HT: Hypertension, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary disease, TSH: Trocar site hernia

No statistically significant relationship was found between HT, diabetes, and dyslipidemia with hernia ($p>0.05$).

No statistically significant relationship was found between smoking and hernia ($p>0.05$).

In patients with COPD, the incidence of hernia (13.3%) was statistically significantly higher than in patients without COPD (0%) ($p:0.004$; $p<0.05$). The hernia risk in cases with COPD was 1.154 times higher (OR:1.154; 95% CI:0.946-1.407).

The incidence of hernia in cases with constipation (3.1%) was higher than in cases without constipation (0%); however, this difference was near significance but not statistically significant ($p:0.070$; $p>0.05$). The hernia risk in cases with constipation was 1.032 times higher (OR:1.032; 95% CI:0.988-1.077).

In cases with wound site infection, the incidence of hernia (50%) was statistically significantly higher than in cases without wound site infection (0.4%) ($p:0.016$; $p<0.05$). The hernia risk in cases with wound site infection was 241 times higher (OR:241; 95% CI:8.066-7200.466).

The mean age of cases with hernia detected by ultrasound (66.0 ± 2.83) was statistically significantly higher than those without hernia (39.06 ± 12.07) ($p:0.020$; $p<0.05$). The hernia risk in older cases was 1.251 times higher (OR:1.251; 95% CI:1.008-1.553).

There was no statistically significant difference in BMI averages between cases with and without hernia detected by ultrasound ($p>0.05$) (Table 3).

DISCUSSION

In this study, the factors influencing the development of TSH and the effect of internally ligating the trocar entry site on hernia development are discussed.

Various risk factors for TSH have been identified. These may be related to patient factors (such as advanced age, smoking status, obesity, comorbidities like diabetes)⁵, technical and perioperative factors (such as surgery duration, trocar size), and postoperative factors like wound infection.⁶

Table 3. Evaluation of parameters affecting ultrasound findings

		Ultrasound scan 1 year later	
		TSH (n=2)	No TSH (n=242)
		n	%
Gender	Female	2 (1.3%)	148 (98.7%)
	Male	0 (0%)	94 (100%)
HT	Yes	2 (2.6%)	76 (97.4%)
	No	0 (0%)	166 (100%)
DM	Yes	2 (2.3%)	84 (97.7%)
	No	0 (0%)	158 (100%)
Dyslipidemia	Yes	1 (1.1%)	94 (98.9%)
	No	1 (0.7%)	148 (99.3%)
COPD	Yes	2 (13.3%)	13 (86.7%)
	No	0 (0%)	229 (100%)
Constipation	Yes	2 (3.1%)	63 (96.9%)
	No	0 (0%)	179 (100%)
Smoking	Yes	2 (2%)	99 (98%)
	No	0 (0%)	143 (100%)
Wound site infection	Yes	1 (50%)	1 (50%)
	No	1 (0.4%)	241 (99.6%)
Age	mean±SD (median)	66.0±2.83 (66)	39.06±12.07 (38)
BMI	mean±SD (median)	45.40±1.10 (45.4)	43.15±5.42 (42.3)

Fisher's Exact test, +Mann Whitney U Test, * $p<0.05$
HT: Hypertension, DM: Diabetes mellitus, COPD: Chronic obstructive pulmonary disease, TSH: Trocar site hernia, SD: Standard deviation

There are many patient and procedure-related risk factors that predispose individuals to TSHs. Obesity is highlighted as an important factor increasing the risk of TSH. Due to the increased intra-abdominal pressure, obese patients are more likely to develop a weakness in the abdominal wall at the trocar entry site.⁷ The higher intra-abdominal pressure and thicker subcutaneous fat tissue make obesity a significant predisposition factor for TSH, which also complicates full-thickness closure of the trocar site. Furthermore, during LSG, manipulation of the port site with an instrument or finger while removing the resected stomach piece from the 12 mm trocar site theoretically increases the risk of herniation. A study reports that excessive manipulation of the trocar site during specimen removal is a significant risk factor for TSH.⁸ Additionally, a multivariate analysis revealed that advanced age (over 60) is significantly associated with hernias, potentially due to decreased fascial strength. It is also known that postoperative wound infection at the trocar entry site increases the risk.^{9,10}

Our study findings, similar to the literature, show that advanced age, COPD, constipation, and wound site infection increase the risk of developing TSH. However, no risk was identified with gender, HT, and diabetes. One of the two patients who developed wound site infection also developed TSH, consistent with the literature. The prevalence of TSH is uncertain.⁹ Especially in obese patients, clinically detecting a small TSH embedded in thick subcutaneous fat tissue is difficult.^{11,12} Ultrasound and CT scans can diagnose more TSH efficiently and help clarify the diagnosis when TSH is clinically suspected.^{13,14} For example, the incidence of TSH in laparoscopic bariatric surgery is generally reported as low single-digit percentages, according

to studies detecting asymptomatic TSH with physical examination only. However, a prospective cohort series with ultrasound follow-up in one study population observed TSH development in 34% of patients at one or more trocar sites.³ Karampinis et al.¹³ reported in a meta-analysis that the incidence of TSH was significantly higher in studies with follow-up periods of 12 months compared to those shorter than 12 months. In our study, ultrasound follow-ups detected one case of TSH at 6 months and one at 1 year, with patients being asymptomatic. In both cases, the TSH developed at the 12 mm trocar site on the right midclavicular line. It is known that manipulation of the port site during the removal of the stomach piece from this port influences hernia development. Post-surgical wound site infection was present in one of the hernia cases. We believe the lower detection of TSH in these follow-ups supports the effectiveness of our closure method.

It is generally accepted that closing umbilical trocar sites, most midline trocar sites of 10 mm or larger, and any port sites enlarged for specimen extraction is a good practice.¹⁵ An international consensus group agreed by 86.8% that 15 mm ports should be closed in all patients.¹⁶ In our study, 5 mm trocar sites were also internally ligated with a Ligasure device for bleeding control. The 10 mm and 12 mm trocar entry sites were also ligated, reducing their openings to 5 mm or less. We believe the lower incidence of hernia development in our study, consistent with the literature, is due to reducing the opening to 5 mm.

In bariatric surgery, a review stated that the general incidence of TSH is 3.2%. This review showed that the incidence of TSH is significantly higher in studies using imaging for diagnosis compared to those using clinical examination or without specific follow-up regimens (16.2% vs. 1.3%). A recent case series of 79 patients undergoing laparoscopic gastric sleeve procedures reported a 21.5% incidence of TSH at the umbilical removal site when examined with CT after a mean follow-up of 37 months. This emphasizes that the true incidence of TSHs is likely underestimated.

We had the chance to observe the trocar entry sites previously ligated with a Ligasure tool in two patients we operated on for gallstones 10 months after their sleeve gastrectomy surgeries. The trocar entry sites were found to be closed (**Figure 8-9**).

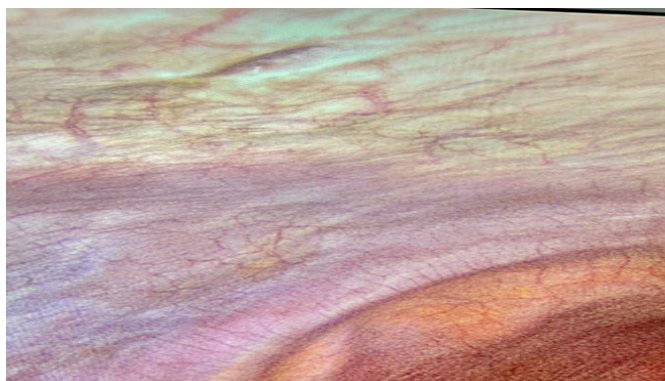


Figure 8. The trocar entry sites after 10 months

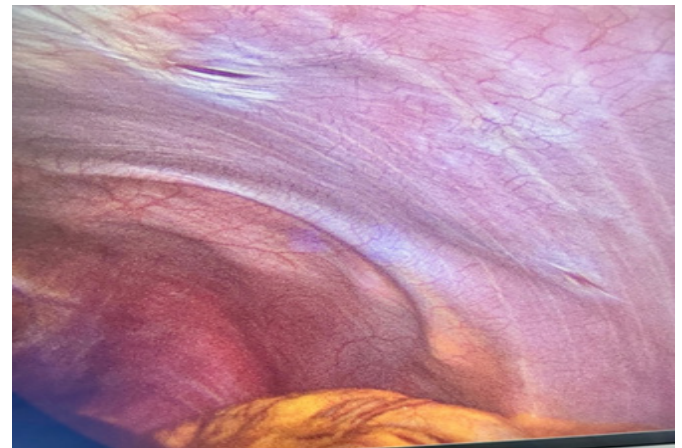


Figure 9. The trocar entry sites after 10 months

Internally ligation with a Ligasure device is commonly used by many surgeons for port site hemostasis. Similarly, ligating and reducing the opening of the trocar entry sites is an easily applicable, cost-effective, and time-saving method. In our method, where patients were followed up for 1 year and their trocar entry sites were checked with ultrasound, the significantly lower TSH rate compared to the literature demonstrates the method's effectiveness.

Limitations

Our study has observational limitations due to its retrospective design and the data obtained from a specific patient group. Larger sample groups and prospective studies are necessary to demonstrate the effectiveness of internal ligation with a Ligasure device in the prevention of TSH.

CONCLUSION

Advanced age, COPD, constipation and wound site infection were identified as risk factors for TSH. Internal ligation of the trocar entry site after LSG is an effective method for reducing the rate of TSH.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was initiated with the approval of the Altınbaş University Health Sciences Scientific Researches Ethics Committee (Date: 14.11.2024, Decision No: 1).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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