

Editor's note:

This article has been retracted.

Original Article

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# Diagnostic value of erythrocyte sedimentation rate levels as a predictor of staple-line leakage in bariatric surgery

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## Abstract

**Aim:** Bariatric surgery is an effective treatment for morbid obesity that has inevitable complications including postoperative bleeding and staple-line leakage. Erythrocyte sedimentation rate (ESR) can be a clinical indicator for prediction of leakage.

**Methods:** This retrospective cohort study was done on 1999 patients who underwent sleeve gastrectomy in Erfan Niyayesh Hospital, Tehran, Iran. ESR levels of patients were evaluated in cases which had postoperative leak. Statistical analyses were performed using SPSS software.

**Results:** Among the 2350 patients, 50 subjects experienced gastric leak (2.12%). ESR mean was 73.1 mm/h for cases, statistically significantly higher in patients with leakage compared to the control group. In addition, ESR serum level mean was 31.34 mm/h for control groups. Other variables including C-reactive protein and platelet count were not statistically significant.

**Conclusion:** Higher ESR serum level can be seen in various conditions, and, in obese patients who undergo bariatric surgery, it can be a reliable predictor for postoperative gastric leak complication.

**Keywords:** Erythrocyte sedimentation rate, postoperative leak, sleeve gastrectomy



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## INTRODUCTION

Bariatric surgery has become one of the most effective treatments for morbid obesity, with extremely good long-term results on weight loss, co-morbidities, and low mortality as well as postoperative complications rate<sup>[1]</sup>. Bariatric surgery for morbid obesity has improved in the last fifteen years<sup>[2]</sup>. According to every published report, bariatric surgery is one of the safest operations with a complication rate of less than 1%<sup>[3,4]</sup>. However, knowledge about its anatomic reconstruction, the physiologic effects of bariatric surgery, and the prevention and management of complications after a bariatric procedure have not been directly incorporated into general procedure preparation programs<sup>[5,6]</sup>. Hence, general surgeons should expand their basic anatomic, clinical, and surgical understanding because they might face postoperatively acute or chronic complications in their patients<sup>[6]</sup>. Bariatric surgery can cause early complications including primarily staple-line leakage and bleeding in the immediate postoperative days. Late postoperative complications include abscess development or delayed postoperative staple-line leakage with fistula as well as sleeve stenosis. In addition, some patients can develop a rare case of sleeve gastrectomy, which is deep vein thrombosis<sup>[7]</sup>.

As mentioned, gastrointestinal staple-line leakage remains one of the most unavoidable complications after the procedure, resulting in increased healthcare cost and postoperative pain in patients<sup>[8]</sup>. According to several meta-analyses, gastrointestinal leak rate has been estimated to range from 2.5% to 7% after various types of bariatric surgery<sup>[6-9]</sup>. Postoperative gastrointestinal leak has been constantly dropping recently and its occurrence is low<sup>[10]</sup>; nonetheless, leakage is still a principal complication, leading to increase morbidity and mortality rate. Various surgeons have employed different interventions for detecting leaks either intraoperatively or postoperatively such as placement of an orogastric tube with distention of the gastric pouch with air, endoscopy with carbon dioxide insufflations, and methylene blue dye<sup>[6]</sup>.

Researchers have recently found that, in patients with low BMI, postoperative increased heart rate (tachycardia > 120 bpm), evidence of respiratory distress, and decreased hemoglobin were significantly associated with bleeding<sup>[11,12]</sup>. Alizadeh *et al.*<sup>[13]</sup> reported that oxygen dependency, hypoalbumenia, sleep apnea, hypertension, and diabetes were critical factors related to increased risk of leak<sup>[13]</sup>. In addition, preoperative platelet count, INR, and systolic blood pressure were not significantly related to postoperative bleeding<sup>[12]</sup>. On the other side, the association between preoperative partial thromboplastin time and bleeding was significant<sup>[12]</sup>. Burgos *et al.*<sup>[11]</sup> stated that increased white blood cell (WBC) and C-reactive protein (CRP) levels, abdominal pain, tachycardia, tachypnea, and fever are more common in subjects with gastric leak<sup>[11]</sup>.

From the clinical perspective, an erythrocyte sedimentation rate (ESR) is one of the blood tests that is usually ordered by physicians for patients with symptoms such as inflammation in the body, headaches, fever, joint stiffness, neck or shoulder pain, weight loss, loss of appetite, anemia, and fever<sup>[14,15]</sup>.

Higher ESR levels may be associated with a medical condition, such as infection or inflammation (especially inflammatory bowel disease), rheumatoid arthritis, cardiovascular or kidney disease, and some types of cancers. Higher ESR levels do not necessarily mean that the patients have a medical condition that requires treatment<sup>[15]</sup>. For example, certain medications and dietary supplements can also affect ESR results, including oral contraceptives, cortisone, vitamin A, and aspirin. A moderate ESR may indicate pregnancy, menstruation, or anemia, rather than an inflammatory disease. A slow ESR may indicate a blood disorder such as polycythemia, sickle cell anemia, and leukocytosis<sup>[14,15]</sup>.

The main purpose of this study was to evaluate correlations of ESR, CRP, and platelet count with incidence of intermediate gastrointestinal leak in obese subjects who underwent sleeve gastrectomy.

## METHODS

### Data source

We performed a retrospective cohort study using the database of Erfan Niayesh Hospital bariatric procedures performed by Taha Anbara, Laparoscopic Surgeon, MD.

### Surgical procedure

Sleeve gastrectomy was performed on all subjects according to the standard protocol and in a similar method by a specific surgeon with similar tools during the same duration. After prep and draping under GA, a 10-mm trocar canula (Covidien, Cincinnati, OH) is inserted above the umbilicus. Then, three 5-mm trocar canulas and one 15-mm canula (Covidien, Cincinnati, OH) are inserted under direct vision in the proper place. The gastrocholic ligament is divided with ligature. Then, the sleeve gastrectomy is done with seven 4.5-mm staples (black cartridges). The divided part of the stomach is taken out later and the place of staple line is sutured with 2-0 yarn. Afterwards, the drain is placed at gastrectomy site. The canulas are taken out later under direct sight and then, when homeostasis is reliable, abdominal gas is drained and the place of Canula 10 is repaired. To determine leakage, we transiently block the flow into the duodenum with long intestinal forceps at the pyloric channel. The removed specimen, which is removed easily through the 15-mm port at the right upper abdominal quadrant, is sent for histological analysis. Finally, one silastic drain is always left at side of the gastric suture line.

### Clinical evaluation

Clinical sign and symptoms were repeatedly surveyed for all subjects every 6 h after surgery. Intraoperative gastrointestinal leakage was not observed during procedure in any subjects.

### Study design and population

Clinical data on 199 adult obese subjects who underwent sleeve gastrectomy were evaluated according to the Current Procedural Terminology code: LSG (43,775). Approval for the use of the data in this study was obtained from the Efran-Niyayesh Hospital. Subjects were categorized into two groups, those who experienced postoperative gastrointestinal leakage (Cases) and those without any types of leakage, whether intraoperative or after procedure (Control). Preoperative co-morbidities and characteristics were examined to determine predictive factors of leakage. Oral contrast was given during the study and the contrast was followed when it went from the mouth to the small intestine. Emergent, revisional, and converted cases were excluded. The time and location of appearance and closure of leakages were diligently recorded in all cases.

### Definition of leakage

The UK Surgical Infection Study Group has defined a standard definition of anastomotic leakage: “the leak of luminal contents from a surgical join between two hollow viscera”. It may also demonstrate a gastrointestinal leak in a suture line around the organ. According to the time of leakage appearance, they have previously been classified<sup>[14]</sup> as follows: early (leaks appearing 1-3 days after procedure), intermediate (leaks appearing four days to a week after surgery), and late (leaks appearing more than one week after procedure).

### Patients

Fifty cases who had postoperative gastrointestinal leakage were considered in the study as well as 149 control cases (ratio 3:1) randomly selected to increase the reliability of the study. The information of control cases was extracted from the medical records of Erfan-Niyayesh Hospital. All cases underwent sleeve gastrectomy during 2017-2019 in Erfan-Niyayesh Hospital under supervision of the same surgeon with the same tools. The variables used in the multivariate analyses included demographic data (BMI, age, and gender), preoperative co-morbidities, procedural type, and various intraoperative and postoperative interventions.

**Table 1. The distribution of study variables**

Variables	Total (n = 199)	Case (n = 50)	Control (n = 149)
Sex (count/percent)			
Male	60 (30.2%)	15 (30%)	45 (30.2%)
Female	139 (69.8%)	35 (70%)	104 (69.8%)
Age (mean)	38.15	37.32	38.42
ESR (mean)	41.83	73.1	31.34

ESR: Erythrocyte sedimentation rate

### Statistical analysis

Adjusted and unadjusted binary logistic regression models were used to evaluate effects of independent variables on leaking outcome (0 = no, 1 = yes). Independent variables included sex, age, and ESR. The significance level was defined as 0.05 ( $\alpha = 0.05$ ). Both adjusted and unadjusted variables with significant levels were included in the final models and are reported below. Statistical analysis was performed using IBM SPSS Statistics 25 (SPSS Inc., Chicago, IL).

The final predicting model for leaking outcome was designed using the following regression model:

$$\log\left[\frac{P_x}{1 - P_x}\right] = a + b_1 X_1$$

The final adjusted prediction model of log (odds) for leaking outcome was calculated using the following equation:

$$y = (-3.576) + 0.50 (ESR)$$

### RESULTS

We investigated, among the 2,350 patients who underwent sleeve gastrectomy from 2016 to 2019, 50 subjects who experienced gastric leak (2.12%). The total sample size was 199 patients, including 50 cases experiencing leak and 149 controls (randomized from 2,350 patients). Overall, 69.8% of the cohort, 70% of cases and 69.8% of controls, were females. The mean age for the cohort was 38.15 (minimum 12 years old and maximum 63 years old). The mean ESR was 73.1 mm/h for cases, which is statistically significantly higher in patients with leakage compared to the control group. In addition, ESR serum level mean was 31.34 mm/h for control groups. More descriptive results are reported in [Table 1](#).

The results of adjusted and unadjusted logistic regression are reported in [Table 2](#). Females were taken as reference group due to bigger proportion in the sample. The only independent variable which had significant association with staple-line leakage was ESR (OR = 1.051). This means that, for every 1 unit increase of ESR, the odds for staple-line leakage occurrence increases by 5.1%.

### DISCUSSION

The sleeve gastrectomy procedure has been popularly employed for the management of morbid obesity and this operation has a series of inevitable complications. Staple-line leakage is one of these complications, with an incidence ranging from 7% to 25% after bariatric surgery<sup>[6]</sup>. Although researchers have mentioned various approaches, surgeons utilize the endoscopic approaches, such as stent inserting, clips, and biologic glue<sup>[16]</sup>. This study comprised our experiences with 199 patients, with or without staple-line leakage, after sleeve gastrectomy. The final adjusted prediction model of log (odds) for leaking outcome can be used to predict leaking outcome. Exponential of ( $y$ ) gives odds of occurrence of leaking for each patient with archived ESR. It should be noted that, because of the impact of other factors affecting on staple-line leakage outcome, this model might not be 100% precise.

**Table 2. Binary logistic regression models results (odds ratio)**

Variables	Unadjusted model		Adjusted model	
	OR (95%CI)	P value	OR (95%CI)	P value
Sex	0.99 (0.49-1.99)	0.979	0.94 (0.38-2.34)	0.909
Age	0.98 (0.95-1.02)	0.490	0.95 (0.917-1.01)	0.056
ESR	1.051 (1.036-1.066)	0.000	1.054 (1.038-1.070)	0.000

ESR: Erythrocyte sedimentation rate; OR: odds ratio

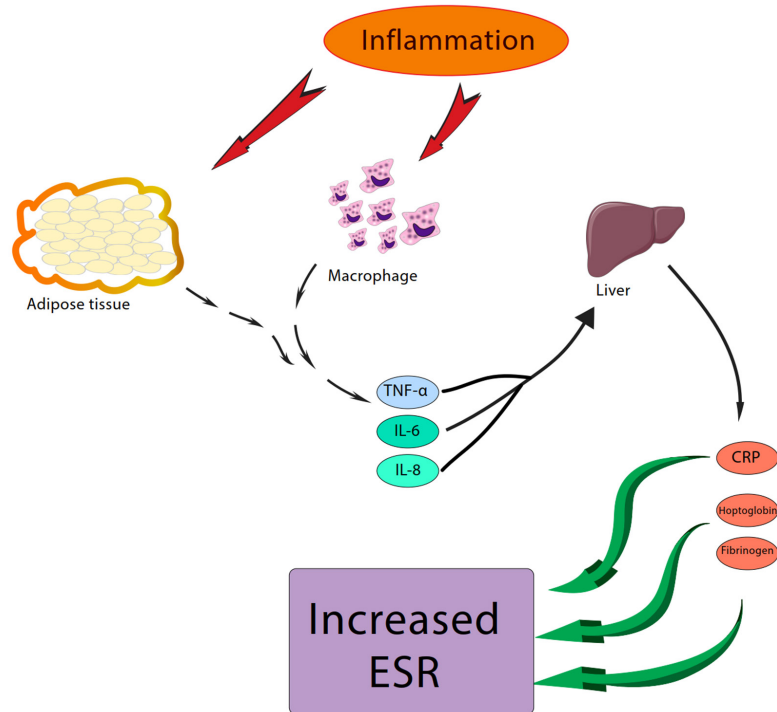
According to the results, ESR serum level in patients with leak after sleeve gastrectomy was significantly increased in comparison with ESR levels of patients without any complications after the surgery. The mean ESR serum levels were 73.1 mm/h for cases and 31.34 mm/h for controls.

As mentioned above, high ESR serum levels can be seen in various conditions such as cardiovascular and kidney disease and obstructive sleep apnea<sup>[14,15]</sup>. However, after bariatric surgery, patients with obesity start to lose weight, which may lead to an increase in ESR serum levels, but mean ESR in patients with leak compared to control group was significantly higher. Thus, for every 1 unit increase in ESR serum levels, the odds for leakage occurrence increase by 5.1% in patients after bariatric surgery. The normal range of ESR for men is 0-22 mm/h and 0-29 mm/h for women<sup>[15]</sup>, but in subjects with obesity, due to a series of interactions, it can be elevated. Macrophages and adipose tissue secrete cytokines and interleukins, resulting in stimulation of liver to produce fibrinogen, CRP, and haptoglobin, which in turn elevate ESR serum levels during inflammation [Figure 1]<sup>[15]</sup>. Therefore, with this diagnostic value of ESR, surgeons can employ ESR serum levels immediately after procedure, instead of common interventions that might increase the cost and duration of treatment<sup>[6]</sup>. In vulnerable patients with abnormal ESR levels, a series of technical recommendations can be done to prevent leakage after operation, including use a 40 Fr size or more bougie, initiate the gastric transection 5-6 cm from the pylorus, use proper cartridge colors from antrum to fundus, reinforce the staple line with buttress material<sup>[5]</sup>, order an appropriate staple line<sup>[6]</sup>, perform an intraoperative methylene blue test, remove the crotch staples, maintain suitable traction on the stomach before firing, avert from the angle of His (at least 1 cm), and check the staple line bleeding during the procedure.

Although gastric leakage can be caused by either mechanical or ischemic reasons, ESR serum levels might be a reliable predictor for postoperative leakage. Hence, in patients with higher ESR, more sedulous management (leaving a shorter antrum and using a smaller bougie) can be performed by surgeons and this may open a new chapter in terms of personalized surgery with fewer cases of leak complications among subjects. Previous studies have not paid sufficient attention to the molecular dimension of gastric leak; instead, most studies have focused on mechanical dimension and the management of this complication. Researchers have found that a greater bougie is related to a leakage rate of 0.6% in comparison with those who used smaller sizes whose leak rate was 2.8%<sup>[16]</sup>. However, Keren *et al.*<sup>[17]</sup> reported normal ESR levels of patients with gastric leakage, which is in contrast to our findings.

Other variables including sex, age, platelet count, and CRP serum level were not significantly different compared to control patients. In line with these results, Keren *et al.*<sup>[17]</sup> in 2015 and Surace *et al.*<sup>[18]</sup> in 2011 reported that gastric leak after sleeve gastrectomy presents no correlation with serum levels of CRP and WBC<sup>[17,18]</sup>. Nevertheless, more studies are warranted to address the question of why ESR serum level has been increased without any significant changes in CRP levels.

In conclusions, this study reports the clinical correlation of gastric leakage and platelet count, ESR, and CRP serum levels and gives practical instructions to prevent and manage leaks after sleeve gastrectomy. In short, these recommendations are: (1) use greater size of bougie; (2) begin the gastric transection 5-6 cm from



**Figure 1.** The impacts of inflammation on serum level of erythrocyte sedimentation rate (ESR)

the pylorus; (3) use suitable cartridge colors; (4) reinforce the staple line with buttress material; (5) follow an appropriate staple line; (6) remove the crotch staples; (7) maintain adequate traction on the stomach before firing; (8) keep distance from the angle of His; (9) check the staple line bleeding; and (10) perform a methylene blue test during the procedure.

## DECLARATIONS

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We appreciate all who helped to exert the present study.

### Authors' contributions

Designed and performed experiments: Kheirvari M, Eshghjoo S

Gathered the data and performed the numerical simulations: Yazdannasab M, Hosseini S

Analysed data and performed bioinformatic analyses: Akbarzadeh I

Contributed to the final version of the manuscript: Alaniz RC, Anbara T

Supervised the research: Anbara T

Discussed the results and commented on the manuscript: Kheirvari M, Akbarzadeh I, Eshghjoo S, Yazdannasab M, Alaniz RC, Hosseini S, Anbara T

### Availability of data and materials

Not applicable.

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None.

### Conflicts of interest

All authors declared that there are no conflicts of interest.

**Ethical approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

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