

# Alcohol Absorption Modification After a Laparoscopic Sleeve Gastrectomy Due to Obesity

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## Abstract

**Background** The different bariatric surgery techniques that alter the digestive anatomy also modify the gastric absorption surface. Since alcohol is a substance that is mainly metabolized in the stomach, the goal of this study was to determine alcohol absorption before and after a laparoscopic sleeve gastrectomy (LSG) in the same patients.

**Methods** Studies were carried out on 12 morbidly obese patients who underwent a LSG (eight men and four women). Each patient was given 3.6 ml of red wine to drink at 14% for each liter of body water mass. Alcotest values (Alcoscan Alcomate AL-6000) were measured 10 min after the wine dose had been consumed. Measurements were then repeated every 5 min until the alcohol had been completely eliminated from the bloodstream. During the postoperative period (median of 2.3 months), the measurement

was repeated with the total dose per kg adjusted to the new water body mass. The results were measured with a nonparametric analysis for repeated samples.

**Results** The maximum average peak of the Alcotest was 2.02 g/l during the postoperative period compared to 0.87 g/l during the preoperative period ( $p=0.001$  Wilcoxon). At 175 min, the blood alcohol level value reaches zero (0) in all pre-operative patients, while after surgery, an average value of 0.26 g/l was observed ( $p=0.027$  Wilcoxon). After 4 h, an Alcotest average of 0.20 g/l was observed in these patients.

**Conclusion** Alcohol absorption was considerably modified after LSG with higher and longer blood alcohol values for equivalent amounts of alcohol.

**Keywords** Sleeve gastrectomy · Alcohol metabolism · Alcotest · Morbid obesity

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## Introduction

Obesity is an ongoing public health problem that is currently increasing around the world, not only in industrialized countries but in developing countries as well. In the United States, 60.5% of the population is overweight (body mass index, BMI > 25 kg/m<sup>2</sup> of body surface), of which 3% are morbidly obese (BMI > 40 kg/m<sup>2</sup>) [1]. In countries such as Chile [2], the prevalence of obesity in adults is 27.3% in women and 19.2% in men. Within this group, 2.3% of women and 0.2% of men are morbidly obese. Obesity is a disease which considerably increases the risk of mortality and is frequently associated with diabetes mellitus II, cardiovascular illnesses and several types of cancer.

In the long term, surgical treatment has shown to be more effective than medical treatment (based on a low-

calorie diet, exercise, change of habit and pharmacotherapy combined in different ways) for morbidly obese patients and morbidly obese patients with associated co-morbidities. Recent studies have shown that surgical treatment is not only more effective in achieving weight loss but it also significantly decreases mortality due to random causes or specific causes such as coronary disease, diabetes and cancer [3].

The internationally accepted criteria [4] for recommending surgical treatment for a patient are the following: morbid obesity ( $\text{BMI} > 40 \text{ kg/m}^2$ ) and severe obesity ( $\text{BMI} > 35 \text{ kg/m}^2$ ) associated with co-morbidities such as high blood pressure, dyslipidemia, sleep apnea and hypoventilation, among others.

The diverse bariatric surgery techniques that are currently available modify the upper digestive tract anatomy, which in turn modifies the normal functions of the said organs.

Laparoscopic sleeve gastrectomy (LSG) has become one of the fasting growing techniques over the last few years for several reasons: it is highly effective in reducing excess weight and associated co-morbidities, it is technically feasible, and it is a safe surgical procedure as well. It significantly decreases the entire surface of the stomach since the longitudinal resection at a distance of 3 cm from the pylorus up to the His angle leaves, as a residual gastric cavity, a tube that is made based on the smallest curve. The capacity of this newly modified stomach is approximately 80 ml, and as a result, the absorbability of the gastric surface greatly decreases. Another consequence of the LSG is the acceleration of the gastric transit [5–7]. These changes may affect not only the absorption of nutrients but also medication, drugs and certain substances, such as alcohol, which undergoes transformation on a gastric level. Alcohol is one of the few substances that is quickly metabolized when it first comes into contact with the gastric mucous. Through an oxidation process, an isoenzyme alcoholdehydrogenase transforms alcohol into acetaldehyde which is then absorbed and undergoes another transformation on a hepatic level. This process is highly efficient since it leaves a minimum of alcohol available to continue on towards the small intestine [8].

Therefore, it is extremely important to understand how the alcohol will behave once it has been consumed by patients who have undergone a LSG. This is important for habitual drinkers who are recommended surgical treatment based on a LSG since this information could lead the patient to reject this surgical option if it were to substantially modify the alcohol ingestion response or even cause the development of an alcohol-related liver disease.

Our hypothesis is that a vertical laparoscopic gastrectomy considerably modifies alcohol absorption. Therefore, the goal of this study is to determine the absorption of alcohol in a

morbidly obese group of patients before and after undergoing LSG surgery.

## Method and Material

### Study Group

The group consisted of 12 patients, eight men and four women, with a mean age of 40.2 and 35.5 years, respectively ( $p > 0.59$ , ANOVA). The mean age of the entire group was 38.6 years.

The body mass index (BMI) average in these patients was  $37.8 \text{ kg/m}^2$  (ranging between 34 and  $44 \text{ kg/m}^2$ ). The mean weight was 108.8 kg (ranking between 88.6 and 139.2 kg), and the mean height was 169 cm (ranging between 154 and 182.5 cm).

### Inclusion Criteria

- To be obese.
- To be a laparoscopic sleeve gastrectomy candidate.
- Consider themselves to be a social drinker, that is to say, he/she is interested in learning about their own future behavior with regards to alcohol consumption.
- Accepts to undergo the same test twice, before and after the operation.

### Exclusion Criteria

- Does not consume wine.
- Rejects repeating the same test twice.
- Alcoholic background, defined as the ingestion of  $> 80 \text{ g}$  of alcohol per day.

### Method

Each patient was subjected to the same intervention (measurement) before surgery, with this measurement being repeated 30 days after surgery (median 2.3 meses). In this way, each patient became his/her own control once all the variables became constant with the exception of two. The first would be the patient's weight, which having decreased due to the surgical procedure, would expose the subject to proportionally drink more alcohol in the second measurement than in the first measurement. This was minimized by calculating the amount of wine to be consumed based on the patient's total water body mass at the time of measurement since alcohol is distributed throughout the entire water body mass without adhering to plasma proteins and since its solubility in fat and bone is undetectable [9]. The second variable is the stomach's anatomy which would

be different at the time of the second measurement during the postoperative period (which is precisely the intent for this study).

The intervention consisted of:

- a. Each patient had to consume a dose of red wine at 14% after a 6-h fast.
- b. The patient's total wine dose was calculated based on 3.6 ml per liter of water body mass. Thus, the average total dose of wine that was given to each patient during the first measurement was 187 ml. During the second ingestion carried out during the postoperative period, the patients consumed a smaller average dose of only 159 ml of wine ( $p < 0.012$ ), a considerable statistical difference (Table 1).
- c. Each patient's water body mass was measured through a Bioimpedance (Biodynamics BIA-310, Biodynamics Corporation, Seattle, WA) before and after surgery. The total amount of measured water body mass was, on average, 47.8 l during the first measurement and 43.9 l during the second measurement, a highly significant difference ( $p < 0.012$ ). The group's average measurement of their water body mass percentage was 44.1% during the first measurement and 46.7% during the second measurement, a difference which is also a highly significant ( $p < 0.041$ ).
- d. Once the total wine dose had been ingested, Alcotest values were measured by applying the Alcoscan Alcomate Prestige AL6000 (AK Solutions, New Jersey, NY), an instrument that measures the alcohol level in exhaled air. Before measuring, each patient received an explanation of how to perform this test, and they were all tested beforehand to confirm that they registered an Alcotest value of "0" before consuming the wine. Ten minutes after the patients had consumed the wine, they blew into the instrument, once for each measurement. It has been previously shown that there is a precise correlation between blood alcohol levels and the presence of alcohol in exhaled air, which in turn has validated the use of breath analyzers [10, 11].
- e. This measurement (blowing into the instrument one time) was repeated every 5 min until the alcohol had been completely eliminated from the bloodstream, that is to say, when the Alcotest registered "0".
- f. Measurements were finalized 4 h after the wine had been consumed.
- g. Each patient answered a survey about the symptoms they had felt once they had consumed the wine and any symptoms afterwards which could be attributed to the ingestion of alcohol. This was repeated after the second Alcotest measurement carried out during the postoperative period. The survey asked about the presence (or absence) of the following symptoms: sensation of heat, perspiration, verbosity, double vision, difficulty in speaking, sleepiness, nausea, abdominal pain and headaches.

#### Statistical Calculations

The data obtained from these 12 patients was compared to the average Alcotest values (mean) for each time interval, using two curves—pre-operative and postgastroectomy.

The statistical significance was verified using a non-parametric scale (Wilcoxon test) with a 95% trustworthy interval ( $p < 0.005$ ).

#### Histological Study

As part of the study protocol, a differed histopathological study was carried out on the resected stomach and a 6×6-mm wedge of liver removed from segment III.

#### Results

The patients' weight, on average, decreased by 15.1 kg, and the BMI consequently decreased 5.4 points over a mean of 2.3 months, which includes the preoperative measurement and the postoperative measurement, as can be seen in Table 1.

Out of 12 patients, eight have chronic gastritis and four were diagnosed with minor unspecified stomach alterations. After each patient's liver was studied, hepatic steatosis was found in six cases, minor unspecified alterations in three cases and steatohepatitis without fibrosis in three cases.

During the first measurement, Alcotest levels on average reached a maximum of 0.87 g/l 10 min after ingestion. This

**Table 1** Pre- and postoperative measurements of morbidly obese patients

	1st measurement	2nd measurement	<i>p</i>
Weight (kg)	108.8	92.9	<0.002
BMI (kg/m <sup>2</sup> )	37.8	32.4	<0.002
Wine dose (ml)	187	159	<0.012
Maximum level of Alcotest (g/l)	1.5	4.0	<0.001
Peak level of Alcotest (min)	10	10	
Duration of (+) Alcotest (min)	177.4	304	<0.001

level remained the same for the first 30 min and then began to continuously decrease until 0 g/l had been reached. The total time for this process was, on average, 173 min (Table 1 and Fig. 1). During the second measurement, the average values reached a maximum of 2.02 g/l at 10-min time as well and then began to decrease rapidly for the following 20 min, reaching a value of 1.3 g/l. Then, the values gradually decrease until a 0.26-g/l value is obtained (without reaching zero), on average, 4 h after the study began ( $p < 0.027$ ). This determined a difference of 0.93 g/l between both measurements ( $p < 0.001$ ).

The maximum Alcotest values obtained were 1.5 g/l during the first measurement and 4.0 g/l during the second measurement ( $p < 0.001$ ). The maximum peak during both measurements was obtained after 10 min and positive Alcotest values were obtained, on average, for 177.4 min (median 180 min) after the first ingestion and 204 min (median 210 min) during the postgastroectomy ingestion ( $p < 0.001$ ).

Symptom survey results did not indicate any relation with the Alcotest values registered in either measurement period.

## Discussion

This study suggests that there is a marked alcohol absorption modification after undergoing a LSG as treatment for obesity.

After surgically reducing the stomach's size and surface, the same proportional amount of wine causes a great increase in the maximum Alcotest peak which can increase up to four times the value obtained under normal anatomical conditions before surgery. On the other hand, the period of time in which positive Alcotest values were obtained also significantly increased. It was even demonstrated that after 4 h, there are patients that still have the presence of alcohol in their bloodstream, which indicates that a LSG patient needs more time to reach a zero Alcotest value.

This alcohol absorption study based on the ingestion of wine was posed since wine has been considered recommendable from a general health standpoint for adults and since it is also a beverage which people are continually exposed to. A 3.6-ml dose of wine per kilo of water body mass was arbitrarily chosen since this dose equals an amount ranging from 150 to 200 ml to be consumed by patients with a BMI ranging from 35 to 40 kg/m<sup>2</sup>. This dose is equivalent to one or two glasses of wine.

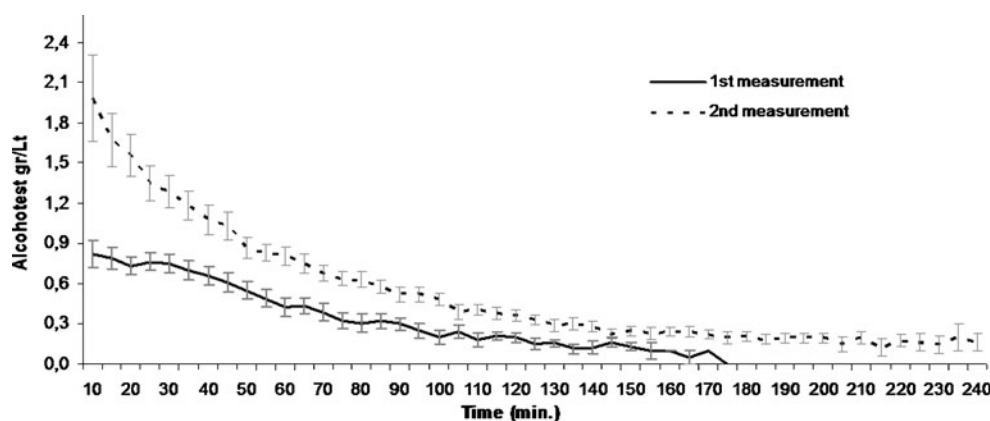
Recent reports [12] validate bioimpedance as a recommendable method for measuring total body water mass, specifically in morbidly obese patients, as is the case for the group of patients in this study. Therefore, this method is highly recommendable since it is easily available, noninvasive and inexpensive.

What is interesting about the analysis obtained from both Alcotest curves is that the values in both curves never come near each other or intersect. This indicates that after alcohol is consumed, behavior is very different before and after the surgical procedure.

Klockhoff et al. [13] previously demonstrated that in 12 female patients who had undergone gastric bypass surgery, higher concentrations of alcohol and a faster absorption rate were observed compared to the controls. Hagedorn et al. [14] reached similar conclusions in a study which compared 19 patients who had undergone gastric bypass surgery to controls.

This report is the first published study designed to evaluate alcohol absorption in patients who underwent a LSG, in which each subject is his/her own control. The objective was to eliminate the bias that occurs when comparing patients who have undergone surgery to the control patients since they will have different BMIs in addition to different ages, sex, liver function and any habits prior to alcohol ingestion. In order to reduce the bias that may be caused by having less weight after surgery, the total water body mass was considered and this was used as the base for determining the amount of alcohol to be administered. Thus, the patients can be compared to

**Fig. 1** Levels of alcohol in the same patient before and after sleeve gastrectomy



themselves and even though body water mass slightly increased (2.6% on average) during the postoperative period, the total amount of water had a significant decrease in the end. Therefore, even though the patients consumed less wine during the second measurement, they registered higher positive Alcotest values for a longer period of time.

A limiting factor of the conclusions obtained from this study is the number of subjects that were studied. However, the behavior obtained from both curves is so different that if we were to include more cases, the observations would probably only be accentuated.

The symptoms survey showed no relation, in any way, between the symptoms caused by alcohol in the bloodstream and Alcotest values. This means that even though patients have high blood alcohol values, this does not necessarily result in symptoms or secondary behavioral changes associated with being drunk. This fact is particularly important for patients who have undergone a LSG, since if they consume a similar dose of wine and if they are controlled by the police with a breath analyzer while driving a motor vehicle, they will register high blood alcohol levels.

In conclusion, this study indicates that alcohol absorption is altered in morbidly obese patients after a laparoscopic sleeve gastrectomy in comparison to their preoperative absorption level based on equivalent wine doses. The modification first consists of increasing the maximum Alcotest value by two and half times and then, the duration of the Alcotest (+) is increased by 87%.

The symptoms that occurred during the wine ingestion period had no relation with the blood alcohol level.

**Conflict of Interest** The authors declare that they have no conflict of interest.

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