nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2023; 43(4):238-243
DOI: 10.12873/434saleem

Micronutrient status assessment in Saudi patients prior to laparoscopic sleeve gastrectomy: a retrospective study

Rimah A SALEEM[1], Majed M RAMADAN[2], Muhammad S SHEIKH[1], Juhaina S BAJAMAN[1], Samah H ZARROUG[1], Ghada A GARAWEEN[1], Noara K ALHUSSEINI[1]

1 College of Medicine, Alfaisal University.
2 King Abdullah International Medical Research Center (KAIMRC), King Saud Bin Abdulaziz University for Health Sciences.

Recibido: 4/septiembre/2023. Aceptado: 28/octubre/2023.

ABSTRACT

The prevalence of obesity is rapidly increasing worldwide, and bariatric surgery has emerged as an effective treatment option, leading to significant sustained weight loss in morbidly obese patients. Laparoscopic sleeve gastrectomy (LSG) has rapidly gained popularity and currently accounts for most bariatric surgeries performed in Saudi Arabia. This procedure can result in harmful postoperative nutritional deficiencies postoperatively. Despite an enormous body of research on the outcomes of bariatric surgery in Saudi Arabia, there is a paucity of published articles on preoperative nutrient deficiencies in this region. This study aimed to investigate demographic trends and characteristics of Saudi patients undergoing LSG in different regions of the country. We retrospectively analyzed 285 patients who underwent LSG between 2016 and 2021 at a tertiary care center. The mean patient age was 46 years, and the mean preoperative BMI was 36.50 kg/m^2. Females comprised more than two-thirds of the patients (69%). Among the pre-operative blood parameters, hemoglobin and vitamin B1 deficiency were noticeable in both sexes. This predictive analysis could assist surgeons in identifying common deficiencies and expected post-surgical micronutrient deficiencies relevant to undesirable complications.

KEYWORDS

Laparoscopic sleeve gastrectomy, BMI, weight loss, Obesity, blood profile.

Correspondencia:
Rimah Abdullah Saleem
rsaleem@alfaisal.edu

INTRODUCTION

The worldwide prevalence of obese and overweight individuals has been rising alarmingly[1]. A recent Saudi Ministry of Health (MoH) National Survey estimated the nationwide prevalence of adult obesity to be 24.7%, with cases mainly concentrated in eastern Saudi Arabia and Riyadh. Obesity is equally prevalent among males (49.9%) and females (50.1%)[2]. The Saudi MoH emphasizes the necessity for lifestyle modifications, including dietary regimentation and increased physical activity, to counter the multidimensional negative impacts of obesity on the population[3]. However, these interventions typically fail to achieve sustained weight loss, particularly in severely obese patients[4]. Bariatric surgery has emerged as an effective treatment modality for such patients, resulting in significant long-term weight loss compared with non-surgical weight reduction plans[5].

Bariatric surgery is indicated for obese individuals with a body mass index (BMI) ≥40 kg/m^2 or individuals with a BMI ≥35 kg/m^2 with severe comorbidities (such as hypertension, hyperlipidemia, and type II diabetes)[6]. Several types of bariatric surgery are available; however, Laparoscopic Sleeve Gastrectomy (LSG) is the procedure of choice globally, followed by the Roux-en-Y gastric bypass (RYGB)[7]. LSG involves resection of the fundus and greater curvature of the stomach, effectively reducing stomach capacity by 80%[8]. Although bariatric surgeries promote weight loss, they can place patients at considerable risk for nutritional deficiencies, e.g. iron, thiamine (vitamin B1), and fat-soluble vitamins (mainly A and D)[9].

According to medical records, LSG is the most performed procedure, followed by RYGB and gastric banding in Saudi Arabia[10], as it is suggested to be uncomplicated and possibly safer than RYGB[11].

While research on the postoperative effects of bariatric procedures has experienced an increase, a need remains to ex-

plore the nutritional status of patients pre-operatively (particularly in the Arabian Gulf). Therefore, this study aimed to elucidate the characteristics (demographic and nutritional indices) of Saudi patients prior to LSG in different regions of Saudi Arabia. The results are expected to help predict post-surgical micronutrient deficiencies among Saudi patients and assist clinicians in accurately diagnosing possible severe declines and complications post-surgery.

METHODOLOGY

Study Design and Setting

In total, 285 adult patients aged ≥18 years from all regions of Saudi Arabia (Riyadh, Jeddah, Dammam, and Al-Madinah) who underwent LSG between 2016 and 2021 at the National Guard Hospital (NGH) were included in this cross-sectional study. This study aimed to explore subjects' baseline characteristics (age, sex, and BMI) and compare variations between sexes in blood minerals, chemistry, and vitamins. Parameters monitored included minerals (potassium, calcium, and magnesium), complete blood count (CBC), and vitamins (B1, B12, and D).

Ethical considerations

The study was conducted with the approval of the Institutional Review Board of the King Abdullah International Research Center (approval number (NRJ21J/278/11).

Statistical Analysis

Categorical variables (sex, geographical location, and surgery date) were reported as numbers and percentages. In contrast, continuous variables (age, BMI, blood, and chemistry profile) were reported as means ± standard deviation (SD). Chi-square and t-tests were used to examine baseline demographic variables, including age, sex, geographical distribution, body mass index (BMI), and surgery date. In addition, univariate analysis of baseline sex differences in mineral, vitamin, and blood profile results was performed using a t-test. Finally, the normality assumption for the numeric variables was examined. Log transformation was used for variables with non-normal distributions, and normality was measured. Statistical significance was considered for *P*-values less than 0.5, using SAS 9.4 statistical software.

RESULTS

The mean age of the 285 enrolled patients was 46 ± 11.6 years, and the percentage of females (68.77%) was significantly higher than that of males (31.23%). Pre-LSG mean BMI across both genders was 36.5 ± 8.86. The NG hospitals in Riyadh, Jeddah, and Dammam accounted for more than half (60.7%) of all patients, with the remainder (39.3%) from the NG Hospital in Al-Madinah. The highest numbers of LSGs were observed in 2016 and 2017. In contrast, the lowest numbers of procedures were observed in 2020 and 2021 (Table 1).

The pre-LSG blood profiles of male and female participants, including minerals, CBC, and vitamins, are reported in Table 2. Independently of our assessment of significant differences between males and females, we also made comparisons with normal ranges. The three minerals assessed in this study, potassium, calcium, and magnesium (Mg), appeared to be normal in all patients. In addition, albumin and all CBC values (hematocrit, MCH, MCHC, MCV, NRBC%, RDW, MPV, NRBC#, platelet count, and white blood cell (WBC) count) except hemoglobin (Hb) were normal in all patients. Hb levels were lower than the normal range in males (118.2 (± 23.65) g/L) and females (114.7 (± 16.92) g/L).

Although many dietary vitamins are essential for health, three vitamins (vitamins B12, B1, and D) were examined in this exploratory study. Levels of vitamins B12 and D appeared normal among males and females. However, vitamin D levels were at the lower limit of the normal range. Vitamin B1 deficiency was observed in males (65.92 (± 19.54) nmol/L) and females (65.28 (± 20.09) nmol/L) (Table 2).

Table 1. Demographic data from patients undergoing LSG surgery

	N (%)
Age (Mean ± SD)	46 ± 11.64
Gender	
Male	89 (31.23)
Female	196 (68.77)
Body Mass Index (BMI)	
(Mean ± SD)	36.49 ± 8.86
Hospital	
Riyadh	95 (33.33)
Jeddah	78 (27.37)
Dammam	70 (24.56)
Al-Madinah	42 (14.74)
Year	
2016	100 (35.09)
2017	112 (39.3)
2018	37 (12.98)
2019	20 (7.02)
2020	10 (3.51)
2021	6 (2.11)

Table 2. Blood profiles of male and female obese patients prior to LSG, including minerals, blood chemistry, and vitamins

	Normal Range	Male	Female	*P* value [1]
Minerals				
Potassium (mmol/L)	3.5 - 5			0.013
Mean (± SD)		4.24 (± 0.49)	4.13 (± 0.46)	
Calcium (mmol/L)	2.2 - 2.6			0.002
Mean (± SD)		2.18 (± 0.18)	2.15 (± 0.15)	
Magnesium (mmol/L)	0.65 – 1.05			0.25
Mean (± SD)		0.77 (± 0.09)	0.77 (± 0.09)	
Blood chemistry				
Albumin (g/L)	35 – 55			<.0001
Mean (± SD)		34.12 (± 6.62)	36.64 (± 4.76)	
Hematocrit (Hct)				<.0001
Mean (± SD)		0.36 (± 0.07)	0.35 (± 0.05)	
Hemoglobin (Hb) (g/L)	138 – 172 (males)			<.0001
Mean (± SD)	121 – 151 (females)	118.2 (± 23.65)	114.7 (± 16.92)	
MCH (pg)	27.5 – 33.2			<.0001
Mean (± SD)		28.77 (± 1.62)	26.86 (± 3.18)	
MCHC (g/L)	330 – 370			<.0001
Mean (± SD)		324.6 (± 9.7)	319.1 (± 14.3)	
MCV (fl)	77 – 98			<.0001
Mean (± SD)		88.65 ± (4.61)	84.11 (± 8.61)	
MPV (fl)	7 – 12			0.23
Mean (± SD)		8.84 (0.95)	8.44 (1.01)	
NRBC %				<.0001
Mean (± SD)		0.09 (± 0.14)	0.15 (± 0.2)	
NRBC#	0 – 0.0001			0.88
Mean (± SD)		0.0081 (0.037)	0.0081 (0.037)	
Platelet Count (PLT)				<.0001
Mean (± SD)2		219.5 (± 78.5)	288.9 (± 96.55)	
RBC (cells/mcL)	4.7 – 6.1 (males)			<.0001
Mean (± SD)	4.2 – 5.4 (females)	4.11 (± 0.8)	4.29 (± 0.6)	

Table 2 continuation. Blood profiles of male and female obese patients prior to LSG, including minerals, blood chemistry, and vitamins

	Normal Range	Male	Female	*P* value [1]
RDW %	11.8 – 14.5 (males)			0.19
Mean (± SD)	12.2 – 16.1 (females)	15.16 (± 2.36)	14.77 (± 2.52)	
White Blood Cell Count (WBC) (x10^9/L)	4.5 – 11			<.0001
Mean (± SD)		7.65 (± 3.53)	7.53 (± 2.92)	
Vitamins				
Vitamin B12 (pg/ml)	190 – 950			<.0001
Mean (± SD)		414.8 (± 633.8)	315.2 (± 363.6)	
Vitamin B1 (nmol/L)	74 – 222			0.4
Mean (± SD)		65.92 (± 19.54)	65.28 (± 20.09)	
Vitamin D (nmol/L)	50 – 125			0.93
Mean (± SD)		82.76 (± 16.73)	72.38 (± 36.85)	

DISCUSSION

While research into the physiological impacts of bariatric surgery has considerably increased in recent years, preoperative clinical features of obese patients undergoing bariatric surgery, specifically LSG, in Saudi Arabia remains limited. Bariatric procedures have proven safe and effective for weight loss and ameliorating associated comorbidities; however, many complications may still occur. Among long-term complications, deficiencies in essential blood elements and nutrients are commonly expected but are seldom addressed or managed by following existing guidelines[12]. As LSG is the most common bariatric procedure in Saudi Arabia, this study evaluated the preoperative blood profiles of Saudi patients undergoing LSG.

Data from NG hospitals in different regions of Saudi Arabia revealed a substantial decline in the number of patients undergoing LSG after 2017 despite an annual increase in operations on a national scale[10]. It must be noted that the NG hospitals across Saudi Arabia are part of the governmental sector healthcare system that provides medical services primarily to NG employees. This finding could be attributed to a shift in the patient population from the public to the private healthcare sector before the pandemic, as approximately 75% of Saudi citizens use private sector healthcare[13]. Furthermore, following the WHO declaration of the COVID-19 pandemic in March 2020, elective surgical procedures, including bariatric operations, were postponed worldwide, which may explain the low number of LSG procedures performed in 2020 and 2021[14].

More than 80% of patients who have undergone bariatric surgery in the United States of America are females and younger than males, despite the prevalence of obesity being relatively equal among both genders[15]. Here, we also demonstrate that more females undergo LSG than males. This is because females comprise a 'severely obese' population in most countries[16]. This also may be attributable to a greater sensitivity to changes in weight and body image ideals driving females to seek bariatric surgery at a higher rate and at a younger age.

Adult obese patients in Saudi Arabia are eligible for LSG if their BMI is 40 or greater, 35 or greater in patients with severe comorbidities, or 30 or greater in patients with poorly controlled type 2 diabetes coupled with high cardiovascular risk[6]. However, the mean BMI of patients in this study was lower than that in previous studies, 36.5 kg/m^2. Therefore, early referral for LSG in Saudi patients may be attributable to severe co-morbidities or obesity-related diseases that can be influenced by age. However, further investigations are required to confirm this assumption.

In the current study, several blood parameters were studied, as each factor plays a role in health protection and preventive management. The three blood parameters considered are mineral content, blood chemistry, and vitamin levels. The analysis comprised comparisons between gender and blood parameters of obese Saudi patients and assessments of the blood parameters with the normal ranges. Although these parameters were statistically significant between males and females, they are clinically insignificant. Hence, further analysis

was performed to evaluate the micronutrient deficiencies based on the reference range values.

Our initial observations showed that potassium, calcium, and Mg levels were normal. These minerals were chosen mainly because they play essential roles in metabolism, obesity, and human health[17]. Although less than 1% of the human body's Mg is found in the blood, it is one of the most prevalent cations in bones and soft tissues[18]. In addition, magnesium deficiency is commonly associated with obesity[19]. Our findings suggest that mineral deficiencies are rare in Saudi patients with obesity.

Blood chemistry parameters, including albumin levels and complete blood count (CBC), were also measured. Complete blood count (CBC) testing, including Hb, hematocrit, MCH, MCHC, MCV, MPV, NRBC, platelet WBC, and RDW platelets, is frequently performed to diagnose hematologic and non-hematologic disorders[20]. Since anemia is a common condition observed in post-surgery LSG patients, CBC examination is warranted to avoid further complications and to provide appropriate treatment before surgery.

Studies have reported high concentrations of Hb in obese patients from different populations. By contrast, we found Hb concentrations below the standard ranges in Saudi males and females[21]. The factor responsible for low Hb levels in obese patients at 46 years of age is unknown. Previous studies have confirmed that up to 8% of bariatric surgery patients have anemia due to low Hb concentrations and iron deficiency[22,23]. These results highlight the necessity for clinical precautions to prevent severe postoperative complications.

Deficiencies in fat-soluble vitamins (mainly vitamins A and D), calcium, iron, vitamin B1, Vitamin B12, and folate (Vitamin B9) are frequently observed in obese individuals after surgery[9]. Pre-surgery deficiencies in these micronutrients could be due to low-quality food intake and underconsumption of healthy foods[9,24]. LSG preoperative studies have found deficiencies in vitamin D and vitamin B12 in patients with morbid obesity[25]. In contrast to other studies, normal vitamin B12 and D levels were observed in Saudi patients prior to LSG. Testing vitamin B12 levels in the bloodstream before LSG is fundamental because vitamin B12 deficiency is commonly detected postoperatively. Vitamin B12 deficiency can develop after LSG due to loss of parietal cells after fundus resection, which is responsible for the release of intrinsic factors that facilitate vitamin B12 absorption[24].

Vitamin D deficiency is one of the most common deficiencies in the Saudi population[26]. Additionally, vitamin D deficiency in pre-LSG patients has been reported in other studies[24]. Given that patients undergoing LSG in this study had normal vitamin D levels, we expect surgery to trigger deficiency because pre-operative values fall within the lower limit of the normal range.

Vitamin B1 is a significant cofactor for multiple enzymes involved in energy metabolism and plays a vital role in nervous tissues[27]. Since vitamin B1 cannot be synthesized endogenously and must be obtained from dietary sources, there is a need for precautions to prevent deficiency after LSG. The prevalence of vitamin B1 deficiency in patients before bariatric surgery is estimated to range from 15% to 29%[28]. Low vitamin B1 levels can predispose patients to severe complications such as Wernicke's encephalopathy and Beriberi syndrome, with either cardiac or neurological manifestations after bariatric surgery[29]. Our results demonstrate preoperative vitamin B1 deficiency in both sexes, emphasizing the necessity for screening and adequate vitamin B1 replacement in all patients before undergoing LSG.

CONCLUSIONS

In this study, the nutritional values obtained from laboratory tests highlighted various health parameters essential to monitor in patients prior to undergoing LSG. Data has shown that Saudi females with a BMI of 36.5 kg/m^2 seek LSG more than Saudi males. Our results also reveal that obese Saudi patients are susceptible to Hb and vitamin B1 deficiencies. Most importantly, determining which micronutrients fall below the lower limit of the normal range (e.g., vitamin D) could predict outcomes and avoid long-term unfavorable complications. This may improve medical management of LSG complications and prevent postoperative susceptibility to disease-related chronic deficiencies. Therefore, these findings highlight the prevalent micronutrient deficiencies among obese Saudi patients, which could be addressed before LSG to avoid serious consequences to patients' health. However, further investigations on the preoperative micronutrient status at a larger scale will help confirm the precautious role of blood parameters in disease prevention after LSG.

LIMITATIONS

Selection bias is one significant limitation of this study because the patients were from a government hospital. This limitation may prevent the generalizability of our conclusions. Assaying ferritin, iron, and folate would help interpret the reasons for low Hb levels in patients.

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