Iron deficiency in bariatric surgery patients: a single-centre experience over 5 years

Bryce Lowry, MD
Krista Hardy, MSc, MD
Ashley Vergis, MMEd, MD

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Correspondence to:
B. Lowry
Department of Surgery
University of Manitoba
AE101-820 Sherbrook St
Winnipeg MB R3A1R9
brycealowry@gmail.com

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Background: As the prevalence of obesity has increased, so too has the demand for bariatric surgery. This study aimed to determine the incidence of postoperative iron deficiency and anemia and the impact of an increased preoperative ferritin target on postoperative outcomes.

Methods: Patients undergoing bariatric surgery in Winnipeg from 2010 to 2014 were included in the analysis. Data capture included age, sex and date of surgery and iron, ferritin and hemoglobin levels before surgery and 12 months postoperatively. Before 2014, there was no protocol for preoperative iron supplementation at our centre; in 2014, a more aggressive preoperative iron supplementation program was introduced to target a minimum preoperative ferritin level of 50 mg/L. Data were analyzed using unpaired *t* tests, paired *t* tests and χ^2 tests.

Results: A total of 399 patients were considered; 288 were included in the analysis. The incidence of iron and ferritin deficiency and anemia at 12 months postoperatively was 14.6%, 9.3% and 15.0%, respectively. In patients who underwent surgery before 2014, the 12-month postoperative levels of iron and ferritin were 12.9 mmol/L and 64.0 mg/L, respectively; patients who underwent surgery in 2014 had levels of 18.3 mmol/L and 124.0 mg/L, respectively (all p = 0.001). The 12-month postoperative hemoglobin levels did not significantly differ between the 2 groups.

Conclusion: Bariatric surgery performed with more aggressive preoperative iron supplementation is associated with increased iron and ferritin levels at 1 year postoperatively. As this improves overall clinical outcomes by avoiding iron deficiency and anemia, a minimum preoperative ferritin target should be implemented in metabolic and bariatric surgery programs.

Contexte : L’augmentation de la prévalence de l’obésité s’est accompagnée d’un accroissement de la demande de chirurgie bariatrique. La présente étude visait à déterminer l’incidence de la carence en fer et de l’anémie postopératoires ainsi que les conséquences de la hausse du taux cible de ferritine avant l’intervention sur les issues postopératoires.

Méthodes : L’analyse a porté sur des patients ayant subi une chirurgie bariatrique à Winnipeg entre 2010 et 2014. Les données recueillies faisaient état de l’âge, du sexe et de la date d’opération des patients, ainsi que de leurs taux de fer, de ferritine et d’hémoglobine avant la chirurgie et 12 mois après celle-ci. Avant 2014, notre centre n’avait pas de protocole de supplémentation préopératoire en fer; en 2014, il a instauré un programme de supplémentation rigoureux visant un taux préopératoire de ferritine d’au moins 50 mg/L. L’analyse des données a été faite au moyen de tests *t* non appariés, de tests *t* appariés et de tests χ^2.

Résultats : Au total, les cas de 399 patients ont été envisagés pour l’analyse, et 288 ont été retenus. L’incidence de la carence en fer, celle de la carence en ferritine et celle de l’anémie 12 mois après la chirurgie étaient de 14,6 %, de 9,3 % et de 15,0 %, respectivement. Chez les patients ayant été opérés avant 2014, les taux de fer et de ferritine à 12 mois étaient de 12,9 mmol/L et de 64,0 mg/L, respectivement, et chez ceux ayant été opérés en 2014, ils étaient de 18,3 mmol/L et de 124,0 mg/L, respectivement (p = 0,001 pour toutes les valeurs). En ce qui concerne le taux d’hémoglobine à 12 mois, aucune différence significative n’a été observée entre les 2 groupes.

Conclusion : Les chirurgies bariatriques effectuées après une supplémentation rigoureuse en fer sont associées à des taux accrus de fer et de ferritine 1 an après l’intervention. Sachant que la prévention de la carence en fer et de l’anémie améliore les issues cliniques en général, les programmes de chirurgie métabolique et bariatrique devraient se fixer une cible quant au taux préopératoire minimal de ferritine.

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The prevalence of obesity in Canada is increasing at an alarming rate; in fact, it tripled from 6.1% in 1985 to 18.3% in 2011.[1] The data are particularly concerning as severe (class 3) obesity increased disproportionately.[1] This trend has been accompanied by an increase in the adverse effects of obesity on patients' quality of life and the economy.[2] The annual cost of obesity to the Canadian economy is estimated to be between $4.6 billion and $7.1 billion.[3,4] Obesity is associated with substantial comorbid conditions, including iron deficiency, anemia, hypertension, hyperlipidemia, type 2 diabetes, cerebrovascular disease, sleep apnea and cancer.[2] Bariatric surgery has proven to be superior to medical management in helping patients to achieve stable weight loss and improve control of blood glucose, low-density lipoprotein (LDL) cholesterol and systolic blood pressure.[5] It is also considered to be cost effective, with favourable incremental cost-effectiveness ratios (ICERs) of $7000 to $12 000 per quality-adjusted life year (QALY) in patients with obesity and diabetes. Despite the overall benefits, however, bariatric surgery is associated with short- and long-term complications.[5]

Iron deficiency and anemia is one of the most substantial long-term complications of bariatric surgery.[5] Brolin and colleagues analyzed nutritional deficiencies in 348 patients who underwent Roux-en-Y gastric bypass (RYGB), reporting an incidence of iron deficiency of 47% and an incidence of anemia of 54% at a mean follow-up of 42 months.[6] The importance of preoperative and postoperative iron deficiency and anemia in bariatric surgery should not be understated. Preoperative iron deficiency is known to increase postoperative complications, specifically infections, transfusions and iron deficiency, whereas perioperative anemia can increase morbidity and mortality and decrease quality of life.[7,8] Additionally, up to 29% of patients are iron deficient and 17% anemic while awaiting RYGB, and it is known that treating iron deficiency even without anemia can improve quality of life and patient outcomes, most notably by decreasing fatigue.[7,9]

It is thought that multiple factors may contribute to the risk of iron deficiency and anemia, including the postsurgical inflammatory state, reduced absorption of iron because of altered anatomy, and the reduced tolerance to alimentary sources of iron seen in many patients. We recently conducted a systematic review of more than 4000 patients and found that younger age, female sex and premenopausal status were the 3 factors associated with increased risk of iron deficiency after bariatric surgery. Interestingly, body mass index was not a contributing factor.[10]

Given the importance of this issue, there has been increased focus on adequate iron supplementation before and after bariatric surgery. This includes the establishment of minimum preoperative ferritin levels.[11] The primary objective of this study was to determine pre- and postoperative iron-deficiency and anemia rates in patients undergoing surgery using a prospectively collected database in a provincially funded Canadian bariatric program. Secondary objectives were to evaluate the effects of a more aggressive preoperative iron supplementation in patients with iron deficiency and to analyze for differences in iron, ferritin and hemoglobin levels between patients undergoing RYGB and laparoscopic sleeve gastrectomy (LSG).

Methods

Patient selection

All patients in the Centre for Metabolic and Bariatric Surgery database who underwent bariatric surgery at the Victoria General Hospital in Winnipeg, Manitoba, Canada, from Jan. 1, 2010, to Dec. 31, 2014, were considered for inclusion in this retrospective cohort study. The University of Manitoba Health Research Ethics Board gave institutional approval for this study.

Data collection

Information obtained from the database included age; sex; date of surgery; surgery type; preoperative iron, ferritin and hemoglobin levels; and postoperative iron, ferritin and hemoglobin levels at 12 months.

Preoperative consultation and postoperative follow-up

All patients underwent comprehensive assessment with a multidisciplinary team consisting of a bariatric surgeon, psychologist, nurse, dietician and kinesiologist. Patients were offered a laparoscopic RYGB with the alternate option of an LSG if medically indicated or if intraoperative findings precluded gastric bypass. Postoperatively, patients were followed up at 6 weeks and at 3, 6 and 12 months and had a routine appointment with a dietitian at 3 months. Laboratory tests were done to evaluate nutritional deficiencies and anemia preoperatively and at 12 months postoperatively.

Intervention

Before 2014, there was no standard protocol at our centre for preoperative iron supplementation on the basis of iron or ferritin levels. In 2014, a more aggressive preoperative iron supplementation protocol was instituted targeting a minimum preoperative ferritin level of 50 mg/L. This value was chosen on the basis of low normal levels for both men and women in our centre and in consultation with the Metabolic and Bariatric Surgery Program's registered clinical dietitian, a pharmacist and a hematologist. For ferritin levels less than 20 mg/L, patients were prescribed ferrous sulfate 300 mg by mouth 3 times per day; for ferritin levels of 21–40 mg/L, patients were prescribed ferrous sulfate 300 mg by mouth twice daily; and for levels of 40–49 mg/L, they were prescribed ferrous sulfate 300 mg by mouth once daily. In addition, patients were told to take vitamin C 250 mg by mouth with each ferrous sulfate dose, and patients were advised to separate their ingestion of both ferrous sulfate and vitamin C from their injestion of any calcium supplements or high-calcium foods by at least 2 hours. Patients were also assessed and followed up by their family physician for investigation and management of pathologies underlying the low ferritin levels.

Outcomes

The rates of preoperative and postoperative iron deficiency and anemia were measured as the primary objective. Postoperative iron, ferritin and hemoglobin levels were measured for patients who underwent surgery before 2014 without preoperative iron supplementation and for those who underwent surgery in 2014 with preoperative iron supplementation, and the values were compared with the minimum ferritin target of 50 mg/L. The differences in iron, ferritin and hemoglobin levels were also measured to compare RYGB and LSG patients in the 2014 group.

Definitions and surgical protocol

Iron deficiency was defined as an iron level less than 32 mmol/L. Low ferritin level was defined as less than 307 mg/L for women and 336 mg/L for men. Anemia was defined as hemoglobin less than 12 g/dL for women and 13.5 g/dL for men.

The RYGB protocol includes an antecolic/antegastric approach to the anastomosis with a 40 cm biliary limb, a 100 to 150 cm Roux limb and a 6 cm gastric pouch as measured from the gastresophageal junction. A 34-French gastric lavage tube is used for sizing the width of the pouch.

The LSG protocol includes resection of approximately 85% of the stomach with a no. 60 purple stapler (Medtronic Endo GIA). A 34-French bougie is used for sizing.

Data analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences, version 22.0 (SPSS). Data were analyzed using unpaired *t* tests comparing continuous variables between groups, paired *t* tests for age and χ^2 tests for sex. Statistical significance was set at a $p < 0.05$.

Results

Of a total 403 patients, 399 were included and 4 were excluded because of a lack of data. Of the 399 patients, 378 (94.8%) were women and 21 were men. Procedures consisted of laparoscopic RYGB in 316 patients (79.2%) and LSG in 83 patients (20.8%). The mean age at the time of surgery was 46.7 years. Of the 399 patients, 288 had complete sets of data available to analyze to 12 months postoperatively. Of these, 219 patients had surgery before 2014; 69 had surgery in 2014 after the protocol for preoperative ferritin supplementation was insituted (Table 1). Of the patients with complete sets of data available, 229 underwent a RYGB and 59 an LSG.

Among all patients, the incidence of preoperative iron deficiency and low ferritin was 26.7% and 5.9%, respectively. The incidence of iron deficiency at 12 months postoperatively was 14.6% and the incidence of low ferritin was 9.3%. The incidence of anemia at 12 months postoperatively was 15.0% (Table 2).

As stated earlier, a preoperative ferritin target of 50 mg/L was established in 2014. There was a statistically significant increase in the mean 12-month postoperative iron and ferritin levels in patients who underwent surgery in 2014 compared with those who underwent surgery before 2014; the hemoglobin levels were similar between the groups (Table 3).

We also analyzed the proportion of patients with iron deficiency, low ferritin levels and anemia at 12 months

Table 1. Patient demographic characteristics

Characteristic	Patients who underwent surgery before 2014 *n* = 219	Patients who underwent surgery in 2014 *n* = 69	*p* value
Sex, %			0.42
Female	94.1	91.3	
Male	5.9	8.7	
Age, mean, yr	46.2	48.4	0.12

Table 2. Overall incidence of iron deficiency, low ferritin and anemia

	No. (%) of patients	
Condition	Preoperative	Postoperative (12 mo)
Iron deficiency	81 (26.7)	42 (14.6)
Low ferritin	17 (5.9)	27 (9.3)
Anemia	32 (10.3)	41 (15.0)

Table 3. Mean levels of iron, ferritin and hemoglobin at 12 mo postoperatively in patients who underwent bariatric surgery before 2014 and in 2014

Measure	Patients who underwent surgery before 2014	Patients who underwent surgery in 2014	*p* value
Iron, mean, mmol/L	12.9	18.3	0.001
Ferritin, mean, mg/L	64.0	124.0	0.001
Hemoglobin, mean, g/L	131.0	133.0	0.19

postoperatively, comparing patients who underwent surgery before 2014 with those who had their procedure in 2014. In the group who underwent surgery before 2014, 16.9% of patients had iron deficiency (37 of 219), 10.0% had low ferritin (22 of 219) and 15.1% had anemia (33 of 219). In the group who underwent surgery in 2014, 7.2% had iron deficiency (5 of 69), 7.2% had low ferritin (5 of 69) and 11.6% had anemia (8 of 69).

There were no statistically significant differences in the 12-month postoperative hemoglobin, iron or ferritin levels when we compared patients who underwent RYGB versus LSG for all 399 patients who met the inclusion criteria: hemoglobin levels were 132 g/L in the RYGB group and 133 g/L in the LSG group (p = 0.55), iron levels were 16.9 mmol/L and 16.1 mmol/L, respectively (p = 0.39) and ferritin levels were 90 mg/L and 94 mg/L, respectively (p = 0.78).

Discussion

Perioperative iron deficiency and anemia have important implications for the quality of life of patients who undergo bariatric surgery. Preoperatively, they predict increased postoperative complications, including infections and the need for blood transfusions. They also increase morbidity and mortality and decrease patients' quality of life.[7] It is recognized that treating iron deficiency without anemia improves patients' quality of life and overall outcomes.[7]

Most studies have reported greater than 40% incidence of iron deficiency and 50% of anemia postoperatively.[7] Toh and colleagues previously provided the most robust results for RYGB, reporting on 149 patients up to 12 months postoperatively. In their study, 21% of patients were found to be iron deficient and 16% anemic.[12] Their results mirror the findings of the current study regarding surgical procedures, laboratory definitions and follow-up time periods. However, our study has substantially higher numbers and improved follow-up and demonstrates a lower incidence of iron deficiency and anemia at 14.6% and 15.0%, respectively.

To the best of our knowledge, no other studies in the literature have looked at the effects of preoperative iron supplementation to a set preoperative ferritin target. This protocol was introduced at our centre to achieve a minimum preoperative ferritin target of 50 mg/L, which resulted in substantial increases in iron levels at 12 months postoperatively (12.9 to 18.3 mmol/L) and in ferritin levels (64.0 to 124.0 mg/L) at 12 months postoperatively. This change brings both the iron and ferritin levels from the low normal range to the mid range. This is important as, per the Ontario Association of Medical Laboratories, ferritin levels of 51–100 mg/L as seen in the group who underwent surgery before 2014 mean reduced iron stores with possible iron deficiency, while ferritin levels in the range of 101–300 mg/L as seen in the group who underwent surgery in 2014 suggest iron deficiency is unlikely.[13] Therefore, these results suggest that implementing a minimum preoperative ferritin target of 50 mg/L can not only increase postoperative iron and ferritin levels, but also potentially improve overall outcomes by avoiding iron deficiency and associated anemias. This comes at the expense of delay to surgery and additional blood draws.

An LSG was performed on 83 people because of patient preference, intraoperative findings or other medical indications such as type 1 diabetes or Crohn disease. Without adjusting for confounders, this study did not demonstrate any statistically significant differences in hemoglobin levels, iron levels or weight loss at 12 months postoperatively. This is in line with existing literature suggesting that there is no significant difference in weight loss or overall quality of life between patients who undergo RYGB versus LSG.[14] A randomized clinical trial by Paluszkiewicz and colleagues in 2012 also found no statistically significant difference in weight loss, prevalence of comorbidities or nutritional deficiencies between patients who underwent RYGB versus LSG.[15]

Limitations

There are several limitations to this study. First, nutritional deficiencies can develop years after bariatric surgery, and although compliance with postoperative laboratory testing was high, testing extended to just 12 months postoperatively. Longitudinal outcomes for this patient group will continue to be followed prospectively and reported. Additionally, iron deficiency and anemia can be influenced by supplement use, which was not recorded. This could represent a confounding factor in this study; however, the same postoperative micronutrient supplementation program was prescribed to all patients, both those who underwent surgery before 2014 and those who underwent surgery in 2014. A new form has since been introduced to record supplement prescription and adherence to address this potentially confounding factor in future data analysis. Finally, menopausal status was not recorded in the database. This may represent a confounder as this factor has been reported in a recent systematic review to be predictive of iron-deficiency anemia.[10] However, the effect of this is probably small as there was no significant age difference between the 2 patient groups in this data set.

Conclusion

Iron deficiency is a substantial cause of morbidity in populations undergoing bariatric surgical procedures. This study demonstrates that preoperative iron supplementation to a target ferritin level can improve iron and ferritin levels postoperatively in a multidisciplinary Canadian bariatric surgery program. We suggest establishing a minimum preoperative ferritin target of at least 50 mg/L to successfully increase postoperative iron and ferritin levels.

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Affiliations: From the Department of Surgery, University of Manitoba, Winnipeg, Man.

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