Screening for undernutrition in gastric bypass: a case study of four patients in the Marrakech Tensift Al Haouz region, Morocco

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ABSTRACT

Undernutrition presents a major risk to patients' health and well-being following gastric bypass surgery. After undergoing this surgery, the nutritional status of three women and one man was examined in this study. Follow-up visits were used to measure weight, body composition, and biological and biochemical data. After 3 months of follow-up after gastric bypass surgery, our findings revealed a reduction in muscle mass. The average loss of muscle mass was 4.375±1.470 kg. Their initial body mass index, which was 45.01 kg/m^2, on average, dropped to 28.38 kg/m^2. Significant drops were observed in the mean levels of albumin and pre-albumin (albumin: 38.6 g/L to 24.8 g/L, pre-albumin: 195 mg/L to 113 mg/L). In our study, patients with micronutritional deficiencies and gastric bypass demonstrated a significant and adaptive reduction in daily caloric intake. Early identification of undernutrition makes it possible to assess its severity and, as part of the patient's overall follow-up, to implement appropriate nutritional management.

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Introduction

Undernutrition is a major concern after gastric bypass, a procedure that offers a glimmer of hope to severely obese patients by improving their quality of life, promoting a better perception of their body image, as well as a significant reduction in the onset or predisposition of several comorbidities.[1,2]

Bypass is considered to be a validated technique for sustainable weight loss over time (from 1 to 5 years minimum) post-surgery in patients with a body mass index (BMI) equal to or greater than 35-40 kg/m^2.[3] It should be noted that this type of surgery is not really a miracle, as it targets a single organ (the stomach), inducing a combination of food restriction and malabsorption.[4]

The definition of undernutrition differs considerably between a standard adult and an adult who has undergone gastric bypass. In order to detect undernutrition in a standard adult patient, we assess the percentage of weight loss: greater than or equal to 10% over 6 months, or greater than or equal to 5% in 1 month.[1] In the case of an adult post-bypass patient, undernutrition is considered a serious nutritional complication that cannot be diagnosed in the immediate post-operative period, as weight loss after surgery is obviously the goal of the procedure. Undernutrition will certainly develop if weight loss is greater than or equal to 10% in just 1 month or greater than or equal to 40-50% in 6 months.[5]

As a result of this mechanism, which is based on this two-fold key principle, a number of physiological defects are often installed: lack of assimilation, some food intolerances, more or less rapid depletion of protein-energy re-

serves, and micronutritional deficiencies.[6,7] As a result, undernutrition can gradually set in. It is therefore crucial to maintain strictly regular and constant monitoring to diagnose it as soon as it appears.[8]

Most people who have undergone this surgery are at significant risk of developing serious nutritional complications, such as muscle wasting and excessive weight loss, which affect up to 40% of patients.[9,10] These problems can compromise the recovery of the patient's quality of life. Careful nutritional management is therefore essential to prevent these complications and ensure optimal recovery after surgery.[11]

The aim of this study is to highlight the vital importance of early diagnosis and personalized management in minimizing risks and improving overall undernourished patient health outcomes in the medium and long term.

Materials and Methods

Study background and sample

This study is part of a larger study of 2021 patients, conducted over a 15-month period from January 2022 to March 2023. The overall study population included individuals consulted and interviewed at various study sites. Of these participants, 1054 were identified as showing signs of undernutrition using our specific assessment methodology, including those diagnosed as post-bypass undernourished (n=4).

Participants

Four participants were selected for this study, including three women (aged 38, 45, and 50) and one man (aged 42), all of whom had undergone gastric bypass surgery. The inclusion criteria included an adult age range (18 to 65 years). They also had to have been regularly followed up as part of multidisciplinary post-operative management after their bariatric surgery.

However, due to delays or missed appointments, they underwent irregular follow-ups, which contributed to the development of undernutrition, underlining the importance of regular nutritional follow-up, recommended at least once a month during the first post-intervention year.

Anthropometric measurements and body composition

Anthropometric measurements, such as weight, height, and BMI, were carried out using a precise mechanical column scale (SECA 756) for weight, with fine graduation for increased accuracy. Height measurements were taken using a measuring tape accurate to 0.1 cm. In addition, body analyses were carried out using an impedance meter (Inbody 570), enabling a detailed assessment of participants' body composition, including fat mass, lean mass, visceral fat, extracellular and intracellular water, as well as other parameters relevant to assessing the percentage of weight loss after gastric bypass. These measurements were taken while the participants were dressed only in underwear, without shoes or socks, and without any metal or jewelry, to avoid any interference with the electrodes of the measuring devices.

Biochemical and biological analyses

After gastric bypass, biochemical and biological analyses are of vital importance in detecting and preventing complications associated with undernutrition, exacerbated by malabsorption of essential nutrients. These tests include albumin, pre-albumin, C-reactive protein (CRP), vitamin D, B12, folic acid (vitamin B9), ferritin, and hemoglobin. It is essential to understand that none of these markers taken individually is sufficient to diagnose a state of undernutrition; a global assessment, taking into account all these parameters, is necessary to obtain a complete picture of the patient's condition for optimal post-surgical management.

Albumin, with normal values between 35 and 50 g/L, and pre-albumin, ideally between 200 and 400 mg/L, are essential markers of protein-energy malnutrition. In particular, albumin is a crucial long-term indicator of overall nutritional status, and its reduction indicates a drop in protein reserves and certainly chronic undernutrition. Similarly, a decrease in pre-albumin, which has a shorter half-life than albumin, is indicative of recent nutrition, making it a potentially more accurate marker for detecting acute undernutrition.

CRP, which is used to assess post-surgical inflammation, can mask signs of undernutrition by giving the impression of improvement due to elevated inflammation. That is why it is essential to interpret elevated CRP levels with care in order to differentiate between an inflammation reaction and true undernutrition.

Vitamin levels also play a crucial role. Vitamin D deficiency (normally between 30 and 100 ng/mL) can lead to bone fragility and immunosuppression, while vitamin B12 deficiency (recommended between 200 and 900 pg/mL) can result in anemia and neurological disorders. Vitamin B9 (normally between 3 and 17 ng/mg) is monitored to prevent undernutrition by maintaining adequate cellular metabolism.

Regarding iron status, ferritin (normally between 30 and 400 ng/mL) is assessed to detect martial deficiency, a potential source of iron-deficiency anemia and increased fatigue. A decrease in hemoglobin (typically 12-16 g/dL for women and 13-18 g/dL for men) affects cognitive and physical function in post-gastric bypass patients.

In parallel, detailed dietary data was collected using a food diary and photos of meals eaten, enabling assessments of appetite, eating habits, and quantities consumed. This information was essential for adjusting individual nutritional management and preventing undernutrition in post-gastric bypass participants.

Ethical considerations

All precautions according to the Declaration of Helsinki were taken to protect the privacy and confidentiality of the personal information of those involved in the research. Informed consent was obtained from the participants, who were properly informed of the objectives and methods.

Results

Post-operative undernutrition is a serious and often underdiagnosed complication, similar to the case of our study, which involved four patients who developed deficiency signs and undernutrition post-gastric bypass, despite successful initial weight loss.

Changes in muscle mass and correlation with weight loss

Changes in muscle mass and their correlation with weight loss are shown in Table 1. Our sample (n=4) showed a decrease in muscle mass after 3 months of post-gastric bypass follow-up. Muscle mass losses averaged 4.375±1.470 kg. Women (Patients 1, 2, and 3) lost between 2.6 kg and 4.9 kg of muscle mass, while the man (Patient 4) lost 6.7 kg. These differences reflect variations in body composition and individual responses to surgery.

The regression coefficient measures the correlation between total weight loss and loss of muscle mass. In this case, the coefficients range from -0.696 to 2.77. Patient 1 showed a moderate negative correlation between weight loss and loss of muscle mass (coefficient of -0.696), while Patient 4 showed a strong positive correlation (coefficient of 2.77), suggesting a different response in men *versus* women.

Interactions between albumin, pre-albumin, weight loss and body mass index after gastric bypass

A change in BMI over 3 months was marked (Table 2). On average, their initial BMI of 45.01 kg/m^2 decreased to 28.38 kg/m^2, reflecting a substantial reduction in obesity. The male percentages of body weight loss and excess weight were 36.5% and 83.25%, respectively, indicating an apparent efficacy of treatment in reducing body weight (Table 3).

However, despite these apparent improvements in BMI, mean albumin and pre-albumin levels showed significant decreases (albumin: from 36.6 g/L to 24.8 g/L, pre-albumin: from 195 mg/L to 113 mg/L) (Table 3), suggesting possible underlying nutritional insufficiency despite weight loss.

Patient 4 as an example showed a marked decrease in BMI from 42.61 to 21.31 kg/m^2, but with even lower albumin and pre-albumin levels (albumin: from 38 g/L to 23 g/L, pre-albumin: from 221 mg/L to 143 mg/L), highlighting the complexity of the individual metabolic response to surgery.

Analysis of post-gastric bypass caloric requirements and intakes

Patients in our study showed a significant, adaptive reduction in daily caloric intake after gastric bypass. All exceeded the average post-surgical caloric intake reduction, potentially threatening undernutrition due to these considerable dietary restrictions (Figure 1).

Patient 1 reduced her intake by 1740 kcal/day, from 2480 kcal/day to 740 kcal/day, thus exceeding the reference mean of 600<750<900 kcal/day used to assess post-bypass requirements.[12] For Patient 2, intakes fell from 1860 kcal/day to 860 kcal/day, a reduction of 1000 kcal/day, also above this average. The post-bypass caloric intake of Patient 3 was also reduced, from 2800 kcal/day to 1000 kcal/day, a reduction of 1800 kcal/day (Figure 1). Lastly, Patient 4 reduced his intake by 2230 kcal/day, dropping drastically from

Table 1. Evolution of muscle mass and weight loss.

Patients	Muscle mass at 0 months(kg)	Muscle mass after 3 months (kg)	Lost kilos	Regression coefficient
Patient 1	19.3	16.7	31	-0.696
Patient 2	23.8	20.5	44	-0.985
Patient 3	29	24.1	48	0.153
Patient 4	44.2	37.5	66	2.77

If the coefficient is close to 0: a weak relationship; if it is close to 1: a strong relationship.

Table 2. Evolution of body mass index and biological values.

Patients	Initial BMI	BMI after 3 months	Initial albumin (g/L)	Albumin after 3 months
Patient 1	43.27	32.79	38	28
Patient 2	43.44	26.72	43	21
Patient 3	51.73	34.72	35.5	26.8
Patient 4	42.61	21.31	38	23

BMI, body mass index.

Table 3. Variations in biological values and weight loss.

Patients	Initial pre-albumin (mg/L)	Pre-albumin after 3 months	% weight loss	% loss of excess weight
Patient 1	184	128	24	57
Patient 2	234	135	39	91
Patient 3	195	113	33	64
Patient 4	221	143	50	121

3150 kcal/day to 920 kcal/day, demonstrating the strict management necessary to meet adjusted nutritional requirements after surgery and aligning with the reference average.

Analysis of nutritional markers post-gastric bypass

The results of nutritional markers for the four patients are shown in Figure 2. Ferritin, essential for iron storage, averaged 11.65±2.25 ng/mL, below normal values, suggesting a predisposition to iron-deficiency anemia. Vitamin B12 levels show a mean of 172.725±16.54 pg/mL, while vitamin B9 (folic acid) has a mean of 2.975±0.74 ng/mL, and vitamin D has a mean of 19.45±7.21 ng/mL, all showing deviations from reference values.

Analysis of protein profiles before and after bypass

The results of variations in protein levels before and after bypass are presented in Figure 3. Before the intervention, protein levels varied between 10.7 kg and 13.4 kg. After surgery, protein levels decreased to 8.3-10.4 kg. Postoperative protein requirements were calculated to be between 52.8 g/day and 78.4 g/day (Figure 3). Actual observed protein intakes were slightly lower than calculated requirements, ranging from 38.7 g/day to 53 g/day. When analyzing spontaneous post-bypass protein intakes, the mean was 0.5025±0.1204 g/kg/day, while the mean protein requirements were 0.8±0.05 g/kg/day (Table 4).

Discussion

Our study had several main objectives: adequate and complete diagnosis to determine cases of undernutrition (n=2021), including patients who had developed post-bypass undernutrition (n=4) in just 3 months post-surgery.

Regular clinical follow-up after bypass surgery is very important, indeed essential, to prevent undernutrition, and the results of our study (n=4) reinforce the hypothesis of non-assimilation of macros and micronutrients leading to severe deficiencies and to potential protein-energy malnutrition.[13,14] These four selected patients did not attend their appointments during the first 3 months post-operatively, and this lack of rigor prevented early detection, enabling any kind of personalized adjustment in terms of food intake and nutritional supplementation.

To properly identify undernutrition in our study population, we calculated BMI before and after the bypass, as this indicator of weight health has its limitations, particularly in our case, with instances of undernutrition despite a high

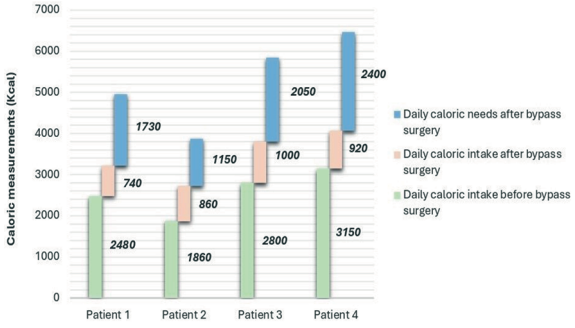

Figure 1. Evolution of caloric needs and intake before and after bypass surgery.

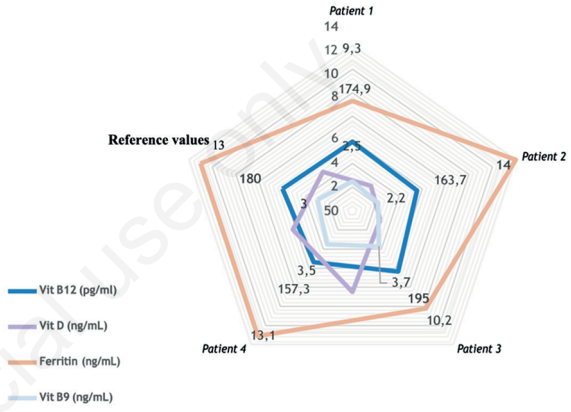

Figure 2. Analysis of nutritional markers in post-gastric bypass.

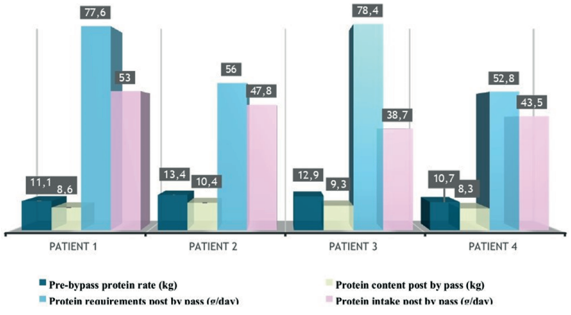

Figure 3. Variations in protein levels before and after bypass.

Table 4. Spontaneous protein values and post-by-pass requirements.

Patients	Spontaneous protein intake post-bypass (g/kg/day)	Protein requirements post-bypass (g/kg/day)
Patient 1	0.55	0.8
Patient 2	0.42	0.8
Patient 3	0.39	0.8
Patient 4	0.65	0.8

BMI after 3 months. Thus, BMI can considerably mask undernutrition; its reduction demonstrates a positive response to the intervention and not to nutritional status. Albumin and pre-albumin were also analyzed, demonstrating underlying protein-energy undernutrition in all patients. These results are similar to a study carried out in Spain in 2015,[15] noting hypoprealbuminemia in 40% of patients in the study population after 3 months.

According to the results of our study, a decrease in body protein reserves was noted after 3 months of bypass, supporting undernutrition, especially as post-intervention protein requirements were not met.[16] Spontaneous intakes calculated in post-bypass patients (n=4) were 0.5025±0.1204 g/kg/day after 3 months. This is similar to a study carried out in France in 2020 in 21 morbidly obese patients,[17] after 3 months from the bypass, reinforcing the hypothesis that protein intakes do not cover patients' protein requirements.[18] Calculated spontaneous protein intakes were 0.43±0.03 g/kg/day, a value similar to the results of our study as being very low compared with average protein requirements (0.8±0.05 g/kg/day).

Our study revealed micronutritional deficiencies, following short-circuiting of the small intestine and dietary restriction.[19] The elements most concerned are vitamin B12, vitamin B9, vitamin D, and ferritin.[20,21] As a result, deficiencies reinforce existing undernutrition. What we obtained after analyzing these elements in our study population are low levels after 3 months, similar to the results of a study carried out in the USA in 2013,[22] a study carried out in Australia in 2020,[23] and another carried out in Australia in 2023.[24] These three studies confirm that bariatric surgery increases the risk of deficiencies,[25] yet the four elements concerned are vitamin B12, vitamin B9, vitamin D, and ferritin.[26,27]

The study of our patient sample (n=4 out of n=2021) shows a growing concern about post-operative undernutrition. On average, they lost muscle mass after just 3 months, underlining the protein-energy degradation with reduced post-operative caloric intake compared to calculated caloric requirements.[28] This underscores the importance of dietary and nutritional follow-up in order to lose weight post-bypass without any deterioration in nutritional status or to limit macro- and micro-nutritional deficiencies. In addition, these claims were validated in a recent study carried out at the Cleveland Clinic in the Arab Emirates, aimed at assessing the value of regular dietary and nutritional follow-up and its obvious positive effects on the health status of gastric bypass patients.[29]

Conclusions

Our study conducted in the Marrakech Tensift Al Haouz region revealed encouraging results regarding post-gastric bypass undernutrition, with a relatively low incidence among patients followed up. These findings underline the effectiveness of the intensive follow-up protocols we implemented, despite the challenges posed by the inclusion of patients from a variety of healthcare institutions. In comparison with other studies, our results show significant variations that can be attributed to distinct care management practices and demographic factors.

Our observations corroborate the crucial importance of rigorous, personalized clinical follow-up to optimize long-term clinical outcomes after bariatric surgery. This approach not only makes it possible to closely monitor patients' nutritional parameters but also to tailor nutritional management strategies to the specific needs of each individual. By strengthening our monitoring strategies and improving post-gastric bypass nutritional management, we aim to reduce the risk of nutritional complications and improve patients' overall quality of life.

References

1. Mechanick JI, Kushner RF, Sugerman HJ, et al. American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. Obesity 2009;17:S1-70.
2. Stocker DJ. Management of the bariatric surgery patient. Endocrinol Metab Clin North Am 2003;32:437-57.
3. Maiz C, Alvarado J, Quezada N, et al. Bariatric surgery in 1119 patients with preoperative body mass index <35 (kg/m(2)): results at 1 year. Surg Obes Relat Dis 2015;11:1127-32.
4. Kaidar-Person O, Person B, Szomstein S, Rosenthal RJ. Nutritional deficiencies in morbidly obese patients: a new form of malnutrition? Part A: vitamins. Obes Surg 2008;18:870-6.
5. Navez B, Thissen JP. Bariatric surgery: follow-up in general medicine. Louvain Médical 2018;137:250-4. [Article in French].
6. Shankar P, Boylan M, Sriram K. Micronutrient deficiencies after bariatric surgery. Nutrition 2010;26:1031-7.
7. Handzlik-Orlik G, Holecki M, Orlik B, et al. Nutrition management of the post-bariatric surgery patient. Nutr Clin Pract 2015;30:383-92.
8. Reiber BMM, Leemeyer AR, Bremer MJM, et al. Weight loss results and compliance with follow-up after bariatric surgery. Obes Surg 2021;31:3606-14.
9. Toh SY, Zarshenas N, Jorgensen J. Prevalence of nutrient deficiencies in bariatric patients. Nutrition 2009;25: 1150-6.
10. Martinez MC, Meli EF, Candia FP, et al. The impact of bariatric surgery on the muscle mass in patients with obesity: 2-year follow-up. Obes Surg 2022;32:625-33.
11. Christou NV, Look D, Maclean LD. Weight gain after short- and long-limb gastric bypass in patients followed for longer than 10 years. Ann Surg 2006;244:734-40.
12. UCSF Health. Dietary guidelines after bariatric surgery. Available from: https://www.ucsfhealth.org/education/dietary-guidelines-after-bariatric-surgery.
13. Brolin RE. Metabolic deficiencies and supplements following bariatric operations. Obes Surg 2004:275-99.
14. Ernst B, Thurnheer M, Schmid SM, Schultes B. Evidence for the necessity to systematically assess micronutrient status prior to bariatric surgery. Obes Surg 2009;19:66-73.
15. Suárez Llanos JP, Fuentes Ferrer M, Alvarez-Sala-Walther L, et al. Protein malnutrition incidence comparison after gastric bypass versus biliopancreatic diversion. Nutr Hosp 2015;32:80-6.
16. Rinaldi Schinkel E, Pettine SM, Adams E, Harris M. Impact of varying levels of protein intake on protein status

indicators after gastric bypass in patients with multiple complications requiring nutritional support. Obes Surg 2006;16:24-30.
17. Guillet C, Masgrau A, Mishellany-Dutour A, et al. Bariatric surgery affects obesity-related protein requirements. Clin Nutr ESPEN 2020;40:392-400.
18. Sarwer DB, Dilks RJ, West-Smith L. Dietary intake and eating behavior after bariatric surgery: threats to weight loss maintenance and strategies for success. Surg Obes Relat Dis 2011;7:644-51.
19. Bloomberg RD, Fleishman A, Nalle JE, et al. Nutritional deficiencies following bariatric surgery: what have we learned?. Obes Surg 2005;15:145-54.
20. Gletsu-Miller N, Wright BN. Mineral malnutrition following bariatric surgery. Adv Nutr 2013;4:506-17.
21. Jauregui-Lobera I. Iron deficiency and bariatric surgery. Nutrients 2013;5:1595-608.
22. Saltzman E, Karl JP. Nutrient deficiencies after gastric bypass surgery. Annu Rev Nutr 2013;33:183-203.
23. Lewis CA, de Jersey S, Seymour M, et al. Iron, vitamin B12, folate and copper deficiency after bariatric surgery and the impact on anaemia: a systematic review. Obes Surg 2020;30:4542-91.
24. Lewis CA, Osland EJ, de Jersey S, et al. Monitoring for micronutrient deficiency after bariatric surgery-what is the risk?. Eur J Clin Nutr 2023;77:71-1083.
25. Goldner WS, Stoner JA, Thompson J, et al. Prevalence of vitamin D insufficiency and deficiency in morbidly obese patients: a comparison with non-obese controls. Obes Surg 2008;18:145-50.
26. Brolin RE, Gorman JH, Gorman RC, et al. Are vitamin B12 and folate deficiency clinically important after roux-en-Y gastric bypass?. J Gastrointest Surg 1998;2:436-42.
27. Love AL, Billett HH. Obesity, bariatric surgery, and iron deficiency: True, true, true and related. Am J Hematol 2008;83:403-9.
28. Nuijten MAH, Monpellier VM, Eijsvogels TMH, et al. Rate and Determinants of Excessive Fat-Free Mass Loss After Bariatric Surgery. Obes Surg 2020;30:3119-26.
29. Hassan M, Barajas-Gamboa JS, Kanwar O, et al. The role of dietitian follow-ups on nutritional outcomes post-bariatric surgery. Surg Obes Relat Dis 2024;20:407-12.