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RESEARCH ARTICLE

Gastric Bypass is not Associated with Protein Malnutrition in Morbidly Obese Patients

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Abstract
Background Patients undergoing bariatric surgery with a gastric bypass lose about 66% of excess weight. Although this procedure induces weight loss, it is unknown whether it leads to protein malnutrition, which is studied here.
Methods One hundred ten obese patients (body mass index, 47.9±8.6 kg/m^2) undergoing gastric bypass had a measurement of plasma albumin and transthyretin (formerly prealbumin) and a calculation of nutritional risk index (NRI) before and throughout the 2 years following the surgery.
Results All but five patients lost more than 15% of initial weight; the mean loss of excess weight was 65.2±26.4% at 2 years. Plasma concentrations of albumin and transthyretin decreased after surgery, but while albumin returned to initial values after 12 months, transthyretin remained low. Only one patient had an albumin below 30 g/l; another one had a transthyretin lower than 110 mg/l. All NRI scores were lower than 83.5 (62±5, ranging 44–70), qualifying patients for severe malnutrition.
Conclusion Malnutrition is difficult to diagnose in obese patients undergoing surgery. The large weight loss is most often not associated with protein malnutrition. Whether gastric bypass induces protein malnutrition remains to be established.

Keywords Morbid obesity · Gastric bypass · Protein energy malnutrition · Albumin · Nutritional risk index

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Background

Obesity prevalence is increasing worldwide, and the proportion of patients with a body mass index (BMI; weight/height^2) greater than 40 kg/m^2 is becoming significant (0.6% in France [1]). Surgery is proposed as one of the solutions to induce weight loss and weight maintenance [2]. This weight loss is associated with a dramatic reduction in comorbidities and overall mortality associated with obesity [3–7]. However, complications and side effects of the surgical procedures and/or of the rapid weight loss have to be acknowledged [8–10] to establish a risk/benefit balance, which would help in choosing the good indications for the treatment.

Among these complications, protein-energy malnutrition (PEM) has been described [9–10]. Among the surgical procedures, adjustable gastric lap-band is supposed to induce little if any PEM. On the contrary, malabsorptive procedures such as bilio-pancreatic diversions with or without duodenal switch do bypass a long segment of the intestine, creating complex macro- and micro-nutrient malabsorptions [10–11], with variable incidence of PEM. Gastric bypass is one of the most frequent procedures [12] that induces caloric restriction through gastric volume reduction and some degree of malabsorption through

Roux-en-Y bypass of the intestine. The relative contribution of the malabsorptive process and gastric volume reduction to weight changes are discussed.

Therefore, the aim of the study was to investigate the occurrence of PEM before and after gastric bypass, by assessing weight loss, and changes in plasma proteins recognized to be indicators of PEM. Furthermore, the classical malnutrition risk indicator, Nutritional Risk Index [13], made use of both weight loss and albumin concentrations.

Subjects and Methods

Protocol

Before and after surgery for obesity, patients were assessed by a multi-disciplinary team. Plasma albumin and transthyretin and weight changes were measured at 3, 6, 12, and 24 months.

Volunteers were recruited to participate in this study and gave their written informed consents for a protocol approved by the local medical school ethical committee.

Subjects

One hundred and ten patients participated. They were aged 42±10 years (mean±SD), with a mean BMI of 47.9±8.6 kg/m^2 before surgery, and were mostly women (87 of 110). Only one surgeon performed a standardized laparoscopic procedure [12] with a mean alimentary limb of 127±24 cm and the addition of the alimentary and the biliopancreatic limbs of 216±34 cm. The volume of the gastric pouch was set at about 50 ml.

Body weight was measured in light clothing at each visit.

Plasma albumin was measured with the capillary electrophoresis method [14], and transthyretin was measured with the immunoturbidimetric method [15].

Calculations and Statistics

Excess weight was calculated as the weight before surgery minus the weight the subject would have for his/her BMI to be 25, given his/her height. Weight lost was expressed as a percent of this excess weight.

Malnutrition was considered according to a consensus by the French Healthcare High Authority (Haute Autorité de Santé) criteria. Mild PEM was considered for a weight loss greater than 10%, an albumin concentration lower than 30 g/l, or a transthyretin concentration lower than 110 mg/l. Severe PEM was considered for a weight loss greater than 15%, an albumin concentration lower than 20 g/l, or a transthyretin concentration lower than 50 mg/l.

Nutritional Risk Index (NRI, 13) was calculated as:

$$\mathrm{NRI} = 1.519 \times \text{plasma albumin} + 0.417 \times (\text{observed weight}/\text{usual weight}).$$

NRI is unitless and corresponds to mild PEM for a score lower than 97.5, moderate PEM between 83.5 and 97.5, and severe PEM below 83.5. In the context of this study, usual weight was taken as the weight before surgery.

Statistics

Results are mean±SD. Differences were considered significant at the 5% level. Cross-sectional differences between gender categories were assessed by nonparametric test (Mann–Whitney). When one data point was missing, the last observation was carried forward to the next evaluation point (3, 6, 12, and 24 months), creating four categories (0–3, 3–6, 6–12, and 12–24 months).

Results

Excess weight was higher in men than in women (76±27 vs. 58±21 kg, P=0.003). Mean weight loss at 1 year was 37±20 kg and 35±14 kg after 2 years. Weight lost was greater than 15% in all but five patients. Excess weight lost was 35±17.1% at 3 months, 48.5±18.7% at 6 months, 63±25.4% at 12 months, and 65.2±26.4% at 24 months, nonsignificantly different between men and women.

Plasma albumin and transthyretin concentrations are given in Table 1 and Fig. 1. Plasma albumin concentrations decreased immediately after surgery then rose to reach initial values by 12 months. Transthyretin concentrations rose after the nadir at 3 months but remained lower than initial values. Before surgery, none of the patients could be classified as malnourished based on plasma protein concentrations. After surgery, only one patient had an albumin concentration below 30 g/l (29 g/l), and another one had a transthyretin concentration of 90 mg/l, both being classified as mildly malnourished. NRI was 62±5, ranging 44–70, therefore classifying all patients as severely malnourished.

Discussion

The present study shows that the prevalence of protein energy malnutrition after surgery for obesity varies as a function of used criteria. If plasma concentrations of albumin and transthyretin are considered only, two patients are classified as mildly malnourished according to the French Healthcare High Authority (Haute Autorité de Santé) definition. If the criterion of weight changes is

Table 1 Changes in plasma proteins before and after gastric bypass in morbidly obese patients

	Before surgery	T0–3 months	T3–6 months	T6–12 months	T12–24 months	*P* for time trend
Albumin (g/l)	41.4±2.7	37.5±3.8	40.2±3.4	41.4±2.5	41.2±1.9	0.038
Transthyretin (mg/l)	251±46	193±51	213±46	214±53	233±41	0.0001

chosen, all patients are found to be malnourished, most of them (105 of 110) severely so since weight loss is greater than 15% at any time point. With NRI, all patients are considered severely malnourished.

PEM can be defined with two sets of criteria, both of them reflecting the protein energy imbalance, the intakes being unable to match outputs. One set of criteria identifies the consequences of the imbalance on body compartments. Body weight changes greater than 10% (or 15% for severe malnutrition) are recognized as a threshold. Another criterion related to weight change is a low BMI, with a value that depends on age. The other set of criteria is related to the consequences of PEM associated with increased mortality and morbidity. In the diseased patients undergoing abdominal surgery or suffering from cancer cachexia, a weight loss is associated with increased complications of treatments, infections, delayed wound healing, and loss of muscle mass and function [16–18]. In this context, some indicators for the risk of these complications have been identified. Albumin has been related to mortality risk [19], complications during hospitalization [20], an increased length of stay, and to muscle mass [21]. Most of the studies included diseased and elderly patients. Albumin is considered as a prognostic factor rather than an indicator of protein mass or protein stores [22]. NRI has been developed in thoracic and abdominal surgery patients as a prognostic factor for mortality and complications arising in the 6 months following the procedure [13]. It is established that very few healthy patients have a score lower than 100 [23–24].

Transthyretin, which is a carrier protein for thyroid hormones and retinol-binding protein, diminishes during calorie and protein restriction. Transthyretin seems to be more sensitive to calorie reduction than protein reduction [25], especially in obese persons [26]. Therefore, transthyretin is both the signature of calorie restriction (i.e., weight loss) and an indicator of future complications [27].

Patients in the present study differ from those considered for malnutrition definitions and described above. Comorbidities resulting from increased energy stores (fat mass) in obese patients are very different from those occurring in protein-energy malnourished people. Weight loss is the objective of the surgical procedure, and the intensity of weight loss may be a poor indicator of a PEM status. Here patients lost about two thirds of their excess weight which is similar to that described in the meta-analyses [5]. Most of weight lost is made of fat [10]. Weight loss is greater than 15% and may not lead to the same consequences due to fat and protein store depletion in patients undergoing abdominal and thoracic surgery or when an inflammatory response occurs [16].

The present weight loss was not associated with dramatic changes in plasma protein concentrations. Indeed, although albumin concentrations decreased with time, they came back to initial values after 12 months, and very few patients had values under the thresholds that define malnutrition. The magnitude of the changes in albumin (about 10%) is in agreement with that observed after 24 weeks of calorie restriction [28]. The profile of transthyretin changes is different (Fig. 1) with a decrease at 3 months, followed by a gradual increase without returning to initial values. The importance of calorie restriction in obese patients studied here makes it an indicator of calorie restriction rather than an indicator of future risk. Since calorie restriction most probably prevailed after 3 months, this is a likely explanation for transthyretin to remain low.

Whether the decrease in plasma protein concentrations is associated with poor outcome after surgery in obese

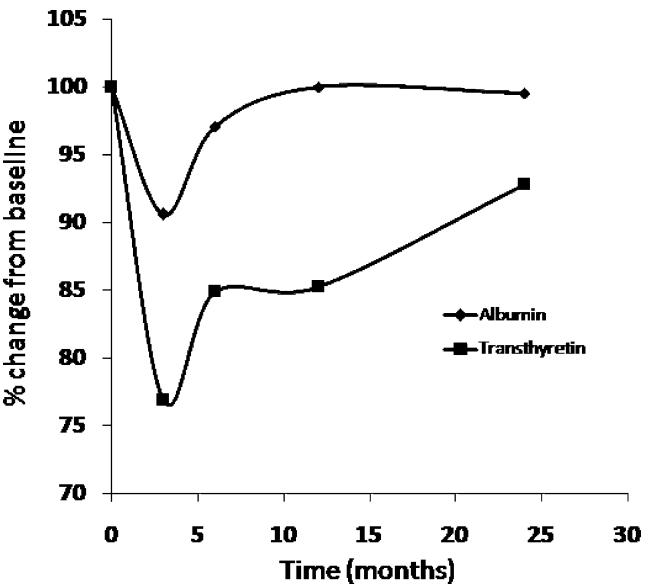

Fig. 1 Percent changes in plasma protein concentrations from baseline

patients remains to be established. Mortality within the 6 months after the gastric bypass procedure is recognized to be less than 1% [5]. In this study, the patient who had low transthyretin died 6 months after surgery. This mortality is far lower than that observed after surgery in malnourished patients, although surgery is then performed in much more dramatic circumstances. Future studies are necessary to establish whether such a rapid weight loss is associated with functional impairments (muscle, gut, or immune function) that would lead to specific requirements/nutritional strategies after bariatric surgery. Furthermore, patients undergoing laparoscopic bariatric surgery do not display difficulties in wound healing, do not show edema, and even improve their fertility. These arguments suggest that such weight losses are not associated with functional impairments [29].

NRI is not a good indicator of PEM in these circumstances, although it was derived from patients who underwent abdominal surgery. Here before surgery, five patients out of 110 had a score between 97.5 and 100 indicating no PEM [23–24]. This proportion is similar to that described by Naber. By calculating the score before weight loss, it is assumed that patients did not change weight. Then, the score is highly influenced by the albumin concentration. Indeed, considering the equation to calculate NRI, any albumin concentration lower than 37 g/l has a score lower than 97.5, the cutoff for mild malnutrition. After surgery, weight loss was greater than 15%, and any value of albumin concentration lower than 41 g/l would classify patients as malnourished (NRI score lower than 97.5). Therefore, there is a discrepancy between NRI score and protein concentrations in the diagnosis of malnutrition. Here, the NRI is low because of the large weight changes.

Some limitations should be acknowledged. Only plasma proteins were assessed and not immune or gut functions. Changes in body compartments were only assessed by means of weight changes, since most of the simple techniques measuring body composition are invalid in morbidly obese patients [30]. Albumin concentrations are measured by a reference method, excluding colorimetric method which tends to overestimate plasma albumin values.

In conclusion, PEM is very difficult to assess after surgery for obesity. Concerning the gastric bypass studied here, a debate persists about whether it induces malabsorption or only calorie restriction. It seems that important weight losses are rarely associated with plasma protein changes that would correspond to PEM. Other assessments of functional consequences of weight losses are needed; NRI is not recommended in these circumstances because its equation is heavily influenced by weight changes.

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