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REVIEW

Selenium Status after Roux-en-Y Gastric Bypass: Interventions and Recommendations

Mohadeseh Hassan zadeh[1] · Gholamreza Mohammadi Farsani[1,2] · Negar Zamaninour[2]

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Abstract

Background Selenium is an essential element that plays a vital role in maintaining human health and its deficiency can lead to cardiovascular and hypothyroidism complications. In this context, the main concern is about morbidly obese patients who undergo a Roux-en-Y Gastric Bypass (RYGB). Although RYGB leads to 60–70% excess weight loss, micronutrient deficiencies are common after this procedure and can be problematic if not promptly detected. This review will therefore examine the evidence regarding selenium deficiency in RYGB patients, as well its nutritional treatment methods.

Methods There were a total of 6 studies regarding RYGB and selenium deficiency, which were retrieved from PUBMED and SCOPUS electronic databases, ranging from 2006 to 2017.

Conclusion Selenium deficiency was observed before and after RYGB. Lifelong supplementation and regular patient monitoring after surgery are recommended.

Keywords Selenium · Deficiency · Roux-en-Y gastric bypass · Gastric bypass · Obesity · Bariatric surgery

Introduction

Selenium is an essential element [1], providing an important part of the multifunctional selenoproteins essential for health [2, 3]. Glutathione peroxidase (GPX) is the most widely known selenoprotein [2] that damages active oxygen species, including hydrogen peroxide and superoxide, and protects cells against free radicals [4, 5]. A new Recommended Dietary Allowance (RDA) for selenium has been set at 55 μg per day. A certain number of patients, however, may require a higher daily intake [6]. The main source of selenium is dietary [7]. Cereals, fish, eggs, and meats contain the highest amount of this element [8–10]. Selenium is absorbed in the duodenum and proximal jejunum [11] through the chelating process, binding to ligands such as acids, organic acids, or amino acids [12]. The rate of selenium absorption from food is about 80% and depends on its chemical form (organic or inorganic) [13]. Inorganic selenium (selenate and selenite), which is found mostly in dietary supplements and food fortifiers, is less readily absorbed than organic selenium (selenomethionine and selenocysteine) in dietary supplements and plant and animal products [13].

The most common way to evaluate selenium status is to measure plasma and serum selenium levels [14]. Blood and urine concentrations of selenium indicate the recent consumption of selenium; however, selenium concentration in hair and nails can indicate long-term use over months and even years. Additionally, to measure the functional index of selenium, one or more selenium proteins (GPX and selenoprotein p) are measured [14].

Selenium deficiency has been associated with several disorders, as follows [15–17]:

1. Keshan disease (cardiomyopathy), which is due to a combination of selenium deficiency and possibly a viral infection [16, 18].

✉ Negar Zamaninour
zamaninour.n@iums.ac.ir

Mohadeseh Hassan zadeh
Mohadese.Hasanzade@yahoo.com

Gholamreza Mohammadi Farsani
mohammadigh53@gmail.com

[1] Department of Clinical Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), Tehran, Iran

[2] Minimally Invasive Surgery Research Center, Iran University of Medical Sciences, Tehran, Iran

2. Kashin-Beck disease (endemic osteoarthropathy) [19, 20], affects epiphyseal, articular cartilage, and epiphyseal growth plates of growing bones and leads to enlarged joints and movement limitations [21].
3. Thyroid gland damage and disruption of thyroid hormone metabolism [22].
4. Cretinism [23, 24].
5. Immune system dysfunction [21].
6. Infertility in men [25].
7. Hypercholesterolemia [26].

Different lines of evidence have shown that serum selenium levels are low in obese and morbidly obese populations [27, 28], despite their dietary selenium intake being sufficient [29]. It has been assumed that obesity can alter antioxidant capacity by free radicals [29]. Unfortunately, over the last three decades, obesity has grown dramatically, with 650 million people worldwide suffering from this disease (www.who.int/news-room/fact-sheets/detail/obesity-and-overweight). Roux-en-Y Gastric Bypass (RYGB) has become the most popular bariatric surgery for controlling morbid obesity [30–32]. Several previous studies have shown a 60–70% excess weight loss after Roux-en-Y Gastric Bypass [30–32]. RYGB is a type of restrictive and malabsorptive surgery [33, 34], in which the surgeon creates a small stomach pouch of about 15 ml, and attaches the pouch to the jejunum by means of a Roux limb [35]. Since the RYGB results in bypass of the duodenum and upper jejunum [35], micronutrient deficiencies such as selenium are common after this procedure and can be problematic if not promptly detected [36, 37]. In this regard, there is limited data on selenium deficiency following RYGB. Therefore, in this review, the focus was on the results of studies that had reported selenium deficiency in patients who had undergone RYGB surgery, as well as studies on its nutritional treatment.

Methods

Two databases were searched, PUBMED and SCOPUS. After screening, articles from 2006 to 2017 were included Fig. 1. The search strategy was (Roux-en-Y gastric bypass OR gastric bypass OR bariatric surgery) AND (selenium OR selenium deficiency OR micronutrient deficiency). The title and abstract of the citation articles were scanned and those that were relevant to the study were selected. Two reviewers independently searched and selected the articles.

Selenium Deficiency after RYGB

Selenium deficiency has been reported in 3% of patients 1 year after undergoing RYGB surgery [11]. In contrast, a 2012 study found no reduced serum selenium levels at 12 months post-operation, while a deficit was reported at 3 months after surgery [39]. Additionally, selenium deficiency has also been observed in 23%, 11%, and 12% of patients within 6, 12, and 24 months after RYGB, respectively [38]. Interestingly, selenium deficiency with clinical symptoms (bilateral leg edema, 2-week history of progressive exertional dyspnea) was reported at 9 months post-RYGB surgery in a case report study. The patient's symptoms improved after 3 weeks of selenium supplementation [42]. Also, in a study on non-morbid obese patients (BMI 25–30), a significant decrease in serum selenium levels was observed 2 years after RYGB, compared to preoperative time. Although the prevalence of selenium deficiency was 11% before RYGB, it reached 46% 2 years after surgery (the cutoff point for selenium deficiency was < 0.75 μmol/l) [40]. In another study, 437 patients underwent obesity surgery, of which 57% were patients who had undergone a gastric bypass. Selenium deficiency was seen in 2% of all patients before surgery, but 11–15% after all three types of bariatric surgery (gastric banding, sleeve gastrectomy, and gastric bypass), indicating a tendency for decreased selenium concentrations in the postoperative period. (The cutoff point for selenium deficiency was < 0.75 μmol/l) [41]. An overview of studies is reported in Table 1.

Causes of Selenium Deficiency after RYGB

Several mechanisms relating to selenium deficiency may occur concurrently after RYGB, they are as follows:

1- The RYGB results in bypass of the duodenum and upper jejunum [35]. Therefore, malabsorption of selenium following RYGB is a possible cause for deficiencies [36, 37].
2- Dietary intake of selenium may be reduced after surgery [39].
3- Discontinuation of postoperative selenium supplementation can lead to decreased levels of serum selenium [42].
4- Some types of multivitamin/mineral supplements do not contain sufficient amounts of minerals [43].
5- Selenium deficiency after surgery may be due to the lack of this element in obese people before surgery [29]. The prevalence of selenium deficiency varied from 2 to 58% in the preoperative phase [11, 40, 41].

Recommendations for Prevention and Treatment of Selenium Deficiency in Post-Surgical Bariatric Patients

1. Although selenium deficiency was reported in the above-mentioned studies, routine evaluation is not recommended after RYGB [44]. Laboratory evaluation of selenium is

recommended only in the presence of unexplained anemia, fatigue, metabolic bone disease, chronic diarrhea, or heart failure [43].

2- In the case of selenium deficiency, dietary and supplemental selenium intakes should be assessed based on the selenium contents of particular foods/supplements and the amounts consumed. Keeping a proper diet and multivitamin supplement could improve selenium deficiency [26]. As stated above, the RDA for selenium is 55 micrograms per day. Considering that no recommendation exists for RYGB patients, they should be consuming at least this amount from selenium-rich foods and supplements. For symptomatic deficiencies, therapeutic doses of 2 μg/kg/day of selenium are proposed [45]. However, selenium-deficient patients with dilated cardiomyopathy or total parenteral nutrition (TPN) may require 150 μg/day of supplemental selenium [45]. Additionally, fistula and aspiration patients can enhance basic requirements. As a result, their minimum requirements are 60 to 100μg/day, with some having greater needs [46].
3- If selenium is inadequate in multivitamin/mineral supplementation, the consumption of the nuts high in selenium (including Brazil nuts) is recommended [43].

Finally, it should be noted that high levels of selenium, like other elements, can be toxic and could lead to gastrointestinal symptoms, hair loss, fatigue, irritability, nerve damage, etc. The upper limit for adults is set at 400 μg/day [47, 48].

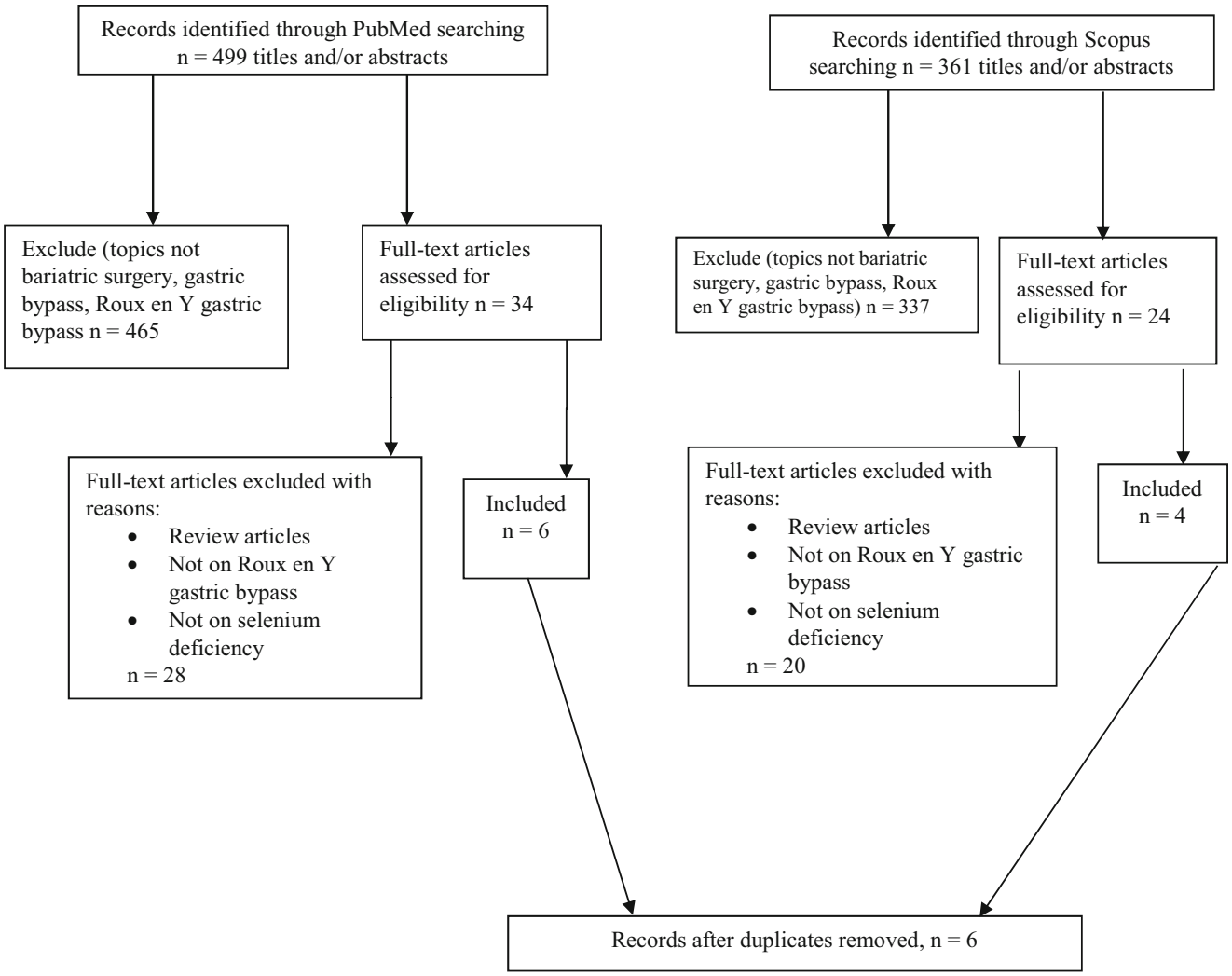

Fig. 1 Reporting items for review flow diagram

Table 1 Overview of studies: selenium deficiency after bariatric surgery

Authors/year/reference	Study type	Duration of study	Sample	Method	Main results
Madan et al. (2006) [11]	Retrospective study	6 months	100 patients who underwent RYGB[1]	Serum vitamin/mineral levels were reviewed before, 3, 6, and 12 months after surgery	Preoperative and 1-year postoperative percentage of selenium deficiencies were 58% and 3%, respectively
Gong et al. (2008) [38]	Retrospective study	69 months	121 patients with morbid obesity who undertook RYGB	Serum levels of vitamins/minerals were evaluated 6, 12, and 24 months after surgery	Selenium deficiency at 6, 12, and 24 months after RYGB obsereved in 23%, 11%, and 12% of patients
Freeth et al. (2012) [39]	Prospective pilot study	24 months	39 patients who underwent RYGB and gastric banding surgery	Serum levels of vitamin/mineral analyzed before surgery and at, 3 and 12 months after surgery	Selenium deficiency was observed only in the third month
Billeter et al. (2015) [40]	Cohort study	24 months	20 patients (BMI:25–35 kg/m^2) with longstanding, insulin-dependent T2DM[2] were treated with RYGB	Serum levels of vitamins/minerals measured before and 24 months after surgery	A significant reduction in serum selenium levels was observed at 24 months postoperatively compared to preoperative
Papamargaritis et al. (2015) [41]	Retrospective study	36 months	437 patients underwent 3 surgeries: gastric bypass (57.3%), gastric banding (22.7%), sleeve gastrectomy (20.1%)	Serum levels of trace elements measured before and at 3, 6, 12, 18, 24, and 36 months after surgery	Selenium deficiency was observed in 2% of all patients before surgery and 11–15% after 3 types of surgery
Massoure et al. (2017) [42]	Case report		A 40-year-old woman with bilateral leg edema, 9 months after RYGB		Symptoms improved after 3 weeks of selenium supplementation

[1] *RYGP*, Roux-en-Y gastric bypass

[2] *T2DM*, type 2 diabetes mellitus

Conclusion

Selenium deficiency has been reported before and after surgery. Therefore, clinicians should promote lifelong supplementation and patients should be monitored after surgery if needed.

Compliance with Ethical Standards

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

Ethical Approval Statement This article does not contain any studies with human participants or animals performed by any of the authors.

Informed Consent Statement Does not apply.

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