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Patients at risk for trace element deficiencies: Bariatric surgery

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ABSTRACT

Obesity is a worldwide epidemic associated with diseases such as diabetes mellitus and cardiovascular disease. Current methods for weight loss are not very effective, particularly for those with morbid obesity. Surgical therapy may be recommended for those with a BMI ≥ 40 kg/m^2, or BMI ≥ 35 kg/m^2 with co-morbidities. This therapy can produce significant weight loss and improve/resolve co-morbidities including hypertension and hyperlipidemia. Yet successes may be tempered by adverse effects on trace element absorption and status. A PubMed literature search identified studies from January 1980 to February 2013 for inclusion in a meta-analysis. Publications that contained keywords 'bariatric surgery or gastric bypass,' 'trace element or mineral or zinc or iron or copper or iodine or manganese', and 'absorption or status or rate or level' were identified. Inclusion criteria were human markers that reflect changes in trace element status before and after bariatric surgery. The meta-analysis found a decrease in blood copper, zinc, hemoglobin, as well as an increase in iron, regardless of the type of surgery. The pooled effect sizes and 95% confidence intervals were 0.17 and −0.09 to 0.43 for plasma/serum iron ($p = 0.20$); −0.49 and −0.67 to −0.31 for blood hemoglobin ($p = 0.00$); −0.47 and −0.90 to −0.05 for plasma/serum copper ($p = 0.03$); −0.77 and −1.20 to −0.35 for plasma/serum zinc ($p = 0.00$). Differences in levels of these minerals pre- and post-surgery may have been influenced by the time period after surgery, a pre-existing deficiency, type and dose of vitamin–mineral supplements, and malabsorption due to elimination of parts of the gastrointestinal tract.

Introduction

Obesity is a global problem associated with health-related conditions such as hypertension, dyslipidemia, and diabetes [1–3]. In the United States, 33.3% of adults are overweight [4] and 34.9% are obese [5]. Worldwide, 500 million adults are obese, and overweight and obesity are reported in half of the European populations [6]. The highest estimates of obesity are found in North America (31.1%), Australia (25.3%) and Western Europe (20.0%) [7].

Morbid obesity [body mass index (BMI) ≥ 40 kg/m^2] is even more devastating, representing 6.6% of the U.S. adult population [8]. On a global basis, the annual mortality rate is about 2.5 million deaths [9]. Bariatric surgery is a solution offered to those with a BMI ≥ 40 kg/m^2, or BMI ≥ 35 kg/m^2 with co-morbidities [6,10,11]. Popularity of this surgery has increased substantially, with 300,000 surgeries performed globally in 2011 [12,13].

Bariatric surgery consisted of two major types: malabsorptive and restrictive. Malabsorptive procedures which reduce nutrient absorption via bypassing the stomach and diminishing contact with intestinal cells include Roux-en-Y gastric bypass and biliopancreatic diversion. Restrictive methods which decrease stomach size, suppress quantity of nutrients available and enhance early satiety) include laparoscopic sleeve gastrectomy, vertical band gastroplasty and adjustable gastric banding [1,11]. The first successful gasterectomy was performed by Schlatter in 1897 [14]. Today bariatric surgery has a mortality rate of 0.1–0.3% and a morbidity rate of 4.5% [12]. Common health complications include anemia [15], osteomalacia [16], dumping syndrome [9], and nutrient malabsorption resulting in vitamin and mineral deficiencies [12,17–19]. Nutritional problems reported include protein–calorie malnutrition [18], and reductions of serum glutamate, methionine and cystathionine [19], as well as vitamins (fat soluble and B vitamins) [12,17,18], and minerals (copper, iron, zinc) [12,18].

To date, gaps are present in the literature regarding the association between bariatric surgery and trace element status. The current study conducted a quantitative meta-analysis of published research that focused on bariatric surgery and plasma/serum iron,

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copper, and zinc status in order to explore trace elements status before and after surgery.

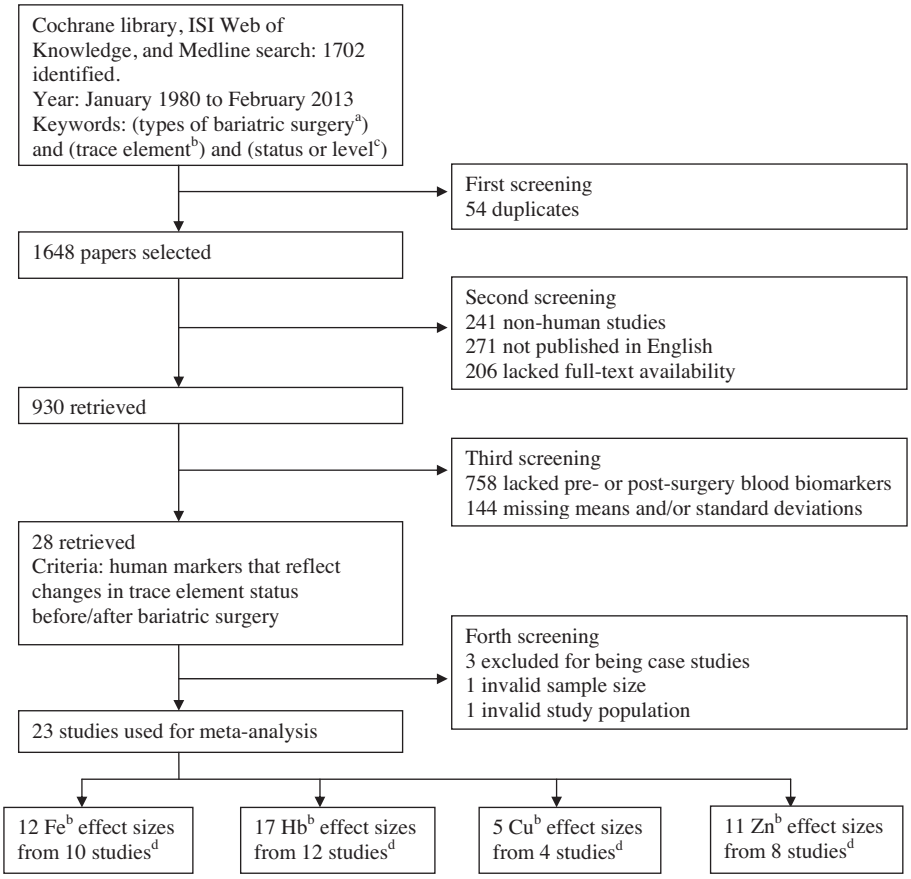
Research design and methods

Literature search and study selection

An extensive literature search was performed by using Cochrane Library, Institute for Scientific Information (ISI) Web of Knowledge, and PubMed databases. Articles published from January 1980 to February 2013 were identified via overall keywords 'type of bariatric surgery,' 'trace element,' and 'status or level of trace element.' Overall and specific terms used for the literature searches for the meta-analysis are detailed in Fig. 1. Exclusion criteria as applied via a four-step screening process included (1) duplicates that were identified in more than one search engine; (2) studies that were not based on humans, not published in English, and lacked full text; (3) articles that lacked pre- and post-surgical trace element status (blood marker) values, or were missing a mean and/or standard deviation values of trace element status; and (4) case studies or experiments with invalid sample size/characteristics (Fig. 1). Inclusion criteria were studies that explored and reported the status of plasma/serum iron, blood hemoglobin, plasma/serum copper, and/or plasma/serum zinc before and after undergoing bariatric surgery. Two investigators independently participated in the screening and selecting process of the articles based on the agreed exclusion and inclusion criteria to increase the eligibility and validity of the procedure. The most recent publication was included in cases where duplications occurred. Disagreements were resolved by consensus between the two reviewers.

Data extraction and statistical analysis

Characteristics of the participants (age, BMI, proportion of men, ethnicity, geographic area, menstrual status), study design (type



[a] Bariatric surgery, gastric bypass, jejuno-ileal, jejunoileal, Roux-en Y, Roux-en Y gastric bypass (RYGB), laparoscopic adjustable gastric banding (LAGB), gastric surgery, gastrojejunal, vertical gastroplasty, sleeve gastrectomy, duodenal switch.

[b] Trace element, mineral, trace mineral, iron (Fe), hemoglobin (Hb), copper (Cu), zinc (Zn), iodine, manganese

[c] Absorption, status, rate, level, deficiency, altered plasma, malnutrition, therapy, response, tolerance, anemia, hemochromatosis, hypocupremia, prevalence, incidence

[d] Some studies overlapped

Fig. 1. Study selection diagram and keywords utilized for meta-analysis of trace elements levels after bariatric surgery.