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Original article

The foregut theory as a possible mechanism of action for the remission of type 2 diabetes in low body mass index patients undergoing subtotal gastrectomy for gastric cancer

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Abstract

Background: The question of whether pure metabolic surgery could be used in nonobese patients with type 2 diabetes has been considered. The objective of this study was to assess the comparative effects of the Billroth I (BI) and Billroth II (BII) reconstruction methods on remission of type 2 diabetes in nonobese patients undergoing subtotal gastrectomy for cancer.

Methods: The charts of 404 patients who underwent radical subtotal gastrectomy for cancer between January 2008 and December 2010 were retrospectively reviewed. From these patients, 49 with type 2 diabetes were included in this study. Diabetes remission rates, the percentage change in fasting plasma glucose levels, glycated hemoglobin levels, body mass index, and fasting total cholesterol levels at 2 years were observed. Outcomes were compared using propensity scores and inverse probability-weighting adjustment that reduced treatment-selection bias. Covariate-adjusted logistic regression models were assessed.

Results: The 2-year diabetes remission rate for the 23 patients who underwent BI reconstruction was 39.1%, compared with 50.0% for the 26 patients who underwent BII reconstruction. At 2 years, the BII group showed lower glycated hemoglobin levels (BI, 6.4%; BII, 6.1%; $P = .003$) and had greater percent reductions in their average glycated hemoglobin levels from baseline (BI, −11.6%; BII, −14.5%; $P = .043$). BII reconstruction was significantly associated with an increased diabetes remission rate (odds ratio, 3.22; 95% confidence interval, 1.05–9.83) in covariate-adjusted logistic regression analysis.

Conclusions: These propensity score-adjusted analyses of patients who had undergone subtotal gastrectomy indicated that BII reconstruction was associated with increased diabetes remission compared with BI reconstruction during the 2-year follow-up period. This study suggests the possibility of employing the surgical duodenal switch for the treatment of nonobese type 2 diabetes patients. (Surg Obes Relat Dis 2014;10:235-242.)

Keywords: Metabolic surgery; Subtotal gastrectomy; Billroth; Type 2 diabetes; Gastric cancer

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Bariatric surgery, originally used as a form of weight reduction intervention, has clearly shown a metabolic effect that improves remission of type 2 diabetes [1]. Both the International Diabetes Federation [2] and a consensus conference [3] have recommended that bariatric surgery

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be considered for controlling type 2 diabetes. A meta-analysis [4] of studies on bariatric procedures involving patients with type 2 diabetes showed an overall rate of hyperglycemia remission of 78% among the different procedures.

Perhaps, the most important factor in the management of type 2 diabetes after bariatric surgery is weight control, and recent evidence indicates that improvements in blood glucose control is related to the degree of weight loss [5–7]. Despite this, bariatric surgery has a remarkable beneficial effect on diabetes almost immediately after surgery and usually long before any significant weight loss occurs [8]. This has led to the theory of the entero-insular axis involvement in the resolution of diabetes in cases in which diabetes remission is independent of weight reduction [9].

Experimental studies in humans [10–12] suggest that certain bariatric procedures may improve diabetes control through mechanisms other than weight loss [13]. Furthermore, surgical procedures that reroute food through the upper small bowel lead to better glycemic control than procedures that do not reroute food; such rerouting may activate mechanisms of diabetes control that are independent of weight loss [8,10].

The life expectancy of gastric cancer patients who have metabolic diseases, especially diabetes, is increasing with early recognition and treatment of gastric cancer, which has improved outcomes [14,15]. Diabetes is significantly associated with mortality from several malignancies other than gastric cancer [16,17]. The Billroth I (BI) and Billroth II (BII) resection and reconstruction techniques are 2 popular methods for subtotal gastrectomy. Although these methods share some characteristics in terms of the extent of gastrectomy, the BII procedure involves the creation of a duodenal switch, while the BI procedure restores the normal configuration of the gastrointestinal tract. Comparing outcomes after these reconstruction methods in gastric cancer patients may improve our understanding of the metabolic effects of the duodenal switch on diabetes control, as well as facilitate further investigation on the efficacy of pure metabolic surgery for nonobese patients.

The aim of our study was to determine if the duodenal switch, characteristic of BII reconstruction after subtotal gastrectomy for cancer, is associated with remission of type 2 diabetes in nonobese patients, compared with the BI reconstruction method. To overcome the limitations associated with the use of nonrandomized observational data from clinical databases, propensity score-adjusted analyses were performed.

Methods

Study population

The charts of 404 patients with gastric cancer who underwent radical subtotal gastrectomy between January 2008 and December 2010 at our center were concurrently reviewed. Patients were excluded from the study if they met any of the following criteria: nondiabetic, body mass index (BMI, weight in kilograms divided by the square of the height in meters) of ≥ 30 kg/m^2, death before the end of the 2-year follow-up period, diabetes secondary to a specific disease or glucocorticoid therapy, other endocrinopathies, surgical history of other organ resection, and recurrence of gastric cancer. A total of 49 diabetic patients remained after applying the exclusion criteria and were included in this study. The diagnosis of type 2 diabetes was based on fasting plasma glucose levels or oral glucose tolerance test results, according to the criteria established by the American Diabetes Association [18]. Patients were considered to have diabetes if they had a history of diabetes and the use of diabetes medication. Gastric cancer staging was performed according to the American Joint Committee on Cancer staging manual [19], and tumor location was determined on the basis of pathology test results. Informed consent was obtained from all patients before surgery. The Institutional Review Board approved this study (No. AN13004-001).

Surgical procedures

Subtotal gastrectomy for gastric cancer was performed for lesions in the distal part of the stomach. The extent of resection was determined according to the location of the primary tumor and lymph node status. Partial omentectomy with D1 plus β lymphadenectomy was mainly performed for early gastric cancer, and total omentectomy with D2 lymphadenectomy was performed for advanced gastric cancer after lymph node classification according to the criteria of the Japanese Gastric Cancer Association [20]. The proximal resection margins from the lesions were at least 2 cm long. Patients undergoing BI reconstruction underwent a complete Kocher maneuver to mobilize the duodenum and a tension-free side-to-end hand sutured gastroduodenostomy. For patients undergoing BII reconstruction, the duodenum was transected approximately 2 cm distal to the pylorus using a linear stapling device. These procedures were followed by distal gastrectomy and BII anastomosis using a hand-sutured or stapled technique. Hand-sutured extracorporeal anastomosis was performed between the gastric remnant and a loop of jejunum chosen approximately 10–15 cm distal to the ligament of Treitz. BII reconstruction was chosen for cases in which the tumor was close to the pylorus, suprapyloric and infrapyloric lymph node invasion was noted, or the tension was too great to perform BI anastomosis; BII reconstruction was performed for intestinal continuity. In all patients, vagotomy was routinely performed during lymph node dissection.

Postoperative management

Patients returned to our center for follow-up at least every 6 months for the first 3 years after surgery. All patients underwent complete evaluations before the operation and