Case report

Relationship of bypassed limb length and remission of type 2 diabetes mellitus after Roux-en-Y gastric bypass

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Received October 19, 2011; accepted October 24, 2011

Laparoscopic Roux-en-Y gastric bypass (LRYGB) is widely accepted as a valid surgery in the treatment of morbid obesity \cite{1} and is known to cause remission of type 2 diabetes mellitus (T2DM), although the exact mechanism of T2DM remission remains unclear. Different lengths of the bypassed limbs in LRYGB have been proposed by surgeons \cite{2}, but no study has reported on the relationship of the length of the bypassed limbs and T2DM resolution. We describe an interesting case of T2DM remission after LRYGB, T2DM recurrence, and, finally, T2DM remission again after surgical adjustment of the length of the bypassed limbs. This case report demonstrates the importance of technical awareness when performing LRYGB for the treatment of T2DM.

Case report

The patient was a 50-year-old woman who weighed 86 kg with a body mass index (BMI) of 34.4 kg/m\textsuperscript{2}. She had had T2DM and hypertension for 10 years. She had been using insulin injections for 4 years but still had poor glycemic control, with a glycosylated hemoglobin (HbA1c) level of 8.8%. She underwent LRYGB with creation of a 25-cm\textsuperscript{3} gastric pouch, 150-cm biliopancreatic limb, and 100-cm alimentary limb. T2DM remission was noted in the first month without the use of any medications or insulin. After 18 months, her BMI and HbA1c was 25.2 kg/m\textsuperscript{2} and 4.6%, respectively, indicating a durable remission of T2DM. However, frequent diarrhea was noted during this period, and medical treatment for this was unsuccessful. She underwent a laparoscopic revision, during which the bypassed limbs were shortened to lengths commonly associated with standard LRYGB (i.e., a biliopancreatic limb of 40 cm and an alimentary limb of 70 cm). Her diarrhea improved, and her BMI remained unchanged at 25 kg/m\textsuperscript{2}; however, T2DM recurred immediately after the reoperation. Despite taking 2 oral hypoglycemic agents, her T2DM control remained poor for 9 months, with the HbA1c eventually increasing to 8.7%. Subsequently, a second revision procedure with laparotomy was electively performed, during which the bypassed limbs were lengthened (the biliopancreatic limb to 100 cm and the alimentary limb to 70 cm; Fig. 1). Medication-free T2DM remission was achieved again after the last operation. At 9 months after the third operation, her BMI was 24.2 kg/m\textsuperscript{2} and her HbA1c was 6.2%. Since the first operation, her body weight has remained stable throughout the period (Fig. 2). The change in fasting blood glucose and HbA1c are shown in Figure 3.

Discussion

Evidence is growing that gastrointestinal bypass operations involving rerouting of the gastrointestinal tract can cause T2DM remission, independent of any weight loss, in a proportion of patients \cite{3}, and this phenomenon can occur even in the nonmorbidly obese patient \cite{4}. The gastrointestinal tract plays an important role in energy regulation, and many gut hormones are involved in the regulation of glucose metabolism \cite{5,6}. Investigations have shown that the main cause of T2DM is likely free fatty acid accumulation in muscles and hepatocytes, which thereby alter the fat metabolism equilibrium and block glucose entry into the
cells. This fat metabolism disequilibrium results in insulin resistance, which achieves its typical clinical presentation in the morbidly obese patient with T2DM [7]. We believe that the effectiveness of gastric bypass depends on 3 fundamental concepts to improve energy and fat metabolism [8–11]. First, the small gastric pouch restricts the amount of energy intake; second, bypass of the duodenum and upper jejunum results in restriction of digestive enzymes and, thus, decreasing fat absorption (additionally, there might be “anti-incretins” [foregut theory] involved); and third, the rerouting of the small bowel stimulates gut hormones that improve the pancreatic beta cell function and insulin sensitivity (the hindgut theory) [8,12,13].

Recent publications have shown different T2DM remission rates for nonmorbidly obese patients after surgery [4,14]. In this group, the T2DM remission and improvement rates have been lower compared with those with morbid obesity, and some proportion of T2DM-remitted patients will experience relapse later after surgery. Pancreatic function seems to be 1 of the most important factors in the mechanisms involved [10]. Many studies have reported that longer bypassed limbs (≥150 cm) might be associated with a very modest weight loss advantage in super obese patients [2,15,16] but has no significant effect on patients with a BMI <50 kg/m². Little published information is available on T2DM remission and recurrence associated with the variation in bypassed limb lengths. We report the case of T2DM remission and recurrence in a morbidly obese patient that was associated with the variation in the bypassed limb lengths. Initially, early T2DM remission was noted after LRYGB, just as in other patients. However, because of frequent diarrhea in the next 18 months despite attempts at medical treatment, the patient underwent revision surgery to shorten the bypassed limbs. T2DM recurrence was noted immediately. Also, even with oral hypoglycemic agents, poor glycemic control remained. At that time, our belief was that her T2DM had recurred because we had shortened the bypassed limb. Gastrointestinal hormones and neural signals are produced at varying sites in the digestive tract. Different surgical methods or different lengths of bypassed limbs might activate different mechanisms of action. Surprisingly, after the last revision surgery, during which we increased the length of the limbs, T2DM remission was achieved again. The patient’s weight was stable throughout the whole process.

As we have seen in some studies, the possibility of excessive weight loss should not be a surgical contraindication for patients with T2DM [4,12,14]. No extreme weight loss occurs in nonobese cases, and the patient’s BMI should not be the only factor when considering surgery; thus, nonobese patients with T2DM should also be candidates for metabolic surgery [12,17,18]. The present case has demonstrated the importance of the gut hormones and malabsorption mechanisms while highlighting that other mechanisms might be involved in nonobese T2DM.

The precise mechanism and effect of gastric bypass in patients with T2DM is still a Pandora’s box; however, the importance of the limb lengths in T2DM remission is clearly illustrated in the present case.
Conclusion

LRYGB is a safe procedure and is effective in the treatment of T2DM. Before considering metabolic surgery for nonobese patients with T2DM, the surgeon should first consider the length of the bypass limbs to enhance the rate of T2DM remission and to avoid adverse effects, such as profuse diarrhea. Additional prospective studies are required before a consensus can be achieved on the ideal type and length of bypass for metabolic surgery in nonobese patients with T2DM.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

References