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# Revision of the Duodenal Switch: Indications, Technique, and Outcomes

Nahid Hamoui, MD, Brandon Chock, MD, Gary J Anthone, MD, Peter F Crookes, MD

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- BACKGROUND:** Duodenal switch (DS) operation combines both restrictive and malabsorptive components and has become an accepted operation in selected patients with morbid obesity. Complications develop in some patients, which are refractory to dietary supplementation. We report a series of 33 patients who required partial revision of the DS.
- STUDY DESIGN:** During the 10-year period after September 1992, 701 patients had DS operation performed; of these, 33 (5 men and 28 women) patients required revision. Revision was performed by side to side enteroenterostomy 100 cm proximal to the original anastomosis. Outcomes measures reviewed include postoperative complications, nutritional parameters, and weight change.
- RESULTS:** Revision was performed a median of 17 (range 7 to 63) months after DS. Indications for revision included protein malnutrition (n = 20), diarrhea (n = 9), metabolic abnormalities (n = 5), abdominal pain (n = 3), liver disease (n = 2), emesis (n = 2), and gastrointestinal bleed (n = 1). Median body mass index at the time of revision was 28. Median serum albumin was 3.6 g/dL and improved to 4.0 g/dL postoperatively (p = 0.01). Complications occurred in 5 of 32 patients (15%) and included wound infection (n = 2), respiratory failure (n = 1), gastrointestinal bleed (n = 1), and small bowel obstruction (n = 1). There was no perioperative mortality. During a median followup period after revision of 39 months, the median weight gain was 18 pounds. Three patients requested repeat operation because of weight regain.
- CONCLUSIONS:** Patients requiring revision of DS for malnutrition can be corrected by a technically simple procedure, but they are at considerable risk for complications. Although many patients are anxious about regaining their weight after reversal, they can be reassured that substantial weight gain is unlikely. (J Am Coll Surg 2007;204:603–608. © 2007 by the American College of Surgeons)
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Bariatric operations provide effective treatment for patients with morbid obesity. Weight loss and reversal of comorbidities are sometimes achieved at the cost of considerable side effects, which include such unpleasant gastrointestinal symptoms as dumping syndrome, diarrhea, and malodorous flatus. In the case of procedures that include an element of malabsorption, additional side effects caused by deficiency of essential minerals or vitamins can occur. Recognition of this consequence after malabsorptive procedures can be difficult for several reasons. First, the patient often can eat a substantial quan-

tity of food without vomiting or postprandial discomfort.<sup>1</sup> Profound weight loss, although viewed with concern by physicians, is often welcomed by patients because of unrealistic expectations of the outcomes of the procedure. Third, organizational aspects of bariatric practice frequently result in patients being lost to followup after the first year. The disadvantage of inducing malabsorption is a higher risk of producing critical nutritional deficiencies, such as anemia, calcium deficiency leading to osteomalacia, and protein calorie malnutrition.<sup>2-5</sup>

Protein calorie malnutrition is characterized by excessive weight loss, hypoalbuminemia, peripheral edema, and muscle weakness. Why this combination of abnormalities develops in some patients and not in others with the same kind of reconstruction is currently unknown.

In patients who suffer malnutrition after restrictive bariatric operation, such as Roux-en-Y gastric bypass, the cause is usually poor intake; in contrast, after malabsorptive procedures patients can consume normal meals

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From the Department of Surgery, University of Southern California, Los Angeles, CA.

Correspondence address: Peter F Crookes, MD, Department of Surgery, 1510 San Pablo St, #514, Los Angeles, CA 90033. email: crookes@usc.edu

**Abbreviations and Acronyms**

BPD = biliopancreatic diversion  
 CC = common channel  
 DS = duodenal switch

and still become malnourished.<sup>6</sup> In fact, the most common reason for revision of a restrictive operation is inadequate weight loss.<sup>7</sup> A report of revisional operation exclusively in the subgroup of patients having procedures with some element of malabsorption has not, to our knowledge, appeared in the literature previously.

Contemporary operations whose mechanism of action depends on substantial malabsorption are derived from biliopancreatic diversion (BPD), described by Scopinaro and colleagues.<sup>8</sup> In this country, the duodenal switch (DS) operation was developed as a “second-generation” BPD (Fig. 1). The chief differences from the Scopinaro BPD are the preservation of the pylorus, removal of the greater curve portion of the stomach to reduce the gastric reservoir, and creation of a longer common channel (generally 75 to 150 cm) than the 50 cm originally described by Scopinaro and colleagues. Between 1992 and 2002, the DS was the major operation performed in the bariatric program at the University of Southern California.<sup>9</sup> The aim of this study was to characterize the clinical features leading to the need for revision of the DS operation and to describe techniques and outcomes.

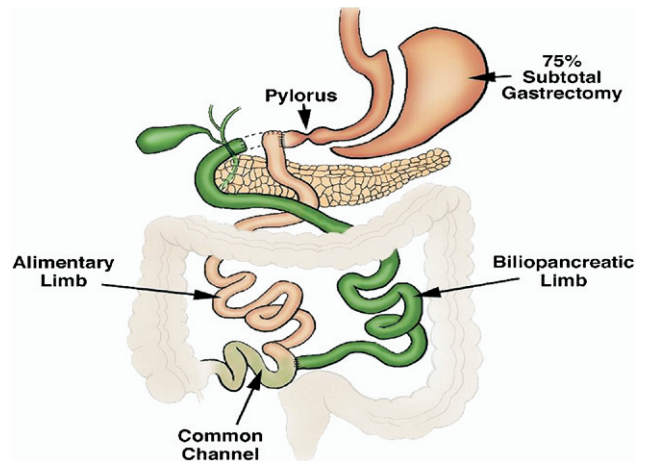


Figure 1. The duodenal switch operation.

**METHODS**

During the 10-year period between September 1992 and September 2002, 701 patients had the DS operation performed at University of Southern California, University Hospital. Followup was 75% at 2 years and dropped to about 40% at 5 years. Of these patients, 33 required revision because of excessive malabsorption. There were 5 male and 28 female patients in the study population, with a median age of 39 years (range 22 to 68). Patients who had a revision performed in the acute setting during an operation for intestinal obstruction requiring small bowel resection were excluded from this analysis.

**Operative technique**

Revision was performed through open laparotomy. Alimentary and biliopancreatic limbs were identified by

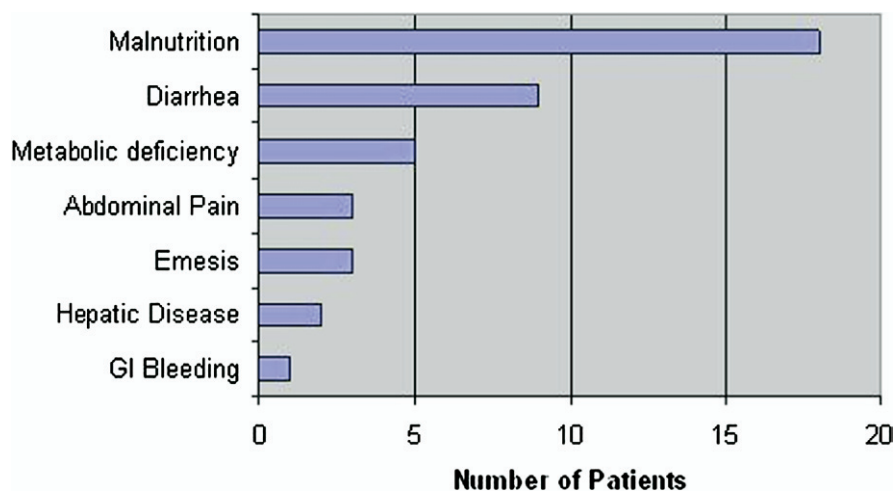


Figure 2. Indications for revision of the biliopancreatic diversion/duodenal switch. Several patients had more than one reason for revision.

tracing the small bowel proximally from the ileocecal valve until the enteroenterostomy was reached. Generally, adhesions were minimal in the infracolic compartment. Both the biliopancreatic limb and alimentary limb were traced to the level of the transverse mesocolon. Reconstruction was accomplished by performing a side to side enteroenterostomy approximately 100 cm proximal to the junction of the alimentary and biliary limbs (the “kissing-x” anastomosis) in 30 patients and by relocating the site of entry of the biliopancreatic limb 50 cm more proximally in the remaining 3 patients. Charts of these patients were reviewed for demographic information, details of the original DS procedure, reasons for revision, perioperative complications, and outcomes. Outcomes measures included postoperative weight and nutritional parameters, which included serum albumin, hemoglobin, calcium, iron, and vitamin D levels. Calcium levels were corrected for serum albumin levels by subtracting the albumin level from 4.0 and multiplying by 0.8. Results are reported as medians. The SPSS software (SPSS Inc) was used for statistical analysis.

## RESULTS

Patients had a median body mass index of 47 at the time DS was performed (range 38 to 78). Fifteen of the patients had a common channel (CC) length of 75 cm (4.9% of all DS patients with 75-cm CC), 11 patients had a CC length of 100 cm (4.5%), 6 patients had a CC length of 50 cm (19.4%), and 1 patient had a CC of 150 cm (4.5%). Patients with 50-cm CC were statistically more likely to be revised than those with 75-cm CC ( $p = 0.002$ ) or with 100-cm CC ( $p = 0.001$ ). Revision was performed a median of 17 months (range 7 to 63 months) after the original DS. Median body mass index at the time of revision was 28 (range 18 to 50)

The most common indication for revision was malnutrition, followed by diarrhea and metabolic abnormalities, including anemia, hyperparathyroidism, and hypoalbuminemia. Several patients had multiple reasons for revision (Fig. 2).

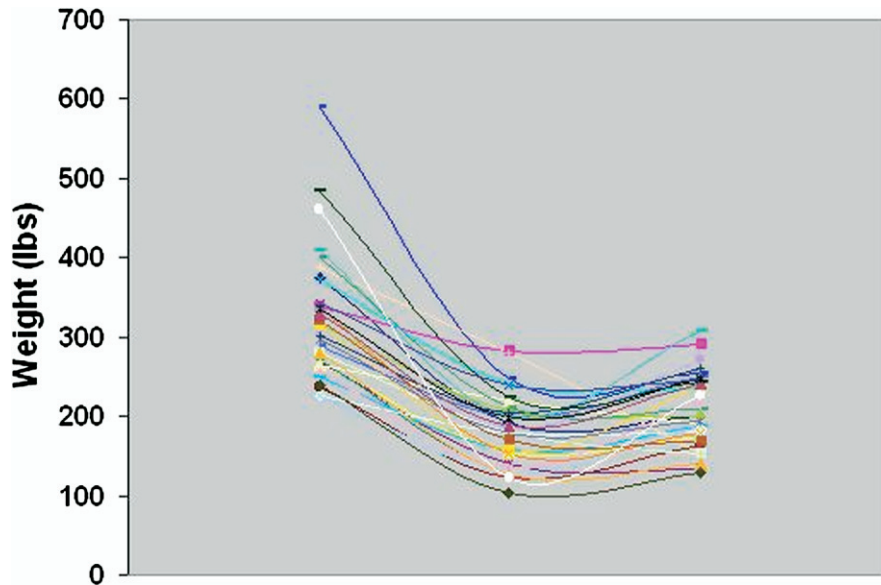
One patient was revised after a nodular liver was noted during an incisional hernia repair. At the time of the original DS, liver function tests were normal; liver biopsy revealed nonalcoholic steatohepatitis and bridging fibrosis consistent with mild cirrhosis. Postoperatively, hepatitis B was diagnosed. In another patient, liver failure developed 1 year after the DS procedure,

**Table 1.** Patient Laboratory Values Prior to Revision of Duodenal Switch Operation

Patient no.	Hemoglobin (g/dL)	Potassium (mEq/L)	Albumin (g/dL)	Corrected calcium (mg/dL)
1	14.5	4.1	4.5	9.1
2	10.4	3.6	1.9	9.4
3	10.3	4.4	4.5	9.7
4	10.7	4.3	3.7	9.6
5	8.8	4.5	4.0	8.5
6	10.8	5.0	3.5	8.8
7	13.6	4.3	4.9	11.0
8	10.7	3.1	3.8	8.9
9	12.9	4.3	3.5	9.7
10	15.1	4.0	4.4	8.9
11	13.7	3.7	3.9	9.2
12	11.9	6.9	3.3	8.4
13	11.1	3.6	4.5	8.5
14	8.2	3.6	3.5	8.1
15	8.9	3.4	3.7	8.2
16	12.7	3.4	4.0	8.9
17	8.3	2.7	3.0	8.5
18	9.4	4.5	3.3	8.7
19	11.1	3.1	2.5	9.1
20	9.9	3.4	3.6	8.6
21	13.0	3.8	3.7	8.6
22	14.0	3.1	3.9	9.3
23	11.6	4.8	3.0	9.6
24	12.7	3.7	2.4	9.1
25	11.0	3.9	4.2	8.4
26	8.6	4.2	2.5	8.6
27	11.5	4.4	3.5	8.9
28	12.5	3.6	3.5	8.8
29	11.4	3.3	2.8	8.8
30	13.6	3.6	3.8	8.7
31	15.1	4.0	3.9	8.9
32	13.7	3.9	2.9	9.1
33	10.8	3.2	3.3	7.6

and a biopsy showed steatohepatitis. This patient also had protein malnutrition, with an albumin of 1.9 g/dL. Another patient became anemic and had gastrointestinal bleeding from an unknown source; he required intraoperative endoscopy, which showed ulcerations in the cecum undetected by colonoscopy. He had a right hemicolectomy and proximal enteroenterostomy performed.

Laboratory values at the time of revision are presented in Table 1. Median serum albumin was 3.6 g/dL, with 11 patients having levels below 3.5 g/dL. Nine patients were hypokalemic, five were hypocalcemic, and seven



**Figure 3.** Subject weight prior to biliopancreatic diversion/duodenal switch, before revision, and at time of latest followup.

patients had hemoglobin values  $< 10.0$  g/dL. Five patients were receiving total parenteral nutrition before revision.

Complications occurred in 5 patients (15%) and included wound infection ( $n = 2$ ), respiratory failure ( $n = 1$ ), gastrointestinal bleed ( $n = 1$ ), and perioperative small bowel obstruction ( $n = 1$ ). One of the patients who had a wound infection progressed to frank dehiscence, and the second had necrotic tissue requiring operative debridement, a skin graft, and subsequent incisional hernia repair. There was no perioperative mortality; the patient who had a small bowel obstruction went on to have respiratory failure develop and had a prolonged ICU stay. Three months after her revision she had another small bowel obstruction and died 2 months later from sepsis. Two more patients without perioperative complications had late small bowel obstructions requiring laparotomy more than 6 months after their revision.

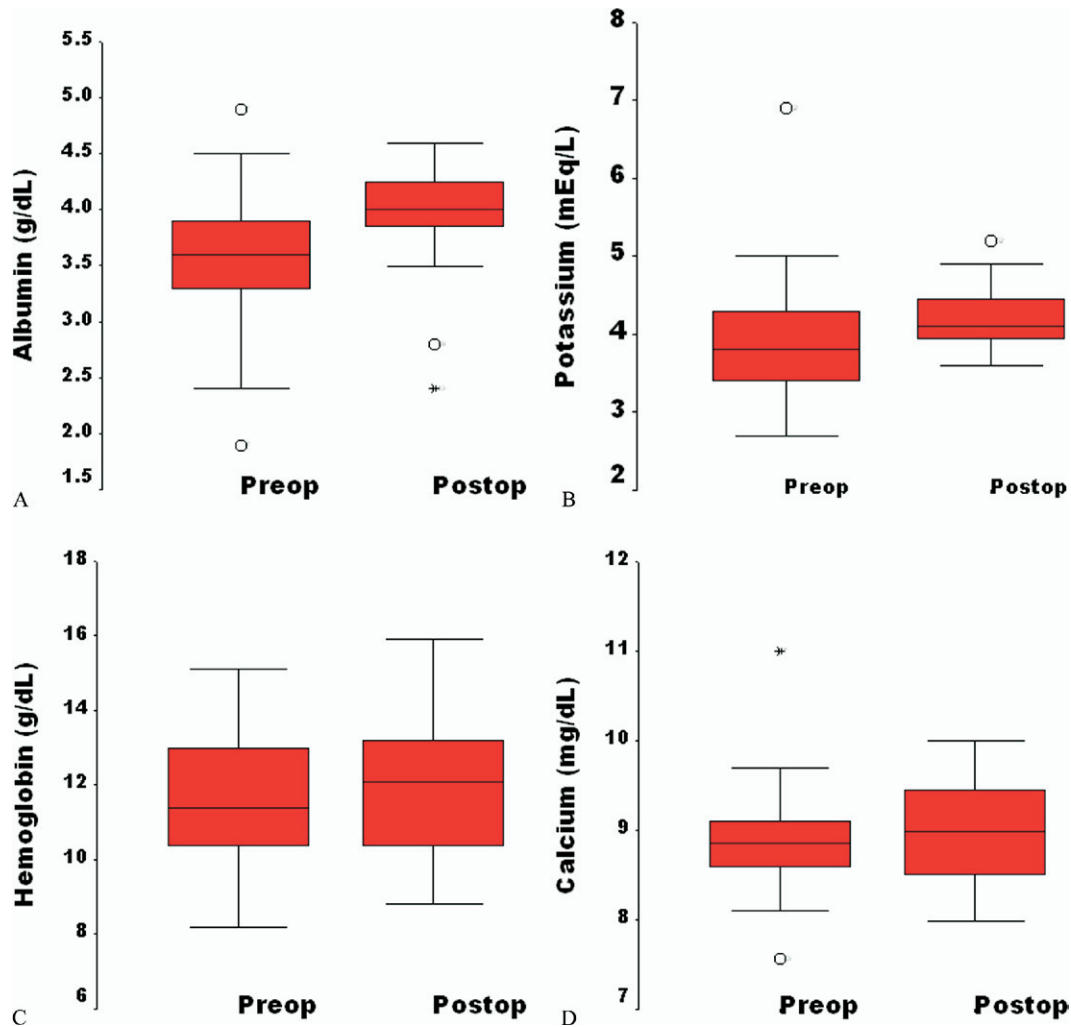
Weight before bariatric operation, prerevision weight, and weight at latest followup are presented in Figure 3. Median followup was 39 months. Median weight loss at the time of revision was 129 lb, and median weight gain after revision was 18 lb. Three patients requested additional operative correction because of excessive weight regain. The enteroenterostomy was divided in two of these patients. The first patient, who had gained 26 lb since revision, initially lost weight, but over a 6-year

period experienced an additional weight gain of 5 lb. The second patient had gained 54 lb since revision and, after the proximal enteroenterostomy was divided, lost 12 lb over a 1-year period.

Median number of daily bowel movements decreased from five to one among patients who underwent revision for diarrhea.

All patients with low prerevision albumin levels had postoperative albumin levels  $> 3.5$  g/dL, with the exception of 1 patient whose albumin increased from 2.5 to 2.8 g/dL. All hypokalemic patients had potassium levels  $> 3.5$  mEq/L at followup. All anemic patients had an increase in hemoglobin to  $> 10$  g/dL, with the exception of 1 patient whose hemoglobin increased from 8.9 to 9.8 g/dL. In contrast, of the 5 patients with hypocalcemia, 2 remained hypocalcemic, 2 had low-normal postoperative calcium levels (8.5 mg/dL), and 1 patient had an increase in calcium from 8.4 to 9.0 mg/dL. Median postrevision albumin, potassium, hemoglobin, and calcium levels were 4.0 g/dL, 4.1 mEq/L, 12.1 g/dL, and 9.0 mg/dL, respectively (Figs. 4A–D).

Of the 33 patients, 11 had been diabetic before the original DS procedure and 10 patients had resolution of diabetes postoperatively. Diabetes redeveloped in 3 of 10 patients after revision. Three patients had resolution of hypertension after having the DS; none experienced recurrence after revision.



**Figure 4.** Median levels of (A) serum albumin, (B) potassium, (C) hemoglobin, and (D) calcium prior to revision of biliopancreatic diversion/duodenal switch and at time of latest followup. Shaded area represents interquartile range.

## DISCUSSION

Although the DS operation is generally very effective in producing weight loss, some patients will become malnourished or have other complications necessitating revision. We have found this to be necessary in about 5% of patients in our series. Although percentage of followup is poor after 2 years, the DS is a fairly specialized operation that is not performed at many other centers in our area. It is to be hoped that patients who were having difficulties postoperatively would return to us for care. It is possible that revisions were performed in some patients at other institutions.

Revision of the DS can be done by a technically simple procedure confined to the infracolic compartment and involves a side to side enteroenterostomy and no gastric dis-

section. This allows food and pancreaticobiliary secretions to mix over a longer length of intestine, reducing the degree of malabsorption created by the DS.

The percentage of complications is rather high, considering the simplicity of the operation. We believe that this is most likely because of the severity of the malnutrition and can be underappreciated by the surgeon. Almost a third of the patients had low serum albumin, a feature known to correlate with increased rate of perioperative complications and poor wound healing.<sup>10</sup> Others have also found a higher rate of morbidity among these patients, compared with those who have revisions after purely restrictive procedures.<sup>11,12</sup>

Revision is effective in improving malnutrition and diarrhea. Most nutritional abnormalities are also cor-

rected after a proximal enteroenterostomy is performed. Interestingly, serum calcium level seems to be an exception. This might be because calcium is preferentially absorbed in the duodenum and, even after revision, food continues to bypass this portion of the intestine.

Many patients are reluctant to agree to revision of the DS because they fear weight regain, even in the face of severe malnutrition. Although, on average, patients do gain some weight, they continue to have an element of restriction as a consequence of the sleeve gastrectomy. In most patients, weight gain is minor. Patients can be reassured that revision is unlikely to cause them to regain all the weight that they have lost after having the DS.

In conclusion, revision of the DS operation can be performed easily in patients requiring it; but these patients are at high risk of complications and should be monitored vigilantly. In most patients, revision will correct nutritional deficiencies at low risk of substantial weight gain.

### Author Contributions

Study conception and design: Anthonie, Crookes

Acquisition of data: Hamoui, Chock

Analysis and interpretation of data: Hamoui, Chock, Crookes

Drafting of manuscript: Hamoui, Crookes

Critical revision: Hamoui, Crookes

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