

# Metabolic effects of bypass surgery for morbid obesity

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## ABSTRACT

Morbid obesity is associated with a high risk for cardiovascular complications, the high incidence of diabetes type II, arterial hypertension, dyslipidemias of the mixed type, osteoarthritis, and increased mortality (approx. 2.8 million death/year due to obesity related cardiovascular diseases). The global problems associated with the pandemic morbid obesity dimensions are the metabolic syndrome and increased incidence with obesity related cancers. Studies confirm the positive long-term effects of surgical interventions for obesity correlated to weight loss, and thus highly important clinical improvement obesity-related associated diseases. Effects of bariatric and metabolic surgical interventions have a favorable effect on components of metabolic syndrome (hyperglycemia, hyperlipidemia, arterial hypertension); OSA is an independent risk factor for cardiovascular complications, non-alcoholic steatohepatitis associated with morbid obesity, reproductive health in both sexes, locomotor skills, psychosomatic health and social life of the patients. Resolution of morbid metabolic components is related to the type of surgical intervention. All over effects are in direct correlation of the impact of surgical techniques, diet, and ad-

justments to life style. Surgical techniques associated to perioperative surgical and non-surgical complications and long-term metabolic complications. Appropriate preoperative individual patient preparation and continuous postoperative short and longterm follow up significantly reduce surgical and metabolic complications, both short and long term. A range of different bariatric procedures are in common use and the mechanisms underlying the efficacy of metabolic surgery are based to interfere with the important role of gastrointestinal and pancreatic peptides, including ghrelin, gastrin, cholecystokinin (CCK), glucose-dependent insulinotropic hormone (GIP), glucagon-like peptide 1 (GLP-1), peptide YY (PYY), oxyntomodulin, insulin, glucagon and somatostatin.

## METHODS

Bariatric and metabolic surgical technique are a) restrictive, b) combination of restriction and malabsorption and c) primary malabsorptive procedures (biliopancreatic diversion, Duodenal switch, Sadi's operation represents single anastomosis duodenal switch, ileal interposition and derived techniques). Primary malabsorptive procedures are mostly two step surgical interventions; stage one is gastric po-

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uch formation that allows moderate EWL% to reduce risk factors and stabilize pathologic metabolic situation and stage two, in the time period of 3–6 months after primary stage, representing malabsorptive part of the procedure. Primary malabsorptive procedures are reserved for patients suffering of metabolic syndrome resistant to treatment modalities. Baseline intervention of combined restriction and malabsorption and primary malabsorptive procedure is small pouch formation from native stomach and malabsorptive part responsible for malabsorptive component of the procedure. The first step of the malabsorptive part of the intervention is small intestinal length measurement and common trunk definition to prevent life threatening metabolic complications. Common trunk lower than 2 m trigger life threatening malabsorptive situation. Schematic situation is presented in Figure 1.

Malabsorptive part of the procedure is correlated to different surgical and functional anatomical situation responsible to reduced nutrient resorption, importantly vitamins, minerals and trace elements; major nutritional complications are typically associated with the malabsorptive effect of bariatric procedures and are usually seen after BPD, RYGB, OAGB and, less commonly in restrictive procedures. Effects of metabolic surgeries to gut peptides are summarised in Table 1.

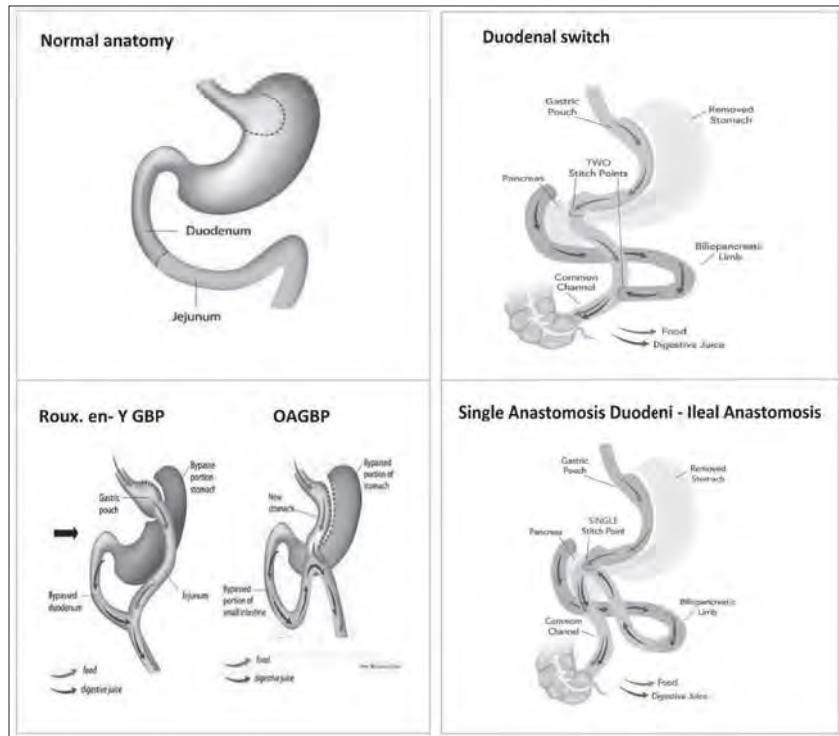


Figure 1. Restrictive and malabsorptive procedures commonly performed and altered anatomy.

Hormone	Obesity (without surgery)	Roux-en-Y gastric bypass
Gastrin (7, 10–12)		↓ postprandial
Ghrelin (total) (6, 7, 14, 16–19, 22, 100, 101)	↔ or ↓ fasting	↓ fasting
	↔ or ↓ postprandial	↓ postprandial
Cholecystokinin (CCK) (6, 19, 26, 101)	↔ fasting	↔ fasting
	↔ or ↓ postprandial	↑ postprandial
Gastric inhibitory peptide (GIP) (10, 31, 38, 84)	↔	↔ or ↓ fasting
Glucagon-like peptide -1 (GLP-1) (6, 19, 22, 40)	↔ or ↓	↔ or ↓ postprandial
Glucagon-like peptide -2 (GLP-2) (67, 69)		↔ or slight ↑ fasting
Peptide YY (PYY) (6, 73, 74, 76, 77)	↓	↑ postprandial
Oxyntomodulin (78)		↔ fasting
		↑ postprandial
Insulin (86, 102)	↔, ↑ or ↓ depending on diabetes status	↓ fasting
		↔ or ↓ postprandial
Glucagon (85, 95, 96)	↔ or ↑	↑ or ↓ fasting
		↔ or ↓ postprandial
Somatostatin (6)		↑ fasting
		↑ postprandial

Table 1. Effects of metabolic surgeries to gut peptides.

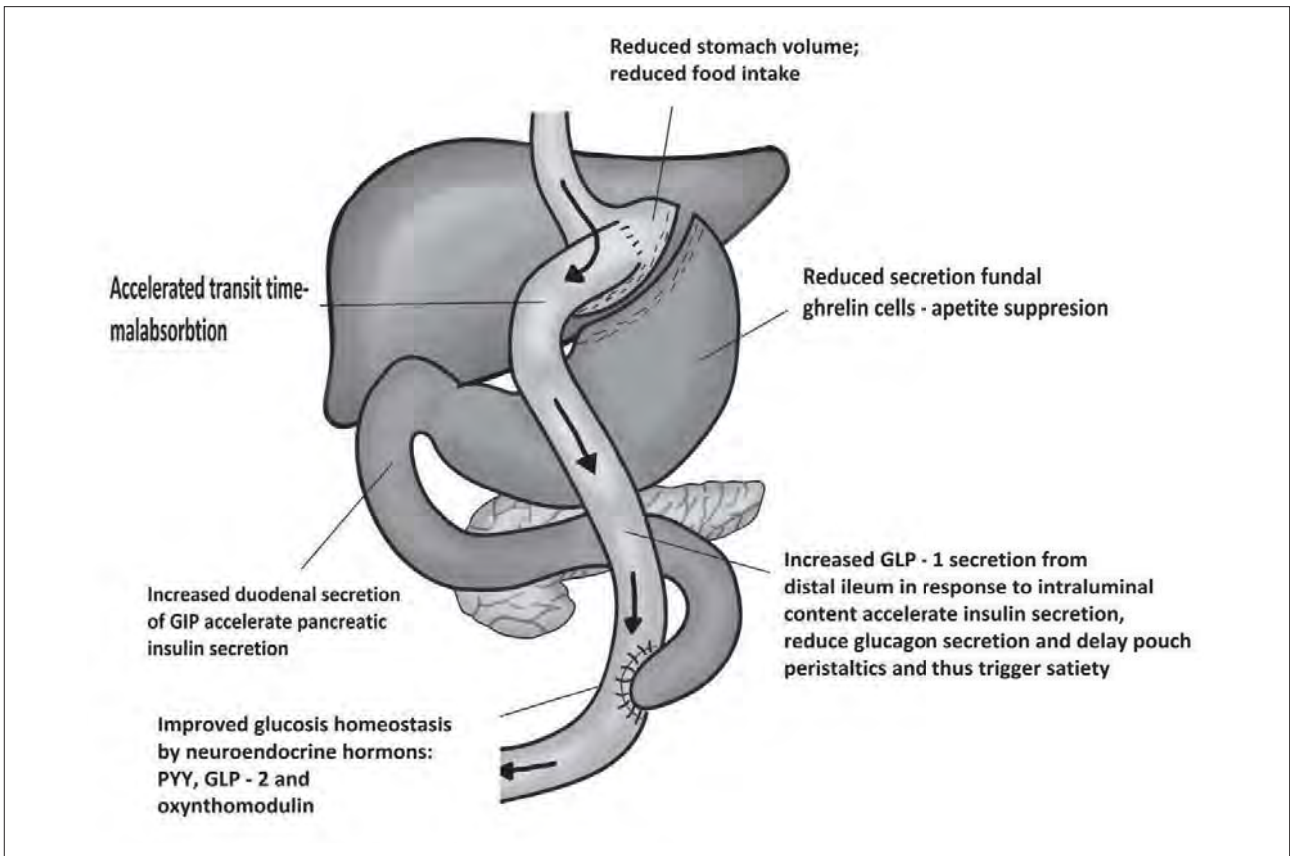


Figure 2. Effects of malabsorptive surgery to improved metabolic parameters, physiologic effects.

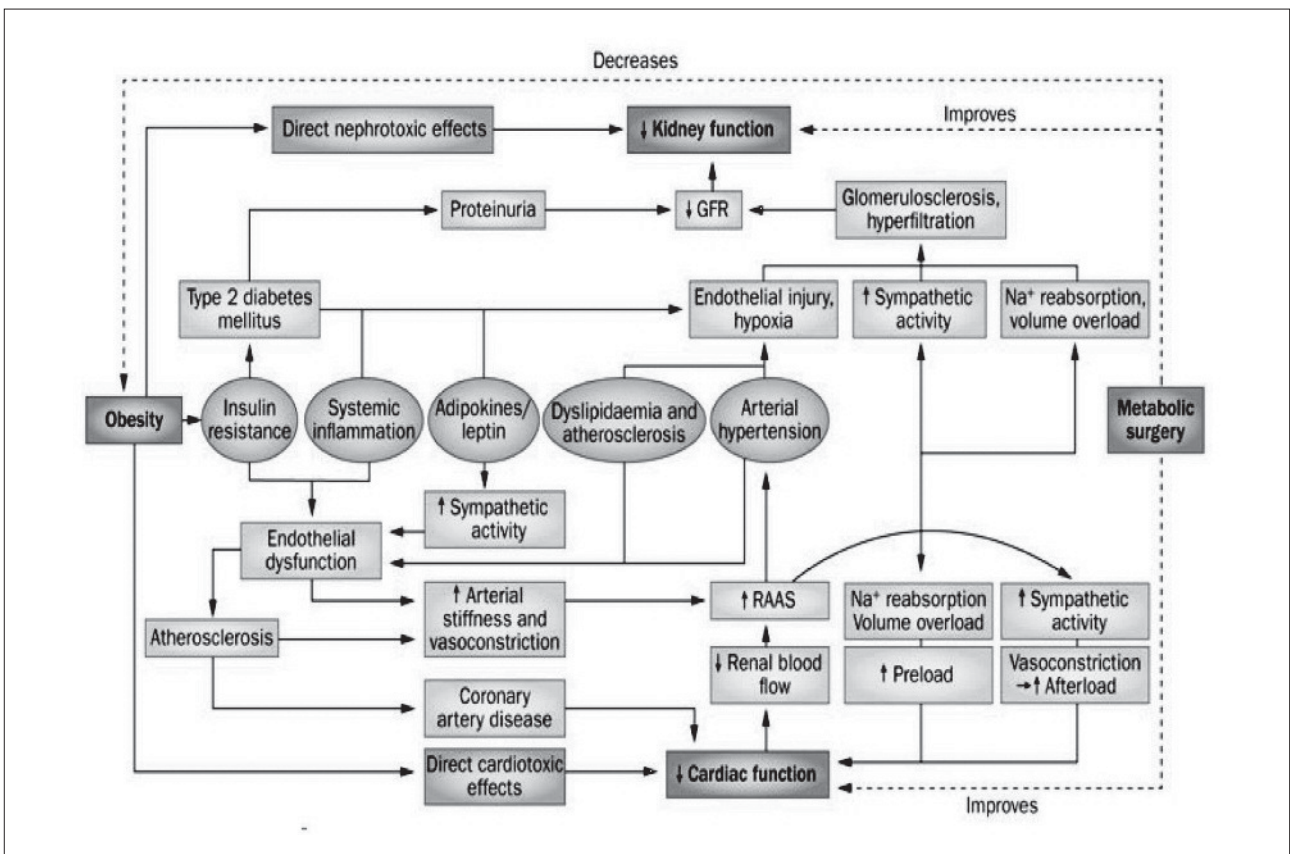


Figure 3. Overall risk reduction and physiological mechanisms triggered with metabolic surgery procedures.

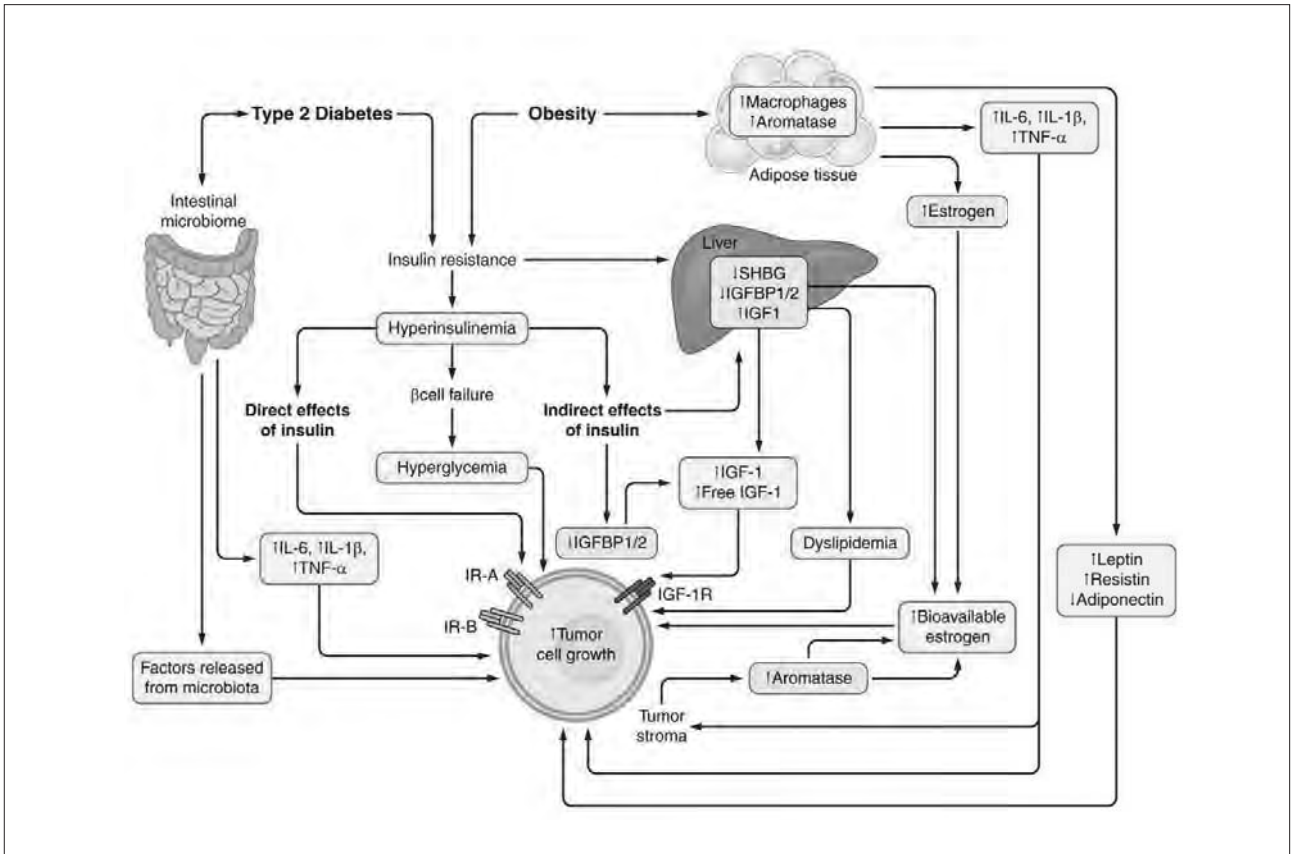


Figure 4. Glucose homeostasis and obesity; risk factors and inflammation.

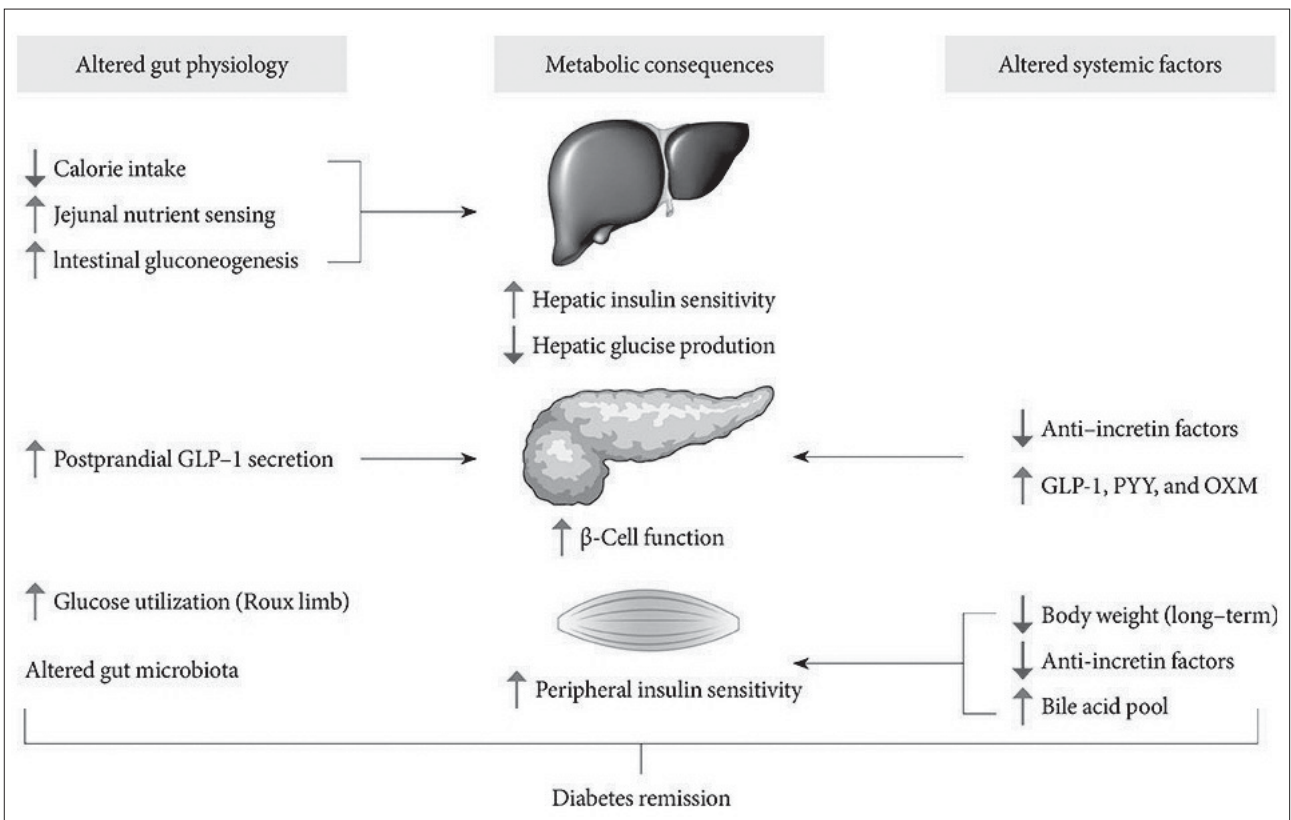


Figure 5. Potential mechanisms involved in diabetes remission after metabolic surgery. Altered gut physiology, systemic and circulating factors improve glucosis homeostasis.

Metabolic complications are mostly related to malabsorptive part of the procedure. The detailed schema to supplementation is needed to all bariatric surgery procedures.

Complication	Clinical Features	Management
Acid-base disorder	Metabolic acidosis, ketosis	Bicarbonate orally or intravenously; adjust acetate content in PN
	Metabolic alkalosis	Salt and volume loading (enteral or parenteral)
Bacterial overgrowth (primarily with BPD-DS)	Abdominal distention	Antibiotics (metronidazole) Probiotics
	Pseudo-obstruction	
	Nocturnal diarrhea	
	Proctitis	
Fat-soluble vitamin deficiency	Acute arthralgia	Vitamin A, 5,000-10,000 U/d Vitamin D, 400-50,000 U/d Vitamin E, 400 U/d Vitamin K, 1 mg/d ADEK, 2 tablets twice a day ( <a href="http://www.scandipharm.com">http://www.scandipharm.com</a> )
	Vitamin A—night vision	
	Vitamin D—osteomalacia	
	Vitamin E—rash, neurologic	
	Vitamin K—coagulopathy	
Folic acid deficiency	Hyperhomocysteinemia	Folic acid supplementation
	Anemia	
	Fetal neural tube defects	
Complication	Clinical Features	Management
Iron deficiency	Anemia	Ferrous fumarate, sulfate, or gluconate Up to 150-300 mg elemental iron daily Add vitamin C and folic acid
Osteoporosis	Fractures	DXA, calcium, vitamin D, and consider bisphosphonates
Oxalosis	Kidney stones	Low oxalate diet Potassium citrate Probiotics
Secondary hyperparathyroidism	Vitamin D deficiency	DXA Serum intact PTH level 25-Hydroxyvitamin D levels Calcium and vitamin D supplements
	Negative calcium balance	
	Osteoporosis	
Thiamine deficiency (vitamin B <sub>1</sub> )	Wernicke-Korsakoff encephalopathy Peripheral neuropathy Beriberi	Thiamine intravenously followed by large-dose thiamine orally
Vitamin B <sub>12</sub> deficiency	Anemia Neuropathy	Parenteral vitamin B <sub>12</sub> Methylmalonic acid

DXA = dual-energy x-ray absorptiometry; PN = parenteral nutrition; PTH = parathyroid hormone.  
Mechanick JL, et al. *Endocr Pract*. 2008;14(suppl 1):1-83.

Figure 6. Metabolic complications after bariatric and metabolic surgery procedures.

## CONCLUSIONS

1. The most effective and durable treatment for morbid obesity is obtained with bariatric and metabolic surgery procedures.
2. Surgery results in significant weight loss and helps prevent, improve or resolve more than 40 obesity-related diseases or conditions including type 2 diabetes, heart disease, obstructive sleep apnea and certain cancers.
3. Individuals with morbid obesity or BMI  $\geq 30$  kg/m<sup>2</sup> have a 50–100% increased risk of premature death compared to individuals of healthy weight.
4. Surgery reduces a person's risk of premature death by 30–40%.
5. Clinical studies have demonstrated significant improvements in safety, showing that the risk of death is 0.1%, and the overall likelihood of major complications is about 4%. Center of excellence program offers better results, short and long term.
6. Postoperative metabolic screening is mandatory to prevent life threatening complications and morbidity related.
7. Metabolic screening is based to the type of metabolic/bariatric surgery type.
8. Long term postoperative controls significantly reduce weight recidivism and morbidity and importantly lifestyle intervention is needed for the purpose to support all type of surgery interventions.