EDITORIAL

Metabolic surgery

Obesity, a chronic illness identified in children, adolescents, and adults, has reached epidemic proportions worldwide.[1-3] Bariatric surgery is increasingly performed worldwide and remains the most effective method of weight loss and can result in partial or complete resolution of multiple obesity-related comorbidities, including type 2 diabetes mellitus, hypertension, hypercholesterolemia, and obstructive sleep apnea.[4]

Bariatric procedures offered to obese patients with a body mass index (BMI) of greater than 40 kg/m^2 or a BMI of 35 kg/m^2 with an obesity related comorbidity (e.g, diabetes, hypertension).

Mechanism of weight loss, bariatric surgical procedures affect weight loss through two fundamental mechanisms: (1) malabsorption and (2) restriction. Some procedures have both a restrictive and malabsorptive component. It has been observed that bariatric surgical procedures contribute to neurohormonal effects on the regulation of energy balance.[5-7]

Ghrelin is a peptide hormone secreted in the foregut (stomach and duodenum) that stimulates the early phase of meal consumption. The normal pulsatile release of this orexigenic (appetite-producing) hormone appears to be inhibited in gastric bypass patients due to its unique foregut bypass configuration.[6] Such inhibition of ghrelin has also been observed in sleeve gastrectomy.[7] The reduced ghrelin levels is the reason of characteristic loss of appetite seen in in post RYGB patients.[8-10]

Malabsorptive procedures decrease the effectiveness of nutrient absorption by shortening the length of the functional small intestine, either through bypass of the small bowel absorptive surface area or diversion of the biliopancreatic secretions that facilitate absorption. Jejunoileal bypass (JIB) and the biliopancreatic diversion (BPD) are examples of malabsorptive procedures. Profound weight loss can be achieved by a malabsorptive operation, depending upon the effective length of the functional small bowel segment.

Restrictive procedures limit caloric intake by reducing the stomach's reservoir capacity via resection, bypass or creation of a proximal gastric outlet. Vertical banded gastroplasty (VBG) and laparoscopic adjustable gastric banding (LAGB) are purely restrictive procedures.

Combination of restriction and malabsorption , the Roux-en-Y gastric bypass (RYGB), the biliopancreatic diversion (BPD) and BPD with duodenal switch (BPD/DS) are both restrictive and malabsorptive.

Roux-en-y gastric bypass (RYGB) remains the most commonly performed bariatric procedure; however, global trends show an overall decline from approximately 65 percent in 2003 to 47 percent in 2011 of all bariatric procedures performed.[2,9]

In RYGB a small (less than 30 mL) proximal gastric pouch is divided and separated from the distal stomach and anastomosed to a Roux limb of small bowel 75 to 150 cm in length.[9-10] The small gastric pouch and the narrow anastomotic outlet serve to restrict caloric intake, while the major digestion and absorption of nutrients occurs in the common channel where gastric acid, pepsin, intrinsic factor, pancreatic enzymes, and bile mix with ingested food.

The small intestine is divided at a distance of 30 to 50 cm distal to the Ligament of Treitz. By dividing the bowel, the surgeon creates a proximal biliopancreatic limb that transports the secretions from the gastric remnant, liver, and pancreas. The Roux limb (or alimentary limb) is anastomosed to the new gastric pouch, and functions to drain consumed food. The cut ends of the biliopancreatic limb and the Roux limb are then connected 75 to 150 cm distally from the gastrojejunostomy. Major digestion and absorption of nutrients then occurs in the resultant common channel where pancreatic enzymes and bile mix with ingested food. The expected excess weight loss after two years is approximately 70 percent.[11,13]

Sleeve gastrectomy (SG) is a partial gastrectomy, in which the majority of the greater curvature of the stomach is removed and a tubular stomach is created. It is the second most commonly performed bariatric procedure worldwide, approximately 28 percent of all procedures.[14]

Sleeve gastrectomy is technically easier to perform than the RYGB, as it does not require multiple anastomoses. It is also safer, as it re duces the risks of internal herniation and protein and mineral malabsorption.[15-16] Stomach at greater curvature is divided approximately 2 to 6 cm away from the pylorus and a sleeve is created around a 32 to 40 French bougie. The tubular stomach is small in its capacity (restriction), resistant to stretching due to the absence of the fundus, and has few ghrelin-producing cells. Weight loss after SG at two years, the expected excess weight loss is approximately 60 percent.[17]

Biliopancreatic diversion with duodenal switch , the biliopancreatic diversion (BPD) with duodenal switch(DS) is a variant of the biliopancreatic diversion(BPD). This procedure is performed only at few centers.

The original BPD procedure involves dividing the duodenum from the pylorus, removing the pylorus, and dividing the ileum. The distal ileum is then anastomosed to the stomach and the proximal ileum, with the output from the liver, pancreas, and duodenum (or biliopancreatic limb) is anastomosed to the terminal ileum some 50 to 100 cm away from the ileocecal valve. The BPD with a DS procedure involves creating a sleeve gastrectomy with preservation of the pylorus, and creation of a Roux limb with a short common channel. The BPD/DS procedure differs from the BPD in the portion of the stomach that is removed, as well as preservation of the pylorus. It is associated with a lower incidence of stomal ulceration and diarrhea than with BPD alone. Although complex, BPD/DS can be performed laparoscopically by experienced surgeons.[18-22] Weight loss after BPD/DS at two years, the expected excess weight loss is approximately 70 to 80 percent.[22]

Laparoscopic adjustable gastric banding (LAGB) Adjustable gastric banding (AGB) is a purely restrictive procedure that compartmentalizes the upper stomach by placing a tight, adjustable prosthetic band around the entrance to the stomach. AGB is performed less often, declining from 24 percent of all bariatric procedures in 2003 to 18 percent in 2011.[2] The decline may be due to its high rate of revision and increasing success of the sleeve gastrectomy.[23]

The gastric band consists of a soft, locking silicone ring connected to an infusion port placed in the subcutaneous tissue. The port may be accessed with relative ease by a syringe and needle. Injection of saline into the port leads to reduction in the band diameter, resulting in an increased degree of restriction. The band is adjustable and is placed laparoscopically.[24-25] The goal of band adjustments is to give the patient a restriction of about a cup of food, and satiety for at least 1.5 to 2 hrs after a meal.

Weight loss LAGB results in an approximate 50 to 60 percent excess weight loss at two years.[26] Many patients have been able to sustain durable weight loss and comorbidity resolution with proper use and maintenance of the band.

Procedures under evaluation, Intragastric Balloon**:** The intragastric balloon (IGB) consists of a soft, saline-filled balloon that promotes a feel-

ing of satiety and restriction.[27] An IGB has been advocated for use as a bridge to a more definitive surgical procedure.[28] At least one IGB device (Reshape Integrated Dual Balloon System) has been approved by the FDA to treat obesity in adults with a body mass index of 30 to 40 kg/m^2, with one or more comorbid conditions such as diabetes, hypertension, or hypercholesterolemia.[29]

An IGB is inserted endoscopically and filled with 400 to 700 ml of saline, generally for a maximum of six months, beyond which time the leak rate increases significantly. A deflated balloon can migrate into the small intestine and cause bowel obstruction. Removal requires a second endoscopic procedure.[28-29]

Weight loss mechanism after IGB, is purely a restrictive procedure. Weight loss is dependent on adherence to lifestyle changes and patient compliance.[29]

The vagal nerve controls gastric emptying and signals the satiety center in the brain. A surgically implanted device that sends intermittent electrical pulses to the vagal nerve has been approved by the US Food and Drug Administration (FDA) as a possible treatment for obesity.[30] The Maestro Rechargeable System has been approved to treat adult patients who have a body mass index (BMI) of 35 to 45 kg/m^2.

Vagal blockade system consists of an electric pulse generator and two wire leads. The wire leads are implanted into the abdomen laparoscopically, one on the anterior vagal trunk and the other on the posterior vagal trunk. A battery-operated rechargeable pulse generator is implanted subcutaneously and connected to the wire leads. The device is typically activated for 12 to 15 hours daily, which requires the battery to be recharged daily for 30 minutes.

Weight loss mechanism vagal blockade electrically stimulate vagal nerve conduction between the brain and the stomach, thereby reducing hunger.[30] However, the specific mechanism for weight loss is not known.

The mini-gastric bypass (MGB), a modification of the loop gastric bypass and technically easier to perform than a Roux-en-Y gastric bypass (RYGB), is performed laparoscopically. MGB is a simple and safe procedure, can be easily revised, converted, or reversed, and has increasing worldwide acceptance.[31-32]

The MGB includes the division of the stomach between the antrum and body on the lesser curvature. The stomach is further divided in the cephalad direction to the angle of His. This subsequent pouch is anastomosed to the jejunum approximately 200 cm distal to the ligament of Treitz.[33]

Endoluminal vertical gastroplasty (EVG) is an endoscopic approach for suturing the stomach that offers the potential to perform gastric-restrictive procedures endoluminally.

The anterior and posterior walls of the stomach are suctioned together then held in place by either a stapler or T-fastener device to create a tube of stomach similar to the SG. Additional fasteners or staples can be applied until the desired lumen size is achieved.[34] The mechanism for weight loss appears to be purely restrictive. Expected excess weight loss EVG At one year, the expected excess weight loss ranges from 27 to 58 percent.[35]

Endoscopic Gastrointestinal Bypass Devices (EGIBD) is a barrier device is deployed to prevent luminal contents from being absorbed in the proximal small intestine. The EndoBarrier is 60 cm long and it extends from the proximal duodenum to the midjejunum and thus mimics a duodenojejunal bypass. It is a safe procedure but is hallmarked by an up to 20 percent rate of early removal due to patient intolerance.[36]

The ValenTx is a 120 cm barrier device that extends from the gastroesophageal junction to the jejunum. This too has a significant rate of early removal, but excess weight loss at three months was reported to be 40 percent, and significant improvement in control of Diabetes was seen in seven out of seven diabetic patients within those

three months.[36-37]

Expected outcomes of EGIBD, data are still lacking about the longevity of these endobarriers and their outcomes once the barrier is removed.

Dr Masood Raza Khan
Consultant General & Laparoscopic Surgeon,
King Fahad Hospital, Madina Munawwara,
Saudi Arab.
Email:surgeonmasood@yahoo.com

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