Obesity

Objectives:

By the end of this topic the student will:

1) Understand the definition and classification of various forms of obesity
2) Understand the basic etiology of obesity
3) Understand the various pathologic consequences of obesity
4) Understand the diagnostic evaluation for obesity
5) Know the various treatment options for obesity
6) Surgical option in obesity
7) Know principle of interventional radiology

Introduction and Definitions

Obesity is the most common nutritional disorder worldwide.

Body mass index (BMI) continues to be the recommended approach to categorize weight relative to height for adults. BMI is calculated as weight (in kilograms) divided by height squared (in meters):

$$\text{BMI} = \frac{\text{Weight (kgms)}}{\text{Height (m)}^2}$$

CLASSIFICATION OF OVERWEIGHT AND OBESITY BY BODY MASS INDEX (BMI)

	Obesity class	BMI (kg/m^2)
Underweight		< 18.5
Normal		18.5-24.9
Overweight		25-29.9
Obesity	I	30-34.9
Obesity	II	35-39.9
Extreme obesity	III	≥ 40

Although, in general, the risk for development of adiposity-related health problems increases continuously as the BMI exceeds 25, it is now recommended to use waist circumference measurements to discriminate among patients who may require more testing.

Overweight and class I obese patients with a waist circumference in the high-risk category deserve a discussion of lifestyle issues as they relate to health and weight loss.

The prevalence of comorbidities and risk of future morbidities increase considerably at a BMI of more than 30, the cut point for obesity.

Class III obesity (BMI > 40) is one feature that would prompt consideration of a patient for bariatric surgery when medical treatments have failed. Patients with class II obesity (BMI of 35.0

to 39.9) may be considered for bariatric surgery if medical treatments have failed and if severe, life-threatening complications are present.

Waist circumference measures are recommended as an office assessment tool to help with the treatment decision-making process. The guidelines agree that the waist circumference cut points of more than 102 cm (40 inches) for men and more than 88 cm (35 inches) for women are indicators of increased metabolic risk.

The recommendation is to measure waist circumference in overweight and class I obesity adults.

Adults with class II or class III obesity are at sufficiently high risk that waist circumference information does not add valuable information.

Epidemiology

There are substantial differences in the prevalence of obesity by age, race, and socioeconomic status. The prevalence of obesity in adults tends to rise steadily from the ages of 20 to 60 years, decreasing in later years. It has been estimated that almost 75% of men aged 60 to 69 years in the United States have a BMI of more than 25.

Because young adults will accumulate greater exposure to metabolic and mechanical damage from being overweight or obese throughout their lives, they are at increased risk for chronic health conditions such as coronary heart disease and type 2 diabetes mellitus.4 By comparison, the increase in mean BMI with age, though deleterious, is not as much of a threat to population health as is a similar increase in the BMI of younger populations.

Etiology

Genetic and constitutional susceptibility to obesity is heavily influenced by the environment.

Genetic Aspects of Human Obesity

Although obesity susceptibility is a classic polygenic condition, there are also a number of syndromic and monogenic obesity syndromes.

Genome-wide association studies have revealed a number of genes associated with higher BMI. Those that appear to predict the greatest amount of variance in BMI include the fat mass and obesity-associated (*FTO*) gene and the melanocortin-4 receptor (*MC4R*) gene. Other genes that have been associated with obesity include *TMEM18, KCTD15, GNPDA2, SH2B1, MTCH2,* and *NEGR1*.

Together, however, the combined effects of all the identified genetic contributions account for less than 1% of the variance in BMI. This emphasizes both the huge environmental effects and the polygenic nature of susceptibility to obesity.

Constitutional Influences on Obesity

ENVIRONMENTAL FACTORS PROMOTING OBESITY

Dietary	Activity
↑ Energy density of food	↑ Sedentary behavior
↑ Portion size	↓ Activities of daily living
↑ Variety of sweets and snacks	↓ Employment related physical activity
↑ Palatability	
↑ Availability	
↓ Cost	
↑ Caloric beverages (sugar-sweetened beverages)	

Regulation of Body Weight and Energy Balance

The regulation of adult body weight is a well-balanced process. The typical adult will take in and expend approximately 2000 to 3000 kcal/day.

There appears to be regulation of both energy intake and energy expenditure through conscious and unconscious processes.

The excess energy consumed by adults is generally stored as triglycerides in adipocytes.

Humans continuously recruit new adipocytes from a large preadipocyte pool to replace dying adipocytes.

Although the primary means by which abdominal adipose tissue mass expands is through increased fat cell size (adipocyte hypertrophy), this process can store only a limited amount of fat. Adults who gain leg fat accumulate more rather than larger adipocytes on average, resulting in a net increase in adipocyte number as more new adipocytes are created than needed to replace dying cells.

Some adults appear to recruit new adipocytes more readily than others do and if they gain body fat will do so more from adipocyte hyperplasia (increased fat cell number) than from hypertrophy. Those who gain fat with large adipocytes are more likely to be insulin resistant.

Leptin is a hormone that is secreted by adipocytes. As such, leptin is one of the most important of the so-called adipokines. Low leptin, such as is seen with leptin deficiency or extreme loss of body fat, results in extreme hunger, which can be reduced by administering leptin.

Energy Intake

Energy intake depends upon hunger, the compelling need or desire for food; satiation, the state of being satisfactorily full and unable to take on more; or satiety, the sense of no longer being

hungry, a complex set of postprandial events that affect the interval to the next meal or the amount consumed at the next meal.

Some of the signals alter just one aspect of eating behavior and others affect multiple aspects. For example, ghrelin, a peptide produced by the stomach, increases hunger but does not appear to affect satiation or satiety. Cholecystokinin causes satiation but has no effect on satiety. Leptin appears to act on multiple pathways; leptin deficiency is associated with increased hunger and reduced satiation and satiety.

BIOLOGIC MODULATORS OF FOOD INTAKE

PERIPHERAL SIGNAL	PROPOSED EFFECT ON FOOD INTAKE
Vagal signal	-
Cholecystokinin	-
Insulin	-
Amylin	-
Glucagon-like peptide 1	-
Leptin	+ when leptin ↓↓
Ghrelin	+

CENTRAL NERVOUS SYSTEM MODULATORS OF ENERGY BALANCE

CENTRAL ANABOLIC (↑ INTAKE)	CENTRAL CATABOLIC (↓ INTAKE)
Neuropeptide Y	α-Melanocyte-stimulating hormone
Melanin-concentrating hormone	Corticotropin-releasing hormone
Hypocretins and orexins	Thyrotropin-releasing hormone
Galanin	Interleukin-1β
Norepinephrine	Oxytocin
Endogenous endocannabinoids	Serotonin

Energy Expenditure

There is a wide range of daily energy expenditure in adults, from less than 1400 kcal/day to more than 5000 kcal/day, with larger, more physically active individuals having the greatest energy needs. Typically, daily energy expenditure is divided into resting (or basal) metabolic rate, the thermic effect of food, and physical activity energy expenditure.

Secondary Causes of Obesity

Medications

DRUGS THAT MAY PROMOTE WEIGHT GAIN	
1) PSYCHIATRIC AND NEUROLOGIC MEDICATIONS • Antipsychotics • Antidepressants	2) STEROID HORMONES 3) ANTIDIABETIC DRUGS: • Insulin • Sulfonylureas

• Monoamine oxidase inhibitors • Antiepileptic drugs: • Mood stabilizers	• Thiazolidinediones

Diseases

Endocrinopathies are the most common secondary cause of obesity. These include Cushing syndrome, insulinoma , and hypothyroidism.

Pathophysiology

❖ Metabolic Complications of Obesity

1) Insulin Resistance

The term *insulin resistance* is typically used in referring to the ability of insulin to promote glucose uptake and to inhibit the release of glucose into the circulation. The primary site of insulin-stimulated glucose uptake, oxidation, and storage is skeletal muscle. The principal site of glucose production is the liver. Insulin resistance initially leads to hyperinsulinemia and may eventually lead to the development of type 2 diabetes mellitus if β-cell exhaustion occurs

The ability of insulin to promote glucose uptake, oxidation, and storage in muscle and to suppress plasma FFA concentrations is reduced in upper body obesity. High plasma FFA concentrations can induce a state of insulin resistance both in the muscle (glucose uptake) and in the liver (glucose release), independent of obesity.

2) Islet Cell Failure and Type 2 Diabetes Mellitus

Many obese individuals are insulin resistant, yet only a subset will develop diabetes mellitus. It follows that those who develop type 2 diabetes develop pancreatic β-cell decompensation with subsequent hyperglycemia.

3) Hypertension

Blood pressure can be increased by a number of mechanisms (Chapter 70). Increased circulating blood volume, abnormal vasoconstriction, decreased vascular relaxation, and increased cardiac output may all contribute to hypertension in obesity. The effect of hyperinsulinemia to increase renal sodium absorption may contribute to hypertension through increased circulating blood volume.

4) Dyslipidemia

Upper body obesity and type 2 diabetes mellitus are associated with increased triglycerides, decreased high-density lipoprotein (HDL) cholesterol, and a high proportion of small, low-density lipoprotein (LDL) particles

This dyslipidemia contributes to the increased cardiovascular risk observed in the metabolic syndrome.

❖ Endocrine Manifestations of Obesity

Obesity is associated with abnormalities of the endocrine system, one of the most common being polycystic ovary syndrome.

This syndrome is characterized by mild hirsutism and irregular menses or amenorrhea with anovulatory cycles. It is most commonly linked with obesity and often improves with weight loss and other treatments that improve insulin resistance.

obese men may suffer from mild to severe hypothalamic hypogonadism. This androgen deficiency improves with weight loss, and attempts to treat this condition with testosterone replacement offer little clinical benefit

Serum growth hormone concentrations are often low in obese adults, but insulin-like growth factor-I concentrations are often normal, and growth hormone concentrations increase with weight loss

- Mechanical and other Complications of Obesity

1) Osteoarthritis

The excess body weight associated with obesity is thought to be responsible for the increased prevalence of lower extremity degenerative joint disease

Extreme obesity can result in premature degenerative joint disease, and this may be especially difficult to treat surgically,

2) Obstructive Sleep Apnea and Sleep Restriction

Sleep apnea is most likely explained by enlargement of upper airway soft tissue, resulting in collapse of the upper airways with inspiration during sleep. The obstruction leads to apneas, with hypoxemia, hypercarbia, and high catecholamine and endothelin levels. The frequent arousals to restore breathing result in poor sleep quality. Sleep apnea is associated with an increased risk of hypertension, and if sleep apnea is severe, it can lead to right-sided heart failure and sudden death.

3) Cancer

The risk of breast cancer and endometrial cancer is increased in obese women.

It is thought that this may be due to the increased estrogen levels associated with obesity in the postmenopausal woman. Obese men also have a higher mortality risk from cancers of the prostate and colon.

4) Gastrointestinal Disorders

Gastroesophageal reflux disease and gallstones are more prevalent in obese patients. Likewise, fatty liver and nonalcoholic steatohepatitis is strongly associated with overweight, obesity, and the metabolic syndrome.

Diagnosis

Evaluation of Obesity

In the office practice, obtaining height and weight allows calculation of BMI. For patients with a BMI above 25 and below 35, a second piece of information—the waist circumference—provides an added indicator as to whether the patient is at greater risk for adverse consequences.

Measurement of blood pressure (which may require a large blood pressure cuff) then provides a third item of health information at almost no cost. The presence or absence of dyslipidemia (HDL cholesterol < 45 mg/dL for women, HDL cholesterol < 35 mg/dL for men, or triglycerides > 150 mg/dL), hypertension, glucose intolerance and diabetes, and hyperuricemia should be documented.

A history suggestive of sleep apnea should prompt a referral for overnight oximetry or a sleep disorder evaluation.

A review of the patient's lifestyle, including an assessment of physical activity level and eating habits, may help provide information about why the patient is obese.

A family history of obesity, or long-standing obesity, provides evidence against a secondary cause of obesity.

A careful medication history, including over-the-counter medications, and social history may help the clinician identify precipitating factors that can be modified.

Treatment

Principles of Obesity Treatment

1) Assess and manage obesity-associated disorders
2) Assess for anxiety and depression
3) Dietary Change
4) Increased physical activity
5) Decreased sedentary behaviors, included screen behaviors
6) Consider pharmacotherapy
7) Consider bariatric surgery

Pharmacotherapy

Although diet, physical activity, and behavioral modifications are the cornerstones of weight management, weight loss achieved by lifestyle modifications alone is often limited and difficult to maintain.

INDICATIONS FOR PHARMACOLOGIC TREATMENT OF OBESITY

Body mass index > 27 kg/m2
One or more complications or conditions that are likely to improve with weight loss
Previous failure of conservative treatment with behavioral intervention, diet, and Exercise
Agree to 2- to 4-wk trial of making initial changes in diet and exercise before starting Pharmacotherapy
Agree to continued treatment with diet, exercise, and behavioral modification while receiving pharmacologic treatment
No contraindications to the specific drug used for pharmacologic treatment
Consider a pregnancy test on initiation of treatment if there is any possibility of pregnancy

Drug	Mechanism of action	Side effects	Selected cases	Cases to avoid
Phentermine	Adrenergic agonist	Dry mouth, insomnia, dizziness, irritability	Younger patients who need assistance with appetite suppression	Patients with uncontrolled hypertension, active or unstable coronary disease
Orlistat	Lipase inhibitor	Fecal urgency, oily stool, flatus with discharge, fecal incontinence	Patients with hypercholesterolemia and/or constipation who can limit their intake of dietary fat	Patients with malabsorption syndromes or other GI conditions that predispose to GI upset/diarrhea;
Phentermine / topiramate ER	Adrenergic agonist/neurostabilizer	Paresthesias, dizziness, dysgeusia, insomnia	Younger patients who need assistance with appetite suppression	Patients with uncontrolled hypertension, active or unstable coronary disease, hyperthyroidism
Liraglutide	GLP-1 receptor agonist	Nausea, vomiting, diarrhea	Patients who report inadequate meal satiety and/or have type 2 diabetes, prediabetes, or impaired glucose tolerance	Patients with a history of pancreatitis, personal/family history of MTC or MEN2

Liraglutide

Liraglutide has been marketed as Saxenda® both in the USA and Europe since 2014 and 2015, respectively.

Mechanism of Action

Liraglutide is a GLP-1 analogue, originally approved for the treatment of T2D GLP-1, an incretin hormone, is secreted by the L-cells of the distal ileum, proximal colon and the vagal nucleus of the solitary tract after meals and has multiple effects: 1) enhances insulin secretion by the pancreatic beta-cells and inhibits glucagon secretion in a glucose-dependent manner, thus it regulates blood glucose; 2) slows gastric emptying and increases postprandial satiety and fullness; and 3) decreases appetite and food consumption by acting in the hypothalamus, limbic/reward system and cortex.

Principle of Anaesthesia in morbid obese patients

Definition of anaesthesia

The word anaesthesia is coined from two Greek words: "an" meaning "without" and "aesthesis “

meaning "sensation" so anesthesia is the loss of sensation in a person's body or part of the body through the use of drugs.

Types of anesthesia:

There are three main types of anesthesia:

General anesthesia

Regional anesthesia (spinal, epidural, and nerve block)

Local anesthesia

The type of anesthesia used for a surgical procedure is determined by several factors:

Type and length of the surgery

Patient health

Preference of the patient and physician.

Patients’ evaluation:

Common Home Medication Which Affects Anesthesia

Drug	Effect
B-blocker	Bronchospasm
Antibiotics	Prolongation of NMJ blocker
Benzodiazepines	Tolerance to Anesthesia
Diuretics	Hypovolemia, hypokalemia

Physical Exam

The focused physical exam should include:

General

BMI Table 1 (body mass index)

Classification	BMI range - kg/m^2
Severe Thinness	< 16
Moderate Thinness	16 - 17
Mild Thinness	17 - 18.5
Normal	18.5 - 25
Overweight	25 - 30
Obese Class I	30 - 35
Obese Class II	35 - 40
Obese Class III	> 40

Jaundice

Different body organ (CVS, pulmonary, CNS ,hematological……etc.)

Airway

Mallampati score/mouth opening

cervical spine mobility

temporomandibular joint mobility

teeth (especially diseased/loose/artificial)

thyromental distance

Routine Labs and Testing:

Complete Blood Count (CBC) mainly HB and HCT

Coagulation profile (PT, Prothrombin conc., PPT and INR)

Kidney function [blood urea nitrogen, creatinine and serum electrolytes

{Na^+ and K^+}].

Liver function [liver enzymes {ALT and AST}, serum direct and indirect bilirubin, PT, serum alkaline phosphates and serum albumin].

Random blood sugar

Electro cardio graph.

Plain X-ray on chest

Blood typing and cross matching

Pregnancy test for pubertal female.

The **ASA physical status classification system** is a system for assessing the fitness of patients before surgery In 1963 the American Society of Anesthesiologists (ASA) adopted the five-category physical status classification system; a sixth category was later added. These are **ASA I, II ,III ,IV ,V ,VI** and **E** Emergency operation Example: An ASA 1 patient having an emergent procedure would be ASA E one.

General Anaesthesia:

Purposes:

General anaesthesia has many purposes including:

Analgesia — loss of response to pain using acetaminophen and nonsteroidal anti-inflammatory drugs (NSAIDs)

Amnesia — loss of memory I.V drugs e.g. benzothiazines

Immobility — loss of motor reflexes, (depolarizing and nondepolarizing muscle relaxant)

Unconsciousness — loss of consciousness by I.V anaesthetic drug (thiopental sodium & propofol)

And inhalation drugs (isoflurane, sevoflurane and desflurane)

Skeletal muscle relaxation

Procedure:

our anesthesiologist usually **induce** anaesthesia by delivers the anesthesia medicines through an intravenous line in your arm. Sometimes you may be given a gas that you breathe from a mask. Children may prefer to go to sleep with a mask.

Once you're asleep, the anesthesiologist gives depolarizing muscle relaxant to insert a flexible, plastic breathing tube into your mouth and down your windpipe. The tube ensures that you get enough oxygen and **maintenance** of anesthesia by inhalational anaesthetic agent with good muscle relaxation using non depolarizing muscle relaxant especially in long surgical procedure, this tube also protects your lungs from oral secretions or other fluids such as stomach fluids (protect from aspiration). The breathing tube is removed at the end of the procedure after cessation of inhalational anaesthetic agent and reversal of muscle relaxant and disconnection from mechanical ventilator as you start to awaken.

Someone from the anesthesia care team monitors you while you sleep. This anesthesia team member adjusts your medicines, breathing, temperature, fluids and blood

pressure as needed. Any issues that occur during the surgery are corrected with medicine and fluids. Rarely, blood transfusions are needed.

Postoperative care:

With complete emergence from general anaesthesia the patient should be fully awake and pain-free with a management plan for postoperative pain relief.

Categorization of obesity

Obsolete classifications include ‘morbid obesity’, ‘super obesity’, ‘super-morbidly obese’ and ‘super super morbidly obese’.

BMI is a commonly used measurement of obesity, its advantage being that it is easy to calculate. BMI does not describe the composition and distribution of body tissue (muscle/adipose) or metabolic state. These are important factors in terms of pathophysiology, perioperative risk and management. BMI can be useful to alert teams and allow planning and preparation. Table 2 details the latest classification of obesity according to BMI, and the ASA grade corresponding to each class.

Table 2 WHO classification of obesity and ASA grades

Category	BMI (kg m^{-2})	ASA grade
Underweight	<18.5	1
Normal weight	18.5–24.9	1
Overweight	≥25	1
Preobese	25–29.9	1
Obese	≥30	1
Class 1	≥30–34.9	1
Class 2	≥35–39.9	2
Class 3	≥40	3

What is a safe BMI for anesthesia?

The ideal range for BMI is from 20 to 25. A BMI over 25 is termed as being overweight and over 30 is termed as being obese. There can be a higher risk of surgical and anaesthetic complications if you have a BMI over 30.

How does morbid obesity affect anesthesia?

A lot of the drugs that we use are fat soluble, so it takes more anesthesia to put someone who's morbidly obese to sleep. It takes longer to wake them up. They are more likely to have cardio and pulmonary complications after surgery than someone who is not heavily overweight.
In addition, the obese patient utilizes increased oxygen consumption attributed to the metabolic demands of excess adipose tissue and impaired ventilation dynamics and efficiency. The clinical result of the above factors is rapid arterial oxygen desaturation with apnea upon induction of anesthesia.
Obesity is associated with a higher risk of developing airway problems under anaesthesia

What is the best anesthesia for morbid obese people?

Propofol is the most commonly used hypnotic agent in obese patients due to its rapid onset of action and quick recovery time. However, being highly lipophilic, the volume of distribution and clearance increases linearly with body weight.

What are the key factors for successful general anesthesia of morbid obese adult patients?

Five key factors for successful general anesthesia of obese adult patients are identified: These are preparing and planning the anesthesia, optimizing patient position, optimizing ventilation, quickly securing the airway, and working in teams.

How can I manage anaesthesia in morbid obese patients?

There are no special or preferred choices of equipment for airway management in obese patients. Tracheal intubation is the recommended technique for airway management. Whatever aid to intubation is used, it should be one with which the anesthetist is most familiar with and which offers the best chance of success
For any obese patient, the implementation of difficult intubation protocols and the use of protective ventilation (low tidal volume 6-8mL/kg of ideal body weight, moderate positive end-expiratory pressure of 10cmH20, recruitment maneuvers in absence of contra-indications), with morphine sparing and semi-seated positioning as much as possible are recommended, associated with a close postoperative monitoring

What anesthesia drugs are used for morbid obese people?

Use short-acting agents e.g. desflurane or propofol infusion. short-acting opioids, multimodal analgesia.

Why is Desflurane as inhalation anesthetic agent better in obese patients?

Desflurane has a low fat-blood solubility coefficient and may be better suited in this population to achieve a rapid emergence; however, sevoflurane has favorable cardiorespiratory properties that might also prove advantageous in the morbidly obese (MO) patient

Does anesthesia depend on weight?

Dose adjustment of anaesthetic in the morbidly obeswith the exception of neuromuscular antagonists, lean body weight is the optimal dosing scalar for most drugs used in anaesthesia including opioids and anaesthetic induction agents.

Why is the morbidly obese patient at high risk of anesthetic complications?

Obesity is often associated with obstructive sleep apnea (OSA), which increases the risk of intraoperative and postoperative complications. The role of preoperative screening of OSA is crucial, with adequate management based on continuous positive pressure before, during and after surgery

What is the obstacle which anaesthesiologists face during general anaesthesia for morbid obese patients?

being significantly overweight can lead to challenges with a number of anesthesia-related processes:

- Locating veins to deliver anesthesia and life-saving emergency medications intravenously
- Determining the right dose of medications
- Ensuring you get enough oxygen and airflow, especially if you have sleep apnea
- Adding to the time it takes to regain consciousness after surgery and your recovery time
- Increasing the risk of breathing problems with narcotics and other pain medicine
- Placing a breathing tube

Regional anesthesia (spinal, epidural and nerve block) for morbid obese patients:

Regional anaesthesia offers many potential advantages for the obese surgical patient. Advantages include a reduction in systemic opioid requirements and their associated side effects, and possible avoidance of general anaesthesia in select circumstances, with a lower rate of complications. Historically, performing regional anaesthesia procedures in the obese has presented challenges due to difficulty in identifying surface landmarks and availability of appropriate equipment. Ultrasound guidance may aid the regional anaesthesia practitioner with direct visualization of underlying anatomic structures and real-time needle direction.

As the BMI increases, the distance to the epidural space increases. Therefore, spinal anesthesia in obese patients is expected to require a spinal needle longer than the standard spinal needle. However, in most obese patients, spinal and epidural anesthesia has been successfully performed with standard length needles

obesity is associated with higher regional block failure and complication rates in surgical and regional anesthesia in the ambulatory setting. Nonetheless, the rate of successful blocks and overall satisfaction remained high in patients with increased BMI. Therefore, overweight and obese patients should not be excluded from regional anesthesia procedures in the ambulatory setting.

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I. Weight-loss surgeries: bariatric surgeries

Indications for bariatric surgery:

1. Bariatric surgery is indicated for patients with severe obesity who had a BMI of ≥35 kg/m^2 with at least one comorbid condition (such as T2DM, hypertension and obstructive sleep apnoea)
2. BMI of ≥40 kg/m^2
3. Selection of patients for bariatric surgery should be performed within a multidisciplinary team with medical, surgical, psychiatric and nutritional evaluations, and the operation should be performed by a surgeon with extensive experience in the particular bariatric procedure

Types of bariatric surgeries

I- Roux-en-Y gastric bypass. (RYGB):

- still considered the 'gold-standard' weight-loss operation and **was** the most frequently performed bariatric procedure worldwide, before it was surpassed in frequency by sleeve gastrectomy.
- **Steps of the procedure:**
  - First, a small gastric pouch of 30 cm^3 in volume is constructed by separating the gastric cardia from the remaining stomach.
  - Next, the small intestine is divided 30–50 cm distal to the ligament of Treitz.
  - The distal end of the divided small intestine is brought up (Roux limb) typically in an antecolic fashion (on top of the colon) and anastomosed to the newly constructed gastric pouch.
  - The length of the Roux limb varies between 75–150 cm.

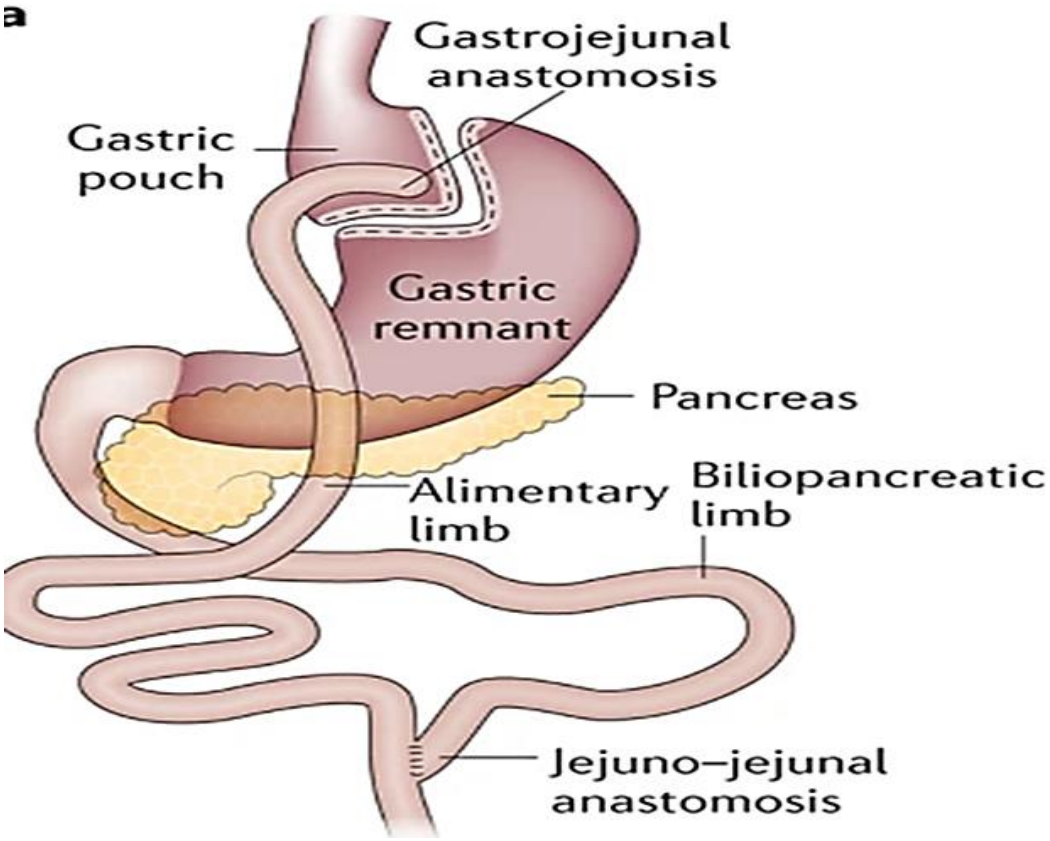
The mechanisms of weight reduction in RYGB:

1) The newly constructed gastric pouch is considerably smaller than the normal stomach, which facilitates the consumption of less food and fewer calories.
2) Additionally, fat malabsorption occurs to some degree, which leads to less absorption of calories and nutrients.

3) Exclusion of the duodenum and proximal jejunum as a result of the gastric bypass can prevent secretion of anti-incretin substances,
4) The early presence of ingested food traveling to the distal small bowel can stimulate secretion of an incretin substance, such as glucagon-like peptide 1, which leads to the improvement of insulin sensitivity by increasing insulin production and/or decreasing insulin resistance.
5) This improvement of insulin sensitivity has been shown to be independent of weight loss.
6) Weight loss with RYGB is 70% of excess weight at 1 year.

Disadvantages:

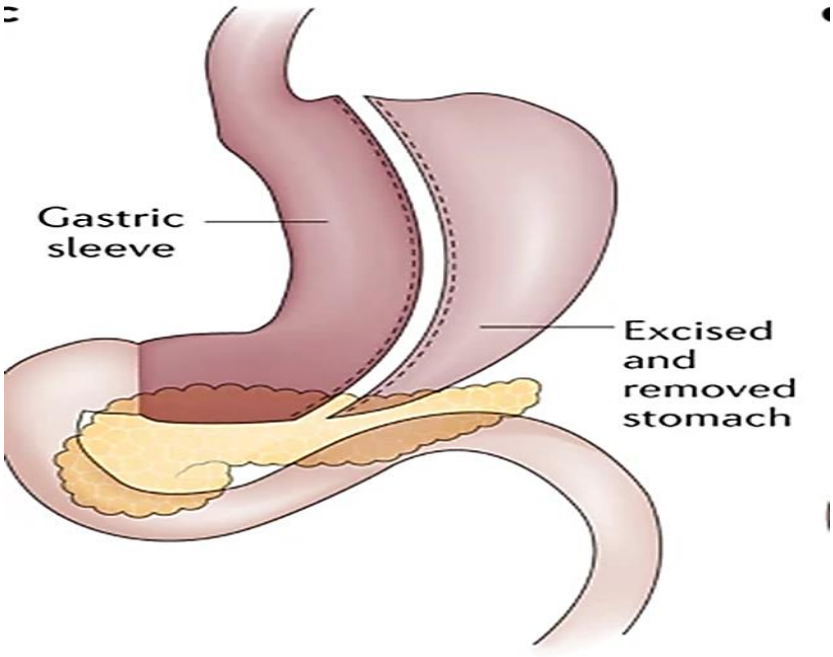
By bypassing the duodenum, RYGB has the potential to cause vitamin and mineral deficiencies.



Roux en-Y gastric bypass

II- laparoscopic sleeve gastrectomy (LSG):

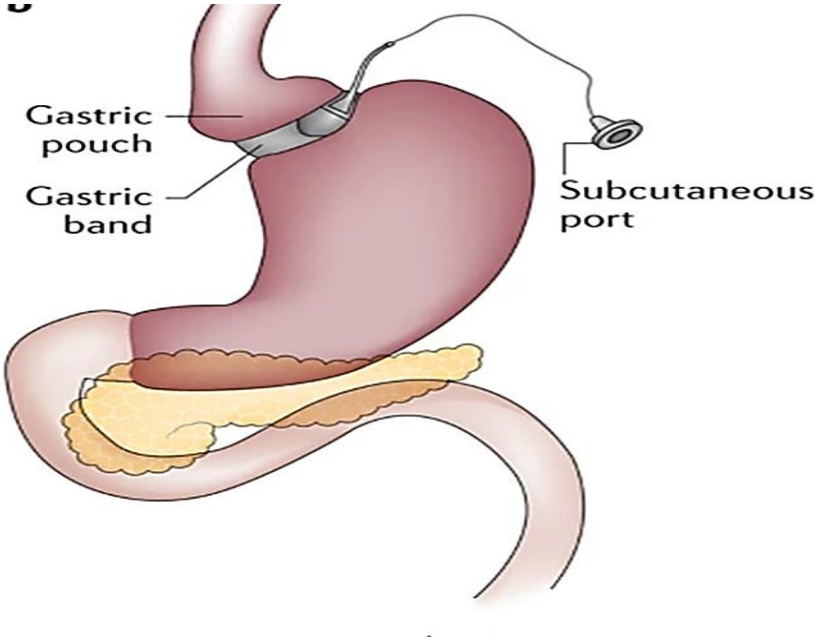
- LSG is constructed by removing about 80% of the lateral aspect of the stomach in a vertical fashion, leaving a remaining long, tubular gastric pouch or sleeve .
- **This procedure works by several mechanisms.**
  - The new stomach pouch holds a considerably smaller volume than the normal stomach, which helps to substantially reduce food intake and the calories that are consumed.
  - An additional effect results from the resection of the greater gastric curvature, which has effects on the levels of gastrointestinal hormones that reside within the stomach, including a reduction in the plasma levels of ghrelin, a hormone that is secreted mainly from the gastric fundus and is responsible for promoting hunger.
  - Weight loss and the improvement or remission of T2DM after LSG is slightly lower than that following RYGB.
  - Improvement of T2DM after LSG is independent from the reduction of weight.
  - Weight loss from the LSG has been reported at 51–70% of excess weight or a reduction of 12–16 BMI points at 1 year after surgery.



Sleeve gastrectomy

III- **Laparoscopic adjustable gastric band.**

- The LAGB involves placement of an adjustable silicone band around the upper portion of the stomach, thereby creating a small gastric pouch above the gastric band (Fig. 1).
- The size of the opening between the upper stomach pouch and the rest of the stomach can be adjusted by filling the band with sterile saline that is injected through the abdominal wall.
- Adjustment of the band can be done gradually over time in the postoperative clinic visit.
- The clinical effect of the band seems to be a reduction of hunger, which results in a decrease in calorie consumption.
- The high rate of late complications resulting from LAGB, such as band erosion,
- slippage, gastro-oesophageal reflux and high variability in weight loss, has led to the decline in the use of LAGB.
- Weight loss after LAGB has been reported at 34% of the excess weight at 1 year or a reduction in 7–10 BMI points at 1 year.



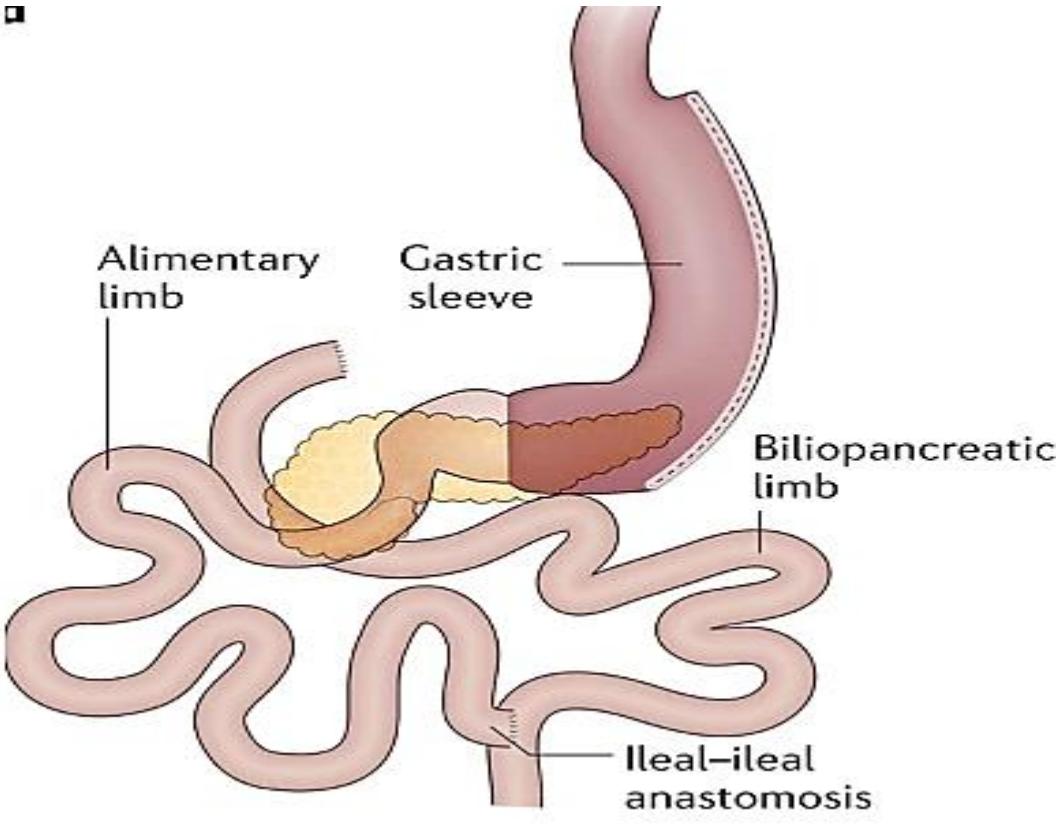
Adjustable gastric band.

IV- Biliopancreatic diversion with duodenal switch.

The BPD–DS is a procedure with two distinct components.

1) First, a vertical gastrectomy is performed, similar to the LSG, to create a tubular gastric pouch.
2) Next, a large portion (= 50%) of the small intestine is bypassed, which creates malabsorption.

- The duodenum is divided just past the pylorus.
- A segment of the distal ileum is then divided at 250 cm proximal to the ileocecal valve and brought up and anastomosed to the duodenum in a Roux-en-Y configuration.
- Another anastomosis of the ileo-ileostomy is performed at 100 cm proximal to the ileo-caecal valve to complete the operation.
- the small gastric pouch associated with the BPD–DS helps to reduce the quantity of food that is consumed.
- Unlike the other procedures, a substantial amount of small bowel is bypassed, which results in a considerable decrease in the absorption of calories from protein and fat, as well as the absorption of certain nutrients and vitamins.
- The BPD–DS, similar to the RYGB and LSG, affects gastrointestinal hormones in a manner that improves glucose metabolism
- The BPD–DS is considered to be the most effective bariatric surgical procedure for the treatment of severe obesity and T2DM, compared with RYGB, sleeve gastrectomy or adjustable gastric banding
- The procedure showed 70% excess weight loss and a reduction of 16 BMI points in patients who received BPD–DS at a follow-up 2 years after surgery
- However, owing to the technical complexity and increased short-term complications (for example, leaks, obstruction) and long-term complications (for example, nutritional deficiencies) of the procedure, its use is limited to a few specialized bariatric centres.



Biliopancreatic diversion with duodenal switch

Advantages and disadvantages of different bariatric surgeries

Roux-en-Y gastric bypass

Advantages:

1. Produces notable long-term weight loss
2. The small gastric pouch restricts the amount of food that can be consumed, thus reducing caloric intake
3. Produces favourable changes in hormones that reduce appetite

4. Produces favourable changes in insulin sensitivity, which leads to increased rates of type 2 diabetes mellitus remission in patients who undergo the procedure compared with those who do not receive bariatric surgery

Diadvantages:

1. A complex procedure that requires rerouting of the intestine, in contrast to the LAGB and LSG
2. Can be associated with long-term vitamin and/or mineral deficiencies
3. Requires a longer hospital stay of 1–2 days and is associated with higher perioperative complications than the LAGB and LSG
4. Can lead to late complications such as marginal ulcer, internal hernia, small bowel obstruction and gastrogastric fistula
5. Has a higher early complication rate and more severe complications than the LAGB such as gastric leaks that can be difficult to manage

Laparoscopic sleeve gastrectomy:

Advantages:

1. Does not bypass the duodenum and consequently tends to avoid problems with iron calcium and vitamin deficiencies
2. Induces rapid and substantial weight loss that is comparable to that of the RYGB
3. Has no foreign material, such as that of the adjustable gastric band
4. Produces favourable changes in the gastrointestinal tract that control appetite
5. Can be used as the initial staged operation before RYGB or BPD–DS

Disadvantages:

1. Can lead to late complications such as chronic obstructive symptoms that require conversion to a RYGB
2. The sleeve can dilate over time, which might lead to weight regain
3. Has been related to an increased risk of postoperative GERD

Laparoscopic adjustable gastric banding

Advantages:

1. Requires no surgical division of the stomach
2. Has a short operative time and can usually be achieved in an outpatient setting
3. Reversible and adjustable
4. No duodenal bypass and consequently has a low risk of vitamin and/or mineral malabsorption
5. Low rate of death and perioperative complications compared with other bariatric procedures

Disadvantages:

1. High rate of late reoperation for obstruction, band slippage or erosion
2. Weight loss is lower than other bariatric procedures
3. The band, tubing and port can break over time
4. Band obstruction can result in progressive dilation of the oesophagus

Body Contouring

Body contouring has advanced significantly over the past decade, fueled by the increased number of massive weight loss patients and the advent of new fat-reduction technologies. This has impacted both the number of cases performed and the range of procedures. Many innovations are being developed as plastic surgeons meet the evolving needs of our patients.

The emergence of body contouring surgery as a subspecialty of plastic surgery has been greatly influenced by the increasing numbers of massive weight loss patients. The subspecialty of body contouring encompasses massive weight loss patients and patients with specific anatomical contour deformities related to pregnancy, aging, or weight reduction from dieting and exercise.

ANATOMICAL CONCEPT

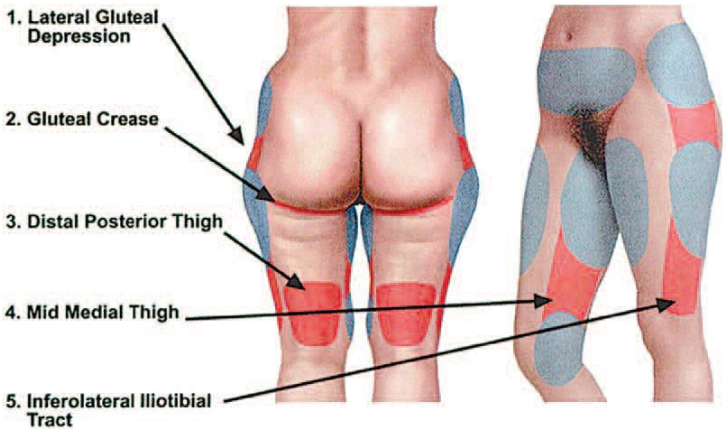
Several anatomical concepts key to body contouring are important to review:

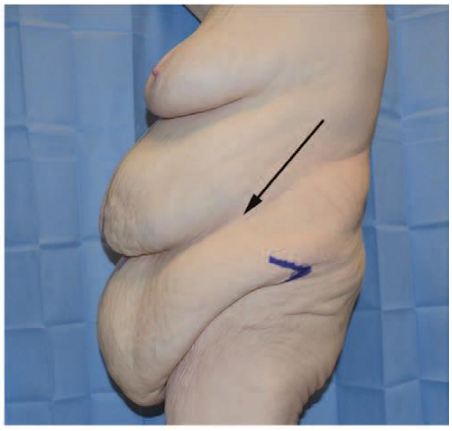
Superficial Fascial System

The superficial fascial system supports the fat of the body, naturally anchors the adipose tissue to surrounding structures, and provides a load-bearing network that, when repaired, can suspend tissues and reduce tension on the dermal closure

Zones of Adherence

Illouz in 1989 introduced the concept of fascial fixed points. These fixed points were further defined by Rohrich et al., who described five regions in which the subcutaneous tissues are consistently firmly adherent to the deep fascia. This represents a condensation of the superficial fascial system. Liposuction should either be avoided or performed cautiously in these areas to prevent contour deformity.





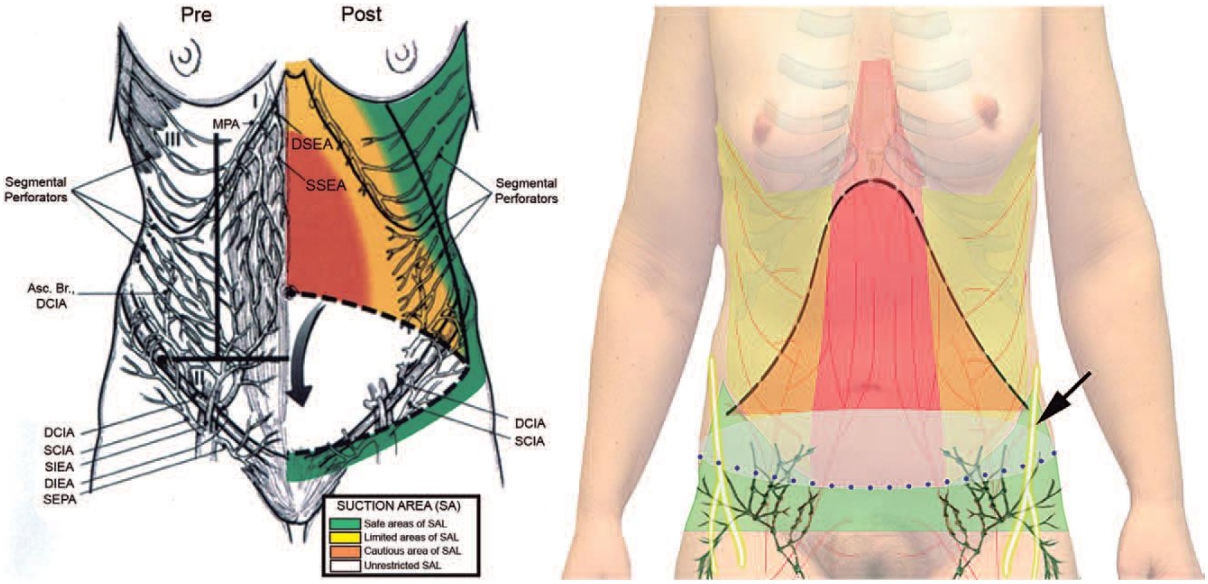
This concept is also important in tissue resuspension during a lower body lift, in which Lockwood advocated disrupting the trochanteric zones of adherence with blunt discontinuous undermining to allow the lateral thigh tissues to be fully mobilized in massive weight loss patients, aberrant fascial thickening

in the mid-abdomen serves as a tethering point and leads to multiple rolls. The surgical release of these points of fixation can have an unfurling effect that improves the appearance of mid-abdominal rolls

Blood Supply and Lymphatic Drainage

To achieve optimal results and avoid complications, the vascularity of all areas of interest should be well preserved. This is only possible by understanding the angiosomes of each skin territory.

Abdominoplasty vascular zones were originally described by Huger shows the vascular zones of the abdomen, relating to liposuction during abdominoplasty.



The lymphatic drainage is equally important, and the dissection and elevation of skin flaps should take into account the preservation of the inguinal lymph node basins, which can be injured when abdominal incisions are marked below the inguinal ligament, as is often seen in massive weight loss patients.
These node basins can also be injured during thighplasty. Surgeons have speculated that the lymphatic channels in the abdomen can be preserved below the umbilicus by elevating the skin flap superficial to the Scarpa fascia. Although this maneuver has been credited with reduced seroma rates, it is unclear whether this is attributable to actual preservation of lymphatic function or changing the contact surface beneath the flap to fatty tissue.

UPPER EXTREMITY CONTOURING

Upper arm procedures can range from simple posterior compartment liposuction to long-scar brachioplasty with liposuction. The decision to choose a procedure depends on the amount of skin laxity and the thickness of the fatty compartments.

The important points in brachioplasty are to avoid injury to the medial antebrachial cutaneous nerve and to avoid overresection, which may lead to excessive tension or inability to close the wound. Longitudinal scar brachioplasty is the most commonly preformed brachioplasty procedure

UPPER TRUNK CONTOURING

Breast Procedures

Breast surgeries include topic in the context of (1) combining breast operations with other body procedures, (2) using adjacent tissues for breast volume augmentation, and (3) combining liposuction with breast fat grafting.

Lateral chest wall tissue can be mobilized into the breast mound during mastopexy, as seen with dermal suspension flaps. This corrects the lateral chest skin roll and enhances breast shape and volume. Lastly, the increasing popularity of breast fat grafting is accompanied by liposuction harvest of hundreds of cubic centimeters of donor fat. We must remember that this harvest now becomes an aesthetic procedure in itself.

Upper Body Rolls

Upper back rolls can be excised with a transverse scar on the upper back, or with bilateral longitudinal or oblique scars on the lateral chest. Correction of upper back rolls can be performed with breast reshaping or gynecomastia correction, and a circumferential approach may be used.

ABDOMINAL CONTOURING PROCEDURES

Panniculectomy
This is a functional procedure that involves limited skin and subcutaneous resection to relieve symptoms of intertrigo. Rectus diastasis is not repaired, and many surgeons do not preserve the umbilicus in this procedure.

Abdominoplasty
The main goals for abdominoplasty are to improve the overall abdominal contour through careful analysis of the deformity, selectively impacting skin and fascial components, and leaving a well-concealed scar with a natural appearing umbilicus.

The umbilicus is situated perfectly in the midline in only 1.7 percent of patients. The indications for this procedure include redundant flaccid skin, excessive adipose tissue, muscular diastasis and musculoaponeurotic laxity, scar deformities, and striae. If a hernia is to be repaired during abdominoplasty, it is important to reestablish the muscular anatomy of the abdominal wall.

Traditional Abdominoplasty
This procedure involves a transverseincision and wide undermining of the abdominal flap. It provides excellent skin draping centrally

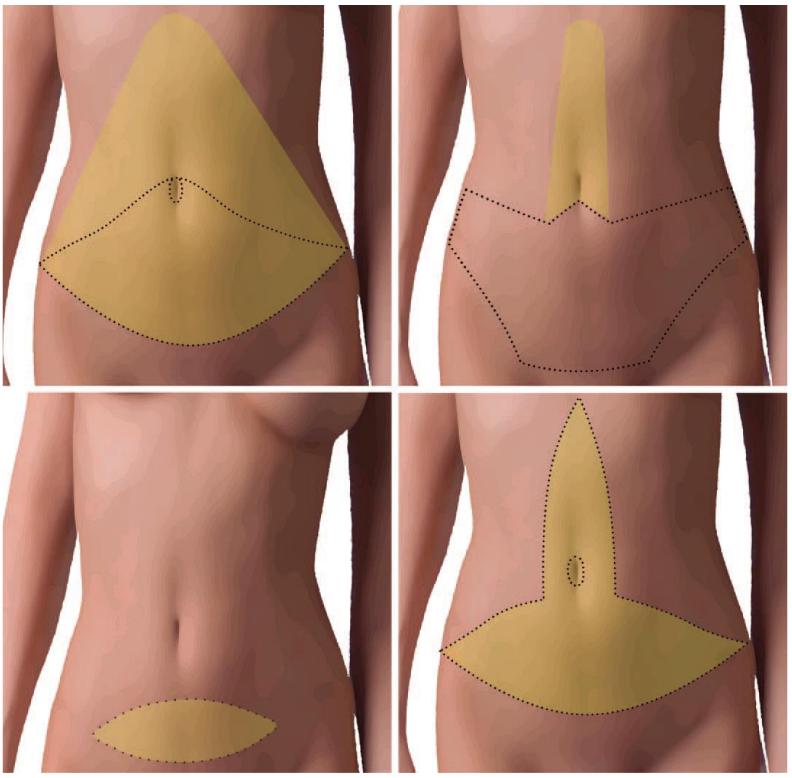
High-Lateral-Tension Abdominoplasty
Described by Lockwood as a refinement of standard abdominoplasty, the high-lateral-tension abdominoplasty technique is based on the concept that epigastric skin excess is both horizontal and vertical in nature.
The main advantage of this technique is the correction of the horizontal laxity, less distortion of the mons, and a tightening effect on the anterior thigh. High-lateral-tension abdominoplasty requires meticulous closure of the superficial fascial system layer, and the scar is higher and longer laterally.

Miniabdominoplasty
The miniabdominoplasty was first described by Greminger.This procedure resects skin below the umbilicus and serves to correct limited infraumbilical skin laxity. Few patients are actually good candidates for this procedure.

Umbilical Float Abdominoplasty
Transection of the umbilical stalk with preservation of the skin supply to the umbilicus is an option for treatment of a high or tethered umbilicus.This operation combines elements of a
miniabdominoplasty (no umbilical scar) with the ability to tighten the epigastrium. In addition, rectus plication is possible with this technique.

Lipoabdominoplasty
This procedure substitutes wide lateral undermining with liposuction to preserve the lateral perforators to the skin flaps, and provides good draping of the central abdominal flap. In theory, this preserves the lateral blood supply to the flap. Proponents of this technique believe that it provides excellent skin redraping without compromising blood supply to the abdominoplasty flap. This operation sets a new perspective on combining liposuction with abdominoplasty.

Vertical
The fleur-de-lis is aimed at epigastric skin useful in certain loss patients. This excellent for epigastric skin multiple
A disadvantage is the addition of scar. There limited
outside of the excision to supply.



Abdominoplasty
abdominoplasty correcting laxity and is very massive weight technique is correcting laxity and abdominal folds. of this technique a midline vertical should be very undermining central skin protect the blood

Above, *left*) Traditional abdominoplasty incision (*dotted line*) and area of skin undermining (*yellow*). (*Above*, *right*) High-lateral-tension abdominoplasty as described by Lockwood, with limited area of undermining (*yellow*). (*Below*, *left*) Miniabdominoplasty resection. (*Below*, *right*) Vertical scar abdominoplasty with limited undermining beyond the excision site.

THIGH, BUTTOCK, AND LOWER EXTREMITY CONTOURING

Lower Body Lift Procedures
There are many recommended procedures for correcting lower body contour deformities;
belt lipectomy (sometimes referred to as circumferential abdominoplasty) and circumferential lower body lift are among these procedures.

Belt lipectomy incisions differ from the lower body lift in that they are typically placed higher than a lower body lift. Belt lipectomy traditionally has more impact on waist shape and less pull on the lateral thighs. A lower body lift incision allows direct shaping of the buttocks and a strong vertical pull on the lateral thighs. Central deepithelialized dermal pedicles can be incorporated to augment the buttocks.

Medial Thigh Lift Procedures
Although the lower body lift corrects lateral thigh laxity, it does little to address skin laxity in the medial thigh. Two procedures are described to contour the medial thigh, the vertical excision and the horizontal excision. The vertical excision provides more reliable results in correcting medial thigh skin laxity. Although a transverse-only medial thigh excision is appealing, this procedure is very underpowered and only corrects skin laxity in the uppermost part of the medial thigh. Anchoring to Colles fascia, as described by Lockwood, helps suspend the tissues after transverse resection, but it is vital to understand that the force of pull is not transmitted to the distal thigh. Aggressive transverse medial thigh lift can lead to significant cosmetic and functional problems and is not a substitute for a vertical thighplasty if that operation is indicated.

LIPOSUCTION AND FAT GRAFTING FOR BODY CONTOURING

Liposuction
Liposuction can be used in nonobese patients to treat selected areas of adiposity resistant to normal diet and exercise and is also a great adjunct in many body-contouring procedures (e.g., abdominoplasty, brachioplasty, and thighplasty). Grafting of the aspirated fat enables redistribution of native tissues.

Suction-Assisted Lipectomy
Suction-assisted lipectomy uses mechanical forces to avulse and aspirate parcels of fat within the subcutaneous tissue with continuous negative pressure.

Power-Assisted Liposuction
Power-assisted liposuction uses a powered cannula that moves in a reciprocating fashion to assist the surgeon in breaking down fibrous tissue and fat.

Ultrasound-Assisted Liposuction
Ultrasound-assisted liposuction uses ultrasound vibration of the cannula to break down connective tissue and emulsify fat. The thermal energy produced has been reported to help with skin tightening but also has been associated with higher rates of complications.

Laser-Assisted Liposuction
Laser-assisted liposuction can be used to treat defined areas in the body, with claims of producing skin tightening and thermal coagulation to minimize bleeding. It is unclear whether these devices have an advantage over other liposuction technologies.

Wetting Solutions
The concept of fluid infiltration was developed by Klein.[101] This modification enabled aggressive liposuction previously possible only under general anesthesia and limited blood loss. Klein introduced the concept of lower concentrations of local anesthetic and epinephrine combined with a higher ratio of injection to aspirate (3:1).

Fat Grafting in Body Contouring
Fat grafting in body contouring has found the greatest applications in buttock augmentation.

COMPLICATIONS

Early Complications

Wound Dehiscence
Wound dehiscence and delayed wound healing are the most common complications, usually self-limited, and treated effectively with local wound care. Seroma formation is a common problem. The rate of seroma in body contouring is reported in many series to range from 5 to 15 percent. Some authors advocate the use of doxycycline injected through the drain to treat increased prolonged fluid drainage. Although\ strong evidence is lacking, the recommended dose is 250 mg of doxycycline in 50 to 100 cc of normal saline, depending on the size of the seroma.
Hematoma for body contouring is between 1 and 5 percent, and varies with procedure preformed.

wound infection in body contouring ranges from 5 to 8 percent. Most wound infections are superficial in nature and respond well to oral antibiotics.

Early postoperative neuropathies are rare in body contouring and can be minimized by careful attention to positioning and padding.

Late Complications
Scarring is a key issue for patients, and scars can migrate, thicken, widen, and hypertrophy. In addition, scar contracture can occur in brachioplasty and may require surgical release.

Edema in the lower and upper extremities is usually managed by elevating the limbs, application of compressive wraps or garments, and lymphatic massage. Lymphedema is a distressing late complication and is more common in the lower extremities than in the upper extremities after excisional procedures.

skin laxity is a vexing problem in the massive weight loss patient and can lead to revision.

Aesthetic complications can include asymmetry and overresection or underresection of tissues.

What is Interventional Radiology?

In interventional radiology (also called IR), doctors use medical imaging to guide minimally invasive surgical procedures that diagnose, treat, and cure many kinds of conditions. Imaging modalities used include fluoroscopy, MRI, CT, and ultrasound. These radiologists work in the department of vascular and interventional radiology.

"Interventional Radiology" (IR) refers to a range of techniques which rely on the use radiological image guidance (X-ray fluoroscopy, ultrasound, computed tomography [CT] or magnetic resonance imaging [MRI]) to precisely target therapy. Most IR treatments are minimally invasive alternatives to open and laparoscopic (keyhole) surgery. As many IR procedures start with passing a needle through the skin to the target it is sometimes called pinhole surgery!

Interventional radiologists make small incisions, usually in the abdomen, and use needles and catheters to treat conditions inside the body. Medical images are used to guide their catheters through blood vessels, arteries, and organs.

Why Interventional Radiology?

Interventional radiology reduces cost, recovery time, pain, and risk to patients who would otherwise need traditional open surgery. Because of this, IR has become the primary way to treat many types of conditions. The treatments IR can effectively perform are ever-changing and expanding.

Examples of IR Procedures

- *Angioplasty- repair or unblocking of blood vessels.*

- *Stenting- small mesh tubes that treat narrow or weak arteries.*
- *Thrombolysis- dissolving blood clots.*
- *Embolization- block blood flow to cancer cells.*
- *Radiofrequency ablation- used to reduce nerve pain.*
- *Biopsies- study of tissues.*

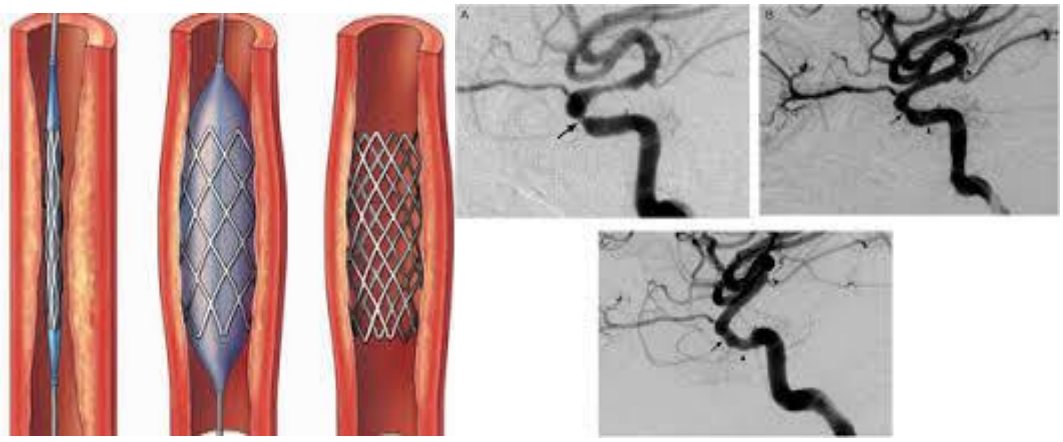
This short film shows what interventional radiology is:
https://www.youtube.com/watch?v=1crWP85QRl0

Well recognised advantages of these minimally invasive techniques include reduced risks, shorter hospital stays, lower costs, greater comfort, quicker convalesence and return to work. The effectiveness of treatment is often be better than with traditional treatments.

Blood vessel disease

Arteries : Narrowing of arteries leading to restricted blood flow (peripheral vascular disease): Interventional radiologists treat this by using balloons to stretch the vessel (balloon angioplasty, PTA) and sometimes metal springs called stents to hold them open. Sometimes arteries or bypass grafts block suddenly with a rapid loss of blood supply to the limb. Unless the blood supply is restored this can lead to amputation. Interventional radiologists can help by infusion of clot busting drugs directly into the artery via small catheters thus saving many limbs.

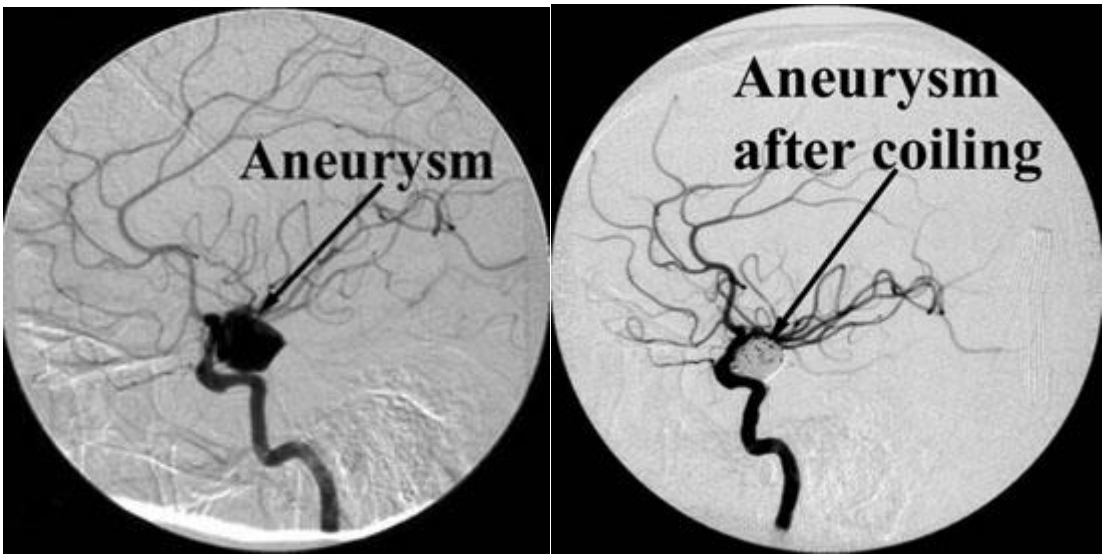
Expanded arteries (aneurysms) at risk of rupture and bleeding: IRs treat these by relining the vessel with a tube called a stent graft.



Bleeding (haemorrhage)

This is the most common vascular emergency treated by IR. Haemorrhage can come from almost anywhere e.g. from the gut, secondary to major injury or following birth. Bleeding can often permanently be stopped by blocking the vessel (embolization), relining the vessel with a stent graft or

by blowing up a balloon in the vessel to stop the bleeding until emergency surgery can be performed. Interventional radiology is also used to prevent bleeding during some sorts of surgery e.g. during caesarean section in patients with a high risk of bleeding from an abnormal placenta (post partum haemorrhage).



Veins

Blood clots in the lung (pulmonary embolism, PE): interventional radiologists perform 2 different forms of treatment, placement of devices (inferior vena cava filters) to capture blood clots before they reach the lung preventing further PE. When there is a massive PE causing collapse an interventional radiologist may use small catheter tubes to break up the blood clot and restore blood flow.

Dilated veins (varicose veins): these most commonly occur in the legs but can occur in the pelvis or scrotum. These can be treated by blocking the vein by heat treatment (laser or microwave) or by the use of irritant drugs and embolisation techniques.

Blocked veins: this can occur in the context of blood clot in the veins (venous thrombosis, DVT) which is sometimes treated by the injection of blood clot dissolving medicines (thrombolysis) through a small catheter passed into the vein. Some patients develop blood clots as a result of a narrowing in a vein, when the clot has been broken down using balloons and stents. Sometimes tumours in the chest will compress a vein leading to facial swelling, headache and other symptoms which can usually be relieved with a stent.

Non vascular intervention

This is sometimes referred to as interventional oncology but the treatments are also effective in benign conditions. IR therapies are used for the following:

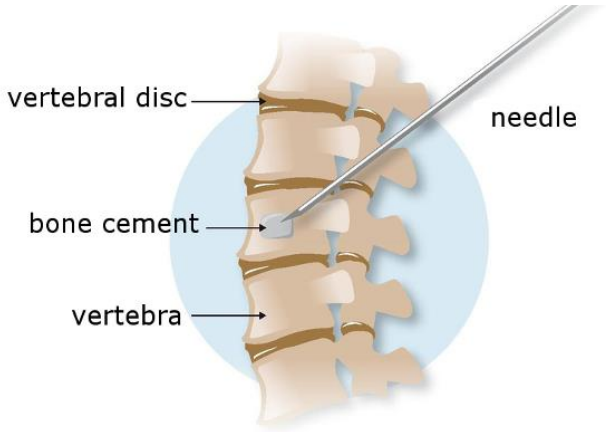
to treat the tumour / cancer (tumour ablation, embolization)

to relieve the effects of the cancer on other systems e.g. blockage of the gullet (oesophagus), bowel, kidney (nephrostomy) or liver (biliary drainage)

To drain collections of fluid or pus in the chest or abdomen

To place feeding tubes (gastrostomy, jejunostomy)

To treat collapsed spinal bones (vertebroplasty)



Tumour therapies: these treatments are intended to shrink or destroy tumours at their primary site or which have spread to other areas (metastases). This is an area of increasing interest and leading to improved survival with reduced morbidity.

Liver, kidney and other tumours (e.g. bone, lung): these can be treated by destructive therapies (ablation) usually involving heat (radiofrequency, laser, microwave, ultrasound) or cold damage (cryotherapy). The treatment is performed and monitored using imaging (ultrasound, computed tomography or magnetic resonance imaging).

Uterine fibroids : heavy menstrual bleeding and pain can be caused by benign tumours called fibroids. These can be treated by blocking blood vessels (uterine fibroid embolization, UFE) which leads to shrinkage. Embolization is sometimes combined with drug therapy (chemoembolization) or radiotherapy (radioembolization) which targets the effect to the tumour and limits some of the side effects of cancer therapy.

Stone Disease

Kidney stones are not uncommon and cause pain, infection and blockage of the kidney. Obstruction of the kidney in the presence of infection will rapidly cause irreversible kidney damage. Interventional techniques include placing a tube in the kidney (nephrostomy) to allow the urine to drain and removing the stones using a variety of instruments placed through the skin into the kidney. Large kidney stones are best dealt with by creating a tunnel into the kidney through a small skin incision and then passing an endoscope directly into the kidney, breaking the stone with special instruments and pulling the fragments out (percutaneous nephrolithotomy).

Gall stones are one of the most common upper abdominal disorders. Most are dealt with by laparoscopic surgery. When stones or tumour stop bile draining from the liver this causes jaundice, this is usually treated via a telescope passed down the throat (endoscopy) but sometimes requires an interventional radiologist to perform drainage by placing catheter tubes through the liver to either remove the stones or place stents to allow drainage.