An Overview of Obesity and Weight Loss Surgery

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Obesity is a nutritional disorder that spans all ages and ethnicities and affects both sexes. In 2000, the World Health Organization (WHO) convened an international consultation on obesity to review epidemiological data worldwide. It concluded that obesity is a rapidly growing epidemic and at the same time acknowledged its status as a disease. Projections for the next decade were felt to be so concerning that urgent public health actions were recommended.[1]

The United States has not been spared from the epidemic of obesity. More than half of the U.S. population is overweight or obese. Body mass index (BMI) is a ratio of a person's weight in kilograms divided by their height in meters squared. The WHO defines weight status based on this ratio (Table 1). Based on the WHO classification, 61% of the U.S. population (> 120 million people) are overweight or obese. Thirty-four percent are overweight, with a BMI of 25–29.9 kg/m^2, and 27% are obese, with a BMI ≥ 30 kg/m^2.[2]

In spite of the growing medical awareness and growth of diet and exercise programs, the prevalence of obesity has increased by more than 75% since 1980.[3] Even our children and adolescents are affected, with just over 10% of 2- to 5-year-olds now being overweight. More than 15% of both 6- to 11-year-olds and 12- to 19-year-olds are also overweight.[4]

Table 1. WHO Classification of Overweight and Obesity

Class	BMI (kg/m^2)	Risk of Comorbidity
Underweight	< 18.5	Low
Normal range	18.5–24.9	Average
Overweight (grade 1 obesity)	25.0–29.9	Mild increase
Obese (grade 2 obesity)	30.0–39.9	Moderate/severe
Morbid/severe obesity (grade 3)	≥ 40.0	Very severe

Adapted from Ref. 1.

COMPLICATIONS AND RISKS ASSOCIATED WITH OBESITY

Obesity has been linked to increased rates of many other chronic disease states. The dramatic increase in obesity in the past decade has been associated with a 25% increase in the prevalence of type 2 diabetes.[5] Among those in whom type 2 diabetes has been diagnosed, 67% have a BMI of at least 27 kg/m^2, and 46% have a BMI of at least 30 kg/m^2.[6] Development of insulin resistance and diabetes seems to be particularly sensitive to the development of visceral adiposity.

Hypertension, dyslipidemia, coronary heart disease (CHD), and stroke have also been linked to obesity. The link between CHD and obesity classically has been thought to be related to the impact of obesity on risk factors including hypertension, dyslipidemia, and impaired glucose metabolism. At least two long-term observational studies, however, have shown that being overweight is a predictor of cardiovascular atherosclerosis independent of its effects on traditional risk factors.[7,8] Other complications, such as obstructive sleep apnea, cholelithiasis, liver disease, musculoskeletal disease, and disorders of reproduction, have all been associated with obesity and overweight.[9–13] Even certain cancers, including colon cancer,[14] endometrial cancer,[15] and postmenopausal breast cancer,[16] have been associated with increasing body weight.

Most studies clearly show an increase in mortality rate associated with BMI (Figure 1). Individuals with a BMI of at least 30 kg/m^2 have a 50–100% increased risk for death from all causes, compared with individuals at a BMI of 20–25 kg/m^2. Most of this increase is because of cardiovascular disease.[17] Clearly, obesity and overweight are associated with a significant amount of excess morbidity and mortality in this country.

IN BRIEF

Obesity has become an epidemic in the United States, with more than 60% of the population now either overweight or obese. Lifestyle modifications and weight loss medications have failed to provide significant, lasting weight loss in the majority of people who are overweight. Weight loss surgery has proven to be a safe and effective means of losing significant and lasting weight and should be considered in those who are morbidly obese.

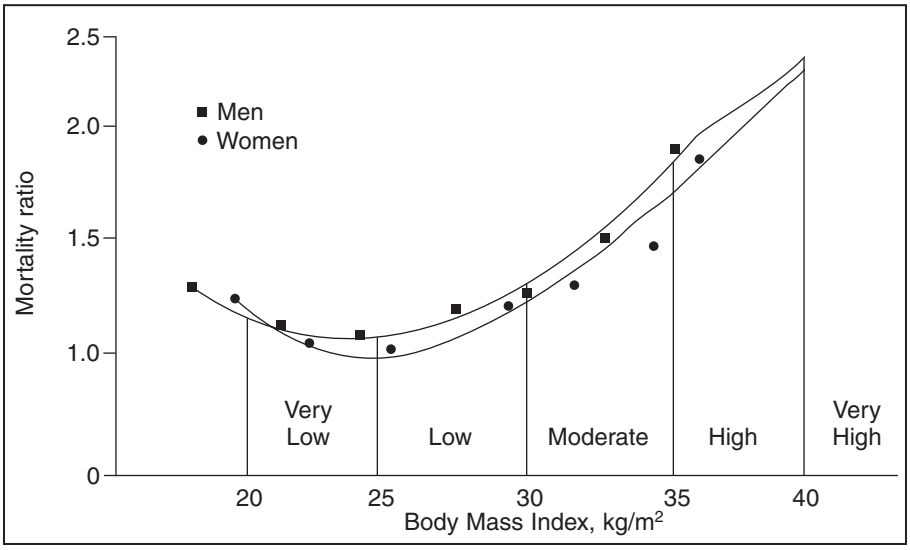

Figure 1. Relation between mortality and BMI. At a BMI below 20 kg/m² and above 25 kg/m², there is an increase in relative mortality for men and women. Data from Lew EA: Mortality and weight: insured lives and the American Cancer Society studies.* Ann Intern Med *103:1024–1029, 1985. Reprinted with permission from the author of Ref. 46.

COSTS OF OBESITY

Obesity and its complications are costly to society. An estimated $52 billion in direct medical costs each year is spent treating obesity-related disease (Table 2). Another $50 billion each year is spent on weight loss attempts.[18] Half of this is spent on diet foods, and the rest is spent on various weight loss programs, supplements, and medications. All together, more than $100 billion is spent each year combating obesity and its consequences. This figure can only be expected to rise as the prevalence of obesity continues to increase.

NONSURGICAL THERAPY

Lifestyle

The National Institutes of Health (NIH) guidelines recommend weight loss for obese people with a BMI of ≥ 30 kg/m² and for people who are overweight (BMI 25–29.9 kg/m²) with two or more obesity-related comorbidities.[19] Lifestyle modifications are generally the recommended first approach to weight loss.

Many studies have shown that overweight individuals can lose about 0.5 kg per week by reducing their daily intake of calories to 500–1,000 calories less than the amount required for weight maintenance.[20] More severe caloric restriction with the use of very-low-calorie diets increases the rapidity of weight loss but not the rate of long-term success in maintaining a lower weight.[19] Although adding exercise to calorie restriction only modestly increases weight loss, it appears to be the most effective component of treatment in weight maintenance once weight is lost.[21] Behavioral therapy helps obese people develop adaptive eating, thinking, and exercise habits that enable them to decrease their weight and avoid regaining weight.[20] People who combine caloric restriction and exercise with behavioral therapy may expect to lose 5–10% of their weight over 4–6 months.

Even this modest weight loss has been shown to improve many obesity-related conditions.[22] Unfortunately, for the vast majority of people, weight loss is followed by slow, progressive weight gain to pre-diet body weight or even higher.[23]

Medications

Pharmacological therapy may be added to diet, exercise, and behavioral therapy to assist with weight loss. Medications are an adjunct to lifestyle modifications, however, and not a replacement.

Expected weight loss with any of the currently available weight loss medications is usually less than 10% of the patients' pre-intervention weight. After initial weight loss, a regain of at least part of the lost weight can be expected. Most studies, however, show less regain in the treatment groups compared with those taking placebo.

Weintraub[24] suggested in the early 1990s that obesity needs to be treated more as a chronic condition that may need prolonged use of medications for appropriate control. Unfortunately, the safety and efficacy of weight loss medications beyond 2 years has not been established, and discontinuation of medication usually results in regain to pretreatment weight or higher. Improvements in obesity-related disease are not sustained if weight is regained. Therefore, it is prudent to consider more sustainable options for weight loss to be added to lifestyle modifications.

WEIGHT LOSS SURGERY

The idea of weight loss surgery was conceived after surgeons noticed that patients undergoing resection of portions of the stomach and small intestine for other reasons lost weight.[25] Surgery for morbid obesity was first described in a case report by Kremen et al. in 1954.[26]

Table 2. Cost of Obesity in the United States

Disease	Direct Cost ($U.S. billions)
Diabetes mellitus	32.4
CHD	7.0
Osteoarthritis	4.3
Hypertension	3.2
Gallbladder disease	2.6
Colon cancer	1.0
Breast cancer	0.84
Endometrial cancer	0.29
Total	51.6

Adapted from Ref. 18.

They published a report of an end-to-end jejunoileostomy performed specifically for weight reduction. Payne then initiated the first clinical program of intestinal bypass for morbid obesity in 1956.[26] Gastric bypass for the treatment of severe obesity was first described by Mason and Ito in 1967.[27] It consisted of a loop gastrojejunostomy and a stapled pouch of ~10% of the gastric volume.[28]

Some of the early procedures were associated with unacceptable sequelae, including diarrhea, malabsorption, electrolytic disturbances, hepatic failure, vitamin deficiencies, and even death.[27–30] The severity of these complications may explain some of the negative attitudes that arose towards the surgical treatment of obesity. Over the past 30 years, numerous modifications were made to the earliest procedures, eventually producing safer and more lasting options for weight loss surgery.

Appropriate Candidates for Surgery

The 1991 NIH consensus conference on obesity surgery released guidelines to help determine which patients are appropriate for weight loss surgery. They suggested that all people with a BMI > 40 kg/m^2 and those with a BMI > 35 kg/m^2 who also have serious comorbidities should be considered for surgery.[31] Patients must have failed conventional methods for weight loss. Also, patients must be good candidates from a psychological standpoint. Serious psychological disease, including some personality disorders and substance abuse, are absolute contraindications. Some patients who are not initially candidates from a psychological standpoint may become acceptable with treatment of their disorder. Surgical candidates must also be committed to maintaining lifestyle changes and continuing long-term follow-up after the surgery.[25]

Current Procedures

Surgical procedures promote weight loss via gastric restriction or malabsorption. Gastric restrictive procedures include Roux-en-Y gastric bypass (RNYGB), gastric banding, and vertical banded gastroplasty. They work by reducing gastric volume, slowing gastric emptying, and creating early satiety. Restrictive procedures lead to significant weight loss in almost all patients, although it is possible to "eat through" the procedure and regain some of the lost weight.[25] This is more of a problem with the vertical banded gastroplasty than with the RNYGB and gastric banding.

The gold standard and most common surgical procedure for weight loss in the United States is the RNYGB. This procedure has proven long-term weight loss, excellent patient tolerance, and acceptable short- and long-term complication rates.[32] RNYGB is accomplished by creating a small (15–30 ml) gastric pouch by placing staples across the proximal stomach and dividing it. The jejunum is divided about 30 cm beyond the ligament of Treitz. The distal limb is brought up, and a proximal end-to-side gastrojejunostomy is performed with the gastric pouch. The proximal limb of the jejunum is anastomosed to the distal jejunum forming a jejunojejunostomy approximately 75–100 cm distal to the gastrojejunostomy[25] (Figure 2).

Table 3 is adapted from Schauer et al.'s article[32] and lists outcomes for RNYGP performed by many of the surgeons who have contributed significantly to the field of bariatric surgery in the past two decades.[33–43] Mortality among patients receiving RNYGB in these trials ranged from 0 to 7.7%. Overall, there were 22 deaths among 3,434 procedures performed, for a 0.64% risk of death related to the surgery. If the 1969 series by Mason and Ito[33] is excluded, then the mortality rates range from 0 to 1.5%, and overall mortality is reduced to 0.58%. Complication rates generally decline as the surgical team gains experience, with many series researchers commenting that a disproportionate number of complications occur early in the cohort. In the long term, patients undergoing this procedure maintain significant weight loss.

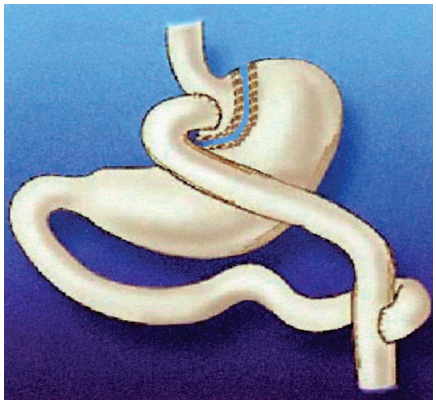

Figure 2. Roux-en-Y gastric bypass.

In the series by Pories et al.,[40] average follow-up was 14 years. Patients lost ~70% of their excess weight in the first 6–12 months and kept off ~50% of their excess weight at the time of reporting. To put this in perspective, a 5'10" male who weighs 350 lb and has a BMI of 50 kg/m^2 can expect to reach a nadir in weight of ~220 lb at 1 year and weigh 258 lb with a BMI of 36 kg/m^2 or less 10 years after the procedure.

The adjustable gastric banding procedure has recently gained recognition as a surgical option and offers some significant advantages. Unlike the vertical banded gastroplasty and RNYGB, the adjustable gastric band (Figure 3) involves no stapling of the stomach wall, no cutting or opening of the stomach, and no alteration of the gastrointestinal tract.[44] Should it become medically necessary, the band can be removed and normal stomach anatomy restored. Also, the degree of restriction created by the band can be adjusted by injecting or withdrawing saline through a port under the skin. This allows the size of the stoma (opening between the upper and lower stomach) to be changed to fit each patient's nutritional and weight loss needs.

Malabsorptive procedures combine gastric restriction with reduced calorie and nutrient absorption. Malabsorptive procedures of preference are the biliopancreatic diversion and the duodenal switch. Neither procedure is widely used because of the high incidence of nutritional deficiencies. The RNYGB is con-

Table 3. Outcomes of RNYGB

Study	*n*	BMI (kg/m²), weight (kg), or % IBW	Early Complication Rate (%)	Mortality (%)	PE Rate (%)	Leak Rate (%)	Hernia (%)	Follow-up (months)	Weight Loss
Mason 1969[33]	42	42 kg/m²	19	7.7	3.4	0	11.5	12	43 kg
Griffin 1981[34]	402	134 kg	4.2	0.75	0.25	5.47	3.5	6	35 kg
Linner 1982[35]	174	126 kg	10.4 (all)	0.57	0	0.57	0	24	64% EWL
Sugerman 1989[36]	182	213%	—	1	0	1.6	18	12	67% EBW
Hall 1990[37]	99	198%	20	0	3	0	2	36	67% lost > 50% EBW
Brolin 1991[38]	90	62 kg/m²	5	0	1.1	0	6.6	43	64% EWL
MacLean 1993[39]	106	50 kg/m²	—	0	—	5.6	—	33	58% lost > 50% EBW
Pories 1995[40]	608	50 kg/m²	25.5	1.5	—	—	23.9	168	49% EWL
Capella 1996[41]	560	52 kg/m²	1	0	0	0	—	60	62% EWL
Fobi 1998[42]	944	46 kg/m²	2.7	0.4	0.6	3.1	4.7	24	80% EWL
MacLean 2000[43]	243	49 kg/m²	—	0.41	—	—	16	66	BMI 44 to > 29

EBW, excess body weight; EWL, excess weight loss; IBW, ideal body weight; PE, pulmonary embolism; —, not reported
Table adapted from Ref. 32.

sidered a purely restrictive procedure because not enough small intestine is bypassed to cause malabsorption. However, several investigators are looking at placing the jejunojejunostomy farther down the jejunum to induce an element of malabsorption. This may prove to have added benefit when operating on the super obese (BMI > 50 kg/m²).

Laparoscopic Approach

Since laparoscopic cholecystectomy was introduced in the late 1980s, the positive impact of laparoscopic surgery on reducing perioperative complications has been repeatedly demonstrated.[32] Morbidly obese patients generally have significant comorbidities, which increase their risks for postoperative cardiopulmonary and wound-related complications. It therefore makes sense that a laparoscopic approach might benefit them even more than it would nonobese people.

In 2000, Schauer et al.[32] published their series of 275 consecutive laparoscopic RNYGBs to compare short-term and long-term complications and outcomes to published outcomes of open procedures. The conversion rate to an open procedure was only 1%. Those patients whose surgeries were performed with a laparoscope had a shorter length of hospital stay, earlier return to work, and equal or better rates of short-term complications compared with patients who had open procedures. There was one death (0.4%) related to a pulmonary embolus. Similar long-term outcomes in relation to weight lost and improvement/resolution of comorbidities were also seen. Most centers now perform weight loss surgery (either RNYGB or adjustable gastric banding) laparoscopically unless other confounding factors prohibit this approach.

IMPROVEMENT IN COMORBIDITIES WITH SURGICAL WEIGHT LOSS

It is generally accepted that most, if not all, obesity-related diseases improve with significant weight loss.

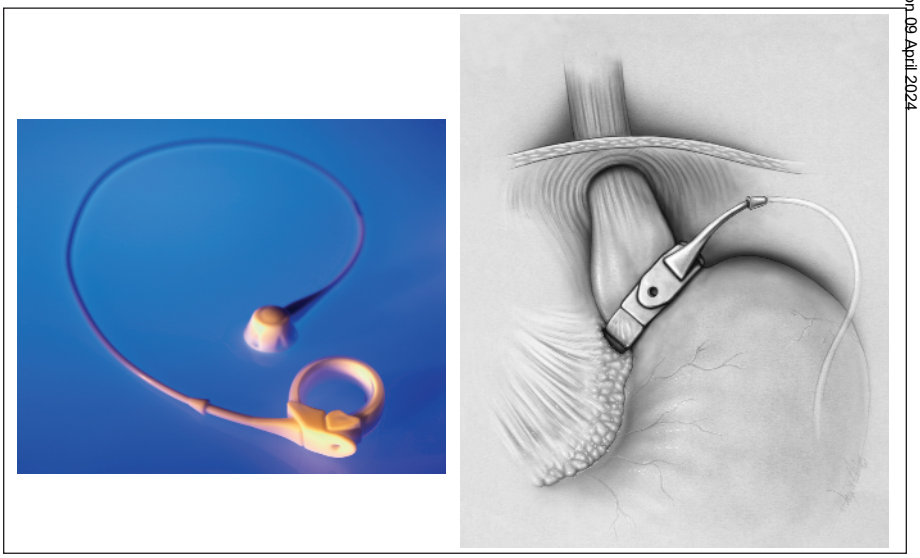

Figure 3. The lap band.

Table 4, adapted from Schauer et al.,[32] shows typical improvements in obesity-related disease that can be expected from RNYGB. Metabolic complications classically associated with mortality in obese patients essentially all improve, if not resolve. These include:

- dyslipidemia: improvement in 96%, resolution in 63%
- hypertension: improvement in 88%, resolution in 70%
- diabetes: improvement in 100%, return to normoglycemia without medications in 82%
- sleep apnea: improvement in 93%, resolution in 74%

Schauer et al.'s original series[32] included only 275 patients and only 18 with diabetes. They published another series 3 years later to report on outcomes in a larger number of patients with diabetes.[45] In the second series, 240 of 1,160 patients undergoing laparoscopic RNYGB over 5 years had type 2 diabetes or impaired fasting glucose. Patients went from a mean preoperative weight and BMI of 308 lb and 50.1 kg/m^2 to a mean of 211 lb and 34 kg/m^2—a mean weight loss of 97 lb and mean excess weight loss of 60%. Fasting plasma glucose and hemoglobin A_{1c} results improved in all patients, with 83% returning to normal on no medications. The remaining 17% did not normalize, but did have significant improvement in glycemic parameters while on less medication.[45]

Improvements in patient outcomes are not limited to physical disorders. When Schauer's patients were surveyed for quality of life changes, 58% said their quality of life was "greatly improved," 37% said it was "improved," and 5% said that there was no change in quality of life. No patient undergoing surgery reported a diminished quality of life.[45]

CONCLUSIONS

Obesity is a growing epidemic affecting a large proportion of the U.S. population. Currently, more than 60% of the U.S. population is either overweight or obese. Projections suggest that this percentage will continue to increase. This trend is even affecting children and adolescents, with a growing number of them developing weight problems at earlier ages. Unfortunately, lifestyle modifications and medical therapies for weight loss have not proven to provide significant, sustained weight loss.

Bariatric surgery has been shown to induce durable weight loss, with most series reporting 50% or greater excess weight loss in the long term. Along with this weight loss comes improvement or resolution of most, if not all, obesity-related diseases.

Surgical candidates should be selected based on currently accepted guidelines and should also comprehend the risks inherent to the procedure. One must balance the ~0.5% risk of death associated with the procedure with the improvement in health status, reduction in comorbidities, and decreased mortality associated with a decreased BMI. The NIH consensus conference concluded that in those with a BMI > 40 kg/m^2 and those with BMI > 35 kg/m^2 and comorbidities, the benefits of the procedure outweigh the risks.

Therefore, weight loss surgery should at least be discussed with all patients meeting the NIH criteria. For those who are willing to undergo the procedure and who do not have any major contraindications, weight loss surgery is a low-risk option with significant benefits.

ACKNOWLEDGMENT

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Table 4. Change in Obesity-Related Comorbidity

Comorbidity	Total Patients	Aggravated (%)	Unchanged (%)	Improved (%)	Resolved (%)
OA/DJD	64	2	10	47	41
Hyperlipidemia	62	0	4	33	63
GERD	58	0	4	24	72
Hypertension	57	0	12	18	70
Sleep apnea	44	2	5	19	74
Depression	36	8	37	47	8
Peripheral edema	31	0	4	55	41
Urinary incontinence	18	0	11	39	44
Asthma	18	6	12	69	13
Diabetes	18	0	0	18	82
Anxiety	7	0	50	17	33
Venous insufficiency	7	0	71	29	0
Gout	7	0	14	14	72

Adapted from Ref. 32. DJD, degenerative joint disease; GERD, gastro-esophogeal reflux disease; OA, osteoarthritis.

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