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Original article

Cost-effectiveness analysis of laparoscopic gastric bypass, adjustable gastric banding, and nonoperative weight loss interventions

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Abstract

Background: Laparoscopic adjustable gastric banding (LAGB) and laparoscopic Roux-en-Y gastric bypass (LRYGB) are the two most commonly performed bariatric procedures. Although both procedures likely reduce healthcare expenditures related to the resolution of co-morbid conditions, they have different rates of perioperative risks and different rates of associated weight loss. We designed a model to evaluate the incremental cost-effectiveness of these procedures compared with nonoperative weight loss interventions and with each other.

Methods: We used a deterministic, payer-perspective model comparing the lifetime expected costs and outcomes of LAGB, LRYGB, and nonoperative treatment. The major endpoints were survival, health-related quality of life, and weight loss. Life expectancy and lifetime medical costs were calculated across age, gender, and body mass index (BMI) strata using previously published data.

Results: For both men and women, LRYGB and LAGB were cost-effective at <$25,000/quality-adjusted life-year (QALY) even when evaluating the full range of baseline BMI and estimates of adverse outcomes, weight loss, and costs. For base-case scenarios in men (age 35 y, BMI 40 kg/m^2), the incremental cost-effectiveness was $11,604/QALY for LAGB compared with $18,543/QALY for LRYGB. For base-case scenarios in women (age 35 y, BMI 40 kg/m^2), the incremental cost-effectiveness was $8878/QALY for LAGB compared with $14,680/QALY for LRYGB.

Conclusion: The modeled cost-effectiveness analysis showed that both operative interventions for morbid obesity, LAGB and RYGB, were cost-effective at <$25,000 and that LAGB was more cost-effective than RYGB for all base-case scenarios. (Surg Obes Relat Dis 2007;xx:xxx–xxx.) © 2007 American Society for Metabolic and Bariatric Surgery. All rights reserved.

Keywords: Laparoscopic adjustable gastric banding; Laparoscopic Roux-en-Y gastric bypass; Cost-effectiveness analyses; Quality-adjusted life-years

Obesity is one of the most common causes of preventable death with >400,000 deaths/yr, an increase of 33% during the past decade [1]. The total healthcare costs for obesity related-issues has been estimated to be >$90 billion/yr, approximately 9% of the total U.S. healthcare expenditures [2]. Obesity is largely refractory to nonoperative interventions [3] but generally responsive to operative ones [4]. Laparoscopic adjustable gastric banding (LAGB) and laparoscopic Roux-en-Y gastric bypass (LRYGB) are the two most commonly performed bariatric procedures. The perioperative risks are lower for LAGB, but patients under-

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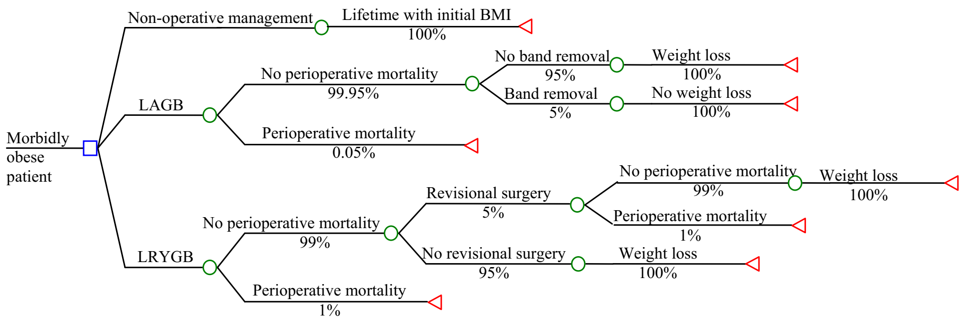

Fig. 1. Deterministic decision analytic model of 3-year operative and nonoperative interventions for morbid obesity. Square represents decision node, circles represent probability nodes, and triangles represent end nodes. Text above lines describes the clinical event and percentage under it represents the probability of the event.

going LRYGB can have more significant weight loss within a shorter period [4]. Previous studies have suggested that both procedures improve patients' quality of life, reduce healthcare expenditures, and improve life expectancy. Given the differential risk and effectiveness of the procedures, the aim of this study was to evaluate the cost-effectiveness of surgical (LRYGB and LAGB) and nonoperative weight loss interventions.

Methods

Model

We developed a deterministic, payer-perspective decision analytic model to compare the lifetime expected costs and outcomes of LAGB, LRYGB, and nonoperative treatment (Fig. 1). This model was derived from a previously published model [5] that involves discrete outcomes at points after surgery. In general, the model describes the possible pathways within the first 3 years to reach the age and body mass index (BMI) of survivors at the end of the 3-year period. The base-case scenarios included morbidly obese male and female patients without obesity-related comorbidities, with a BMI of 40, 50, and 60 kg/m^2, and aged 35, 45, and 55 years. Patients not undergoing operative interventions were assumed to have a stable BMI over time (rather than gaining weight as is expected) to not overestimate the benefits of surgery. The major endpoints were survival and weight loss. Surviving patients could require additional surgical interventions and might undergo band removal. We assumed that 3 years after the initial operation, the patient remained at the initial weight, had lost weight, or had died. If the band was removed, we assumed the patient had remained at their initial BMI and had accumulated lifetime cost and health outcomes the same as in the no-treatment group for that BMI. Successful patients incurred additional costs related to abdominoplasty and cholecystectomy. Postoperative complications were not modeled, because they were not likely to have a long-term impact on the quality of life, and modeling them would have been impractical. Rather, treatment of postoperative complications was assumed into the usual-care medical costs associated with surgery.

Life expectancy and costs

Life expectancy and lifetime medical costs were calculated across age, gender, and BMI strata using previously published data from the Framingham Heart Study and Third National Health and Nutrition Examination Survey [6]. Because the data available from these studies did not include patients with a BMI >37.5 kg/m^2, we applied a simple linear approximation to these estimates to assess the effects of obesity on life expectancy and costs for those with a BMI of 40–60 kg/m^2. We included the usual-care medical costs (in U.S. 2004 dollars) associated with the surgery, including procedural fees, treatment of postoperative complications, follow-up care, and treatment of obesity-related diseases, such as coronary heart disease, stroke, type 2 diabetes, hypercholesterolemia, and hypertension. All cost estimates were adjusted for inflation. The Medical Care Component of the Consumer Price Index for All Urban Consumers was used to adjust prices, when necessary. The expected lifetime medical cost estimates were obtained from published data [6]. For most of the remaining costs, the estimates of nationally representative hospital charges (Table 1 [7–29]) were obtained from the Healthcare Cost and Utilization Project and expert opinion. We obtained the cost of medications and follow-up visits from a source for wholesale drug prices [30].

Utilities

We assumed that a person who lost weight and whose BMI decreased would have the same health-related quality of life as someone who was at the lower BMI at baseline. Utilities determined from patient gender, age, and BMI were derived from the 1997 National Health Interview Survey, previously published by Craig and Tseng [5]. Within each BMI strata, the utilities linearly declined with patient age, and this was accounted for within the base-case analyses.

Table 1
Probabilities and costs for 3 years

Variable	LAGB	LRYGB	Cost
EBWL (%)	55 (38–64) [7–11]	71 (59–89) [12–22]	NA
LAGB	—	—	$16,200*
LRYGB	—	—	$27,560*
Operative mortality (%)	0.05 (0–1) [23]	1 (0.5–2) [23,24]	
Band adjustments	10	NA	$150†
Revisional surgery (%)			
LRYGB	NA	5 (1–10) [17,25,26]	$10,000†
LAGB	5 (2–7) [7,27,28]	NA	$5,000†
Band removal	5 (0–10)†	NA	$6,000†
Perioperative mortality (revision surgery) (%)	0.05 (0–1)†	1 (0.5–2)†	
Minor wound infection (%)	2*	5*	$204*
Major wound infection (%)	0.5*	3*	$11,236*
DVT (%)	0.5 [23]	2.6 [23]	$9,222*
Nonfatal PE (%)	0.1*	1*	$15,582*
Follow-up visit (other than adjustment)	0†	6†	$159†
Dietary supplements (%)	NA	100	$72 [29]
Leak-nonoperative, LRYGB (%)	NA	3 (1–5)†	$50,000†
Laparoscopic cholecystectomy (%)	7.5 (5–25)*	11.4 (5–30)*	$16,000*
Incisional hernia repair (%)	0.5 (0.1–2.5)*	1.7 (0.1–5)*	$14,416*
Abdominoplasty (%)	39 (35–45)*	39 (35–45)*	$13,992*

LAGB = laparoscopic adjustable gastric banding; LRYGB = laparoscopic Roux-en-Y gastric bypass; EBWL = excess body weight loss; NA = not applicable; DVT = deep venous thrombosis; PE = pulmonary embolism.
* Healthcare Cost and Utilization Project.
† Expert opinion.

Probabilities

The probabilities of the clinical events and outcomes of surgical procedures were derived from a comprehensive literature review [23]. Base-case estimates were derived from the average of the reported values. Excess body weight loss was estimated using studies with 36 months of follow-up. The quality-adjusted life-years (QALYs) and costs were discounted at 3%. The incremental cost-effectiveness ratio (ICER) of competing surgical strategies compared with nonoperative strategies was calculated for the full range in the target population.

Sensitivity analysis

One-way sensitivity analysis was performed for all variables in the decision model to determine the effect of uncertainty in the base-case assumptions on the costs, outcomes, and ICERs between LAGB and LRYGB. The purpose of the sensitivity analysis was twofold: to investigate the robustness of the base-case estimates and to determine which factors influence the ICER, favoring LAGB versus LRYGB. A tornado diagram was created using selected variables that had the greatest influence on the model. Several two-way sensitivity analyses were performed for combinations of particularly influential variables. The values used for the one-way sensitivity analyses for the clinical probabilities included the range found in the published data. When estimates were derived from expert opinion, a wide range of probabilities was used to evaluate the impact of this parameter. Costs varied by at least ±25% of the base-case estimate to account for variations in the community.

Results

For both men and women, LRYGB and LAGB were cost-effective at <$25,000/QALY when evaluating the full range of BMI values and estimates of adverse outcomes, weight loss, and costs. For base-case scenarios in men (aged 35 yr with a BMI of 40 kg/m^2), the ICER was $11,604/QALY for LAGB compared with $18,543/QALY for LRYGB. For base-case scenarios in women (aged 35 yr with a BMI of 40 kg/m^2), the ICER was $8878/QALY for LAGB compared with $14,680/QALY for LRYGB. The ICER for LAGB was lower than that of LRYGB for all base-cases (men and women, aged 35, 45, and 55 yr and BMI 40, 50, and 60 kg/m^2) and across the full range of variables tested. In the one-way sensitivity analysis (Fig. 2), the ICER of LAGB was most influenced by the extent of weight loss, operation cost, and frequency of band removal. The ICER of LRYGB was most influenced by the rate of operative mortality, extent of weight loss, and operation cost.

Discussion

Cost-effectiveness analyses (CEAs) of bariatric procedures are critical given the cost of the procedures, the potential for saving future costs related to co-morbid health

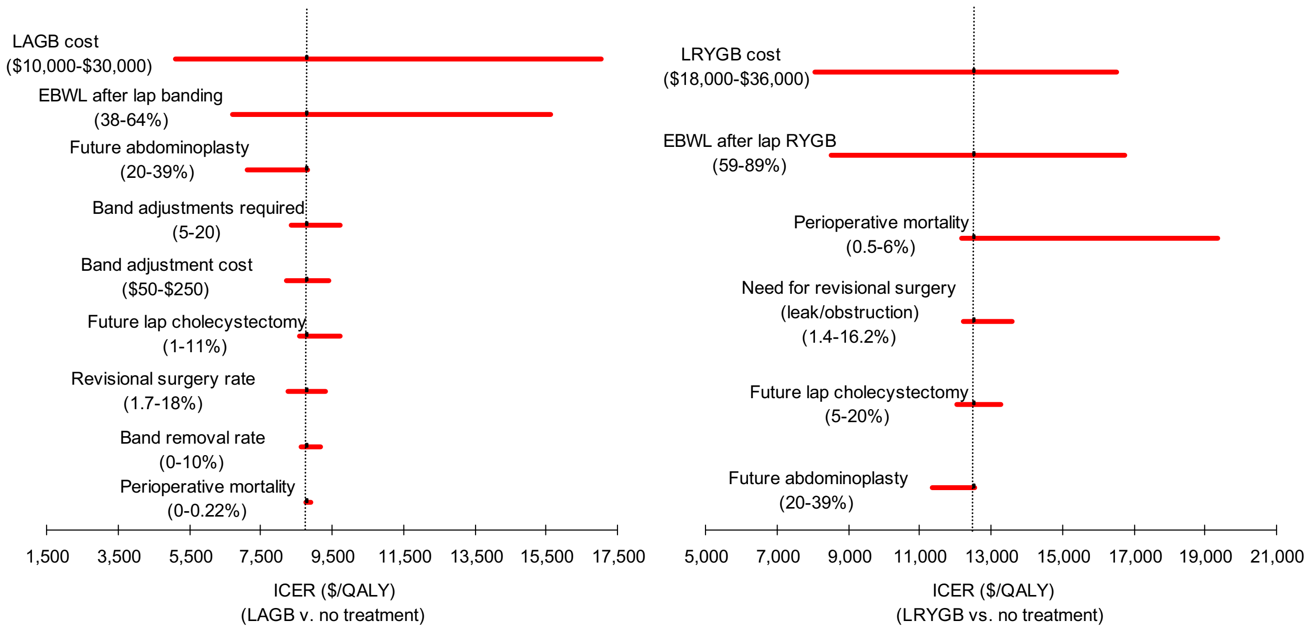

Fig. 2. One-way sensitivity analysis of difference in ICER between strategies of LRYGB and LABG for 45-year-old woman with BMI of 40 kg/m^2. Dashed vertical line represents difference between ICER for LRYGB and LAGB using base-case values. Solid lines demonstrate effect of variables on ICER.

conditions and worker productivity, and the growing population of operative candidates. Economic evaluations of bariatric procedures have so far been limited [31], with only one formal CEA of bariatric procedures [5] evaluating RYGB and none for LRYGB and LAGB. LAGB is increasing in popularity and has minimal operative mortality compared with LRYGB; less is known about its weight loss efficacy over time and in the community at large. Furthermore, only a few small, comparative studies of LAGB and LRYGB have been done [32]. The main elements influencing the cost effectiveness of these procedures is the associated weight loss and postoperative morbidity. Because these procedures have different rates of adverse and, perhaps, positive outcomes, comparing them can be problematic. A CEA is an ideal method to balance these two sets of outcomes. Using this analytic tool probability and the cost estimates associated with competing management strategies (using actual and modeled data) can be used to compare different strategies with an overall metric of cost/QALY. In this study, we found that both bariatric procedures were cost-effective at <$25,000 for all base-case scenarios. This finding was similar to those of previous CEAs [5,33]. We also found that LAGB was more cost-effective than RYGB, with a lower ICER compared with the nonoperative interventions. Also, in certain populations, LAGB resulted in a cost savings. The benefits of LAGB were related to its lower associated mortality rate and were dependent on it resulting in significant and sustained weight loss over time.

A major component of a CEA is the determination of the survival benefit of the intervention. When evaluating the survival benefits of obesity surgery, the mortality rate associated with the procedure is balanced against the long-term survival benefit. In a population-based study, the 30-day mortality rate of gastric bypass in Washington State was nearly 2%, twice the greatest mortality rate previously reported [31]. However, patients surviving the first postoperative year had a significant survival benefit compared with nonoperated patients. Researchers reported at the 2006 International Congress on Obesity [34] that RYGB results in a 40% less risk of mortality than that for matched nonoperated cohorts. This was also exemplified in a retrospective study with 9-year follow-up that showed an overall annual mortality rate of 1% among 154 patients who underwent RYGB compared with 4.5% annual mortality rate among 78 morbidly obese patients referred for RYGB who did not undergo the operation for personal or financial reasons [35]. Using a modeled analysis of survival benefit, Pope et al. [36] reported a 2.3–2.6-year and 3.3–3.4-year gain in life expectancy, respectively, for women and men aged 30–60 years who underwent RYGB.

In contrast, LAGB has very low perioperative mortality (<1%; Table 1), but it can result in a lower extent of excess body weight loss compared with RYGB in the first 3 years after placement. In a recent retrospective series, patients who underwent LRYGB had 66% rate of excess weight loss after 3 years versus 39.3% for those undergoing LAGB [37]. No difference was found in the excess body weight loss between LRYGB and LAGB 5 years after the operation (58.6% versus 49%, P = .84); however, the researchers conceded that the low patient follow-up at 5 years made true comparison faulty. Two research abstracts presented at the 2006 International Congress on Obesity indicated a 62–73%

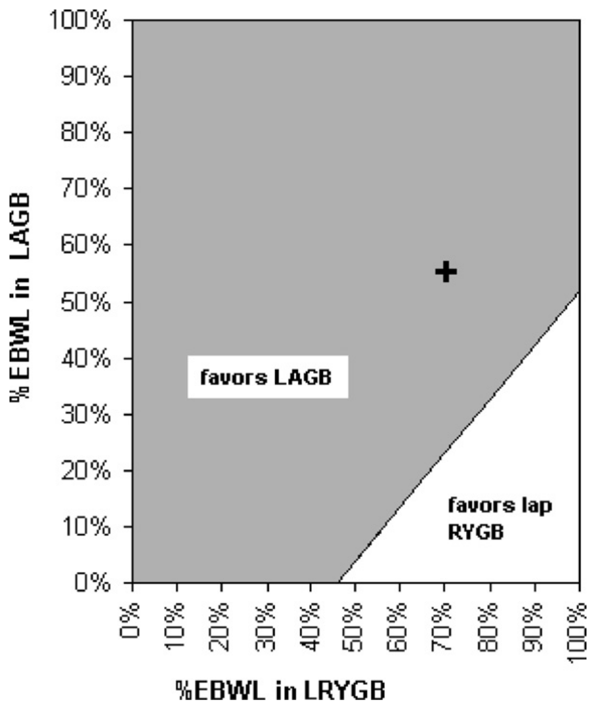

Fig. 3. Two-way sensitivity analysis of cost-effectiveness of LAGB and LRYGB. Diagram depicts difference in cost-effectiveness between LAGB and LRYGB with varying percentage of excess body weight loss (EBWL) achieved with these procedures for 45-year-old women with BMI of 40 kg/m^2. Shaded area represents EBWL values for which difference in cost-effectiveness of surgical procedures favored LAGB. Line depicts scenarios in which LAGB and LRYGB yield same cost-effectiveness. Cross represents difference in cost-effectiveness of these procedures using base-case estimates.

reduction in the mortality rate for LAGB patients compared with a matched cohort [38]. These reports suggest that LAGB might extend survival in a fashion similar to that of RYGB. In our modeled analysis, we found that, despite a lower extent of weight loss in LAGB, it was more cost-effective than LRYGB. A recent systematic review of the weight loss achieved with different procedures [34] showed a similar percentage of excess body weight loss with LAGB and RYGB. However, most of these studies were flawed by the limited number of patients with long-term follow-up >3 years. We assessed the cost effectiveness of these procedures with varying weight loss using a two-way sensitivity analysis (Fig. 3).

Cost is a main issue for the broader use of bariatric surgery. Although the benefits of bariatric surgery on weight reduction and the effect on obesity-related co-morbidities have been shown, many health insurance companies are limiting the use of these procedures. Although the cost of bariatric surgery needs to be evaluated, the cost of nonoperative interventions, including diet, exercise, and medication, also needs to be considered when directing healthcare policy. Reportedly, Americans spend >92 billion dollars annually on obesity-related healthcare, including nonoperative interventions, all of which have been shown to be ineffective over time [3]. Our research group recently compared the costs of operative and nonoperative interventions and found that the operative interventions resulted in cost savings when applied to a population of morbidly obese patients [39].

Clinicians and purchasers of healthcare services are engaged in a discussion to determine the best approach to the treatment of obesity. Cost and effectiveness are two of the elements that help determine this issue, but all healthcare decisions should be individualized to the unique needs of the patient and practice environment. Finally, the results of a CEA might not be a good argument for the health insurance companies in the United States, because many insurance contracts are terminated within 3–4 years. Given that limited timeline, some have suggested that from a business perspective, coverage of a bariatric procedure would be like sustaining the "upfront" costs of the operation and its complications without the long-term benefits of the reduced healthcare costs resulting from the weight loss and reduction in obesity-related co-morbidities. When taken from the broader perspective of the Federal and State governments and large employers (who finance most healthcare costs in the United States), these economic considerations are relevant to the competing crises of spiraling healthcare costs and the loss of productivity related to obesity.

This study had several limitations. The future costs, life expectancy, and quality of life were based on the weight loss achieved by the procedures. Although for RYGB, studies have been published with 7 years of follow-up, only a few studies have reported on the weight loss of patients undergoing LAGB after 3 years. We assumed that beyond the initial 3 years after surgery, the BMI would remain stable. Weight gain after this period would reduce the cost effectiveness of the procedures. To make conservative estimate of the cost-effectiveness of the bariatric procedures, patients undergoing nonoperative management were assumed to have a stable BMI. The estimates of life expectancy, future costs, and quality of life were determined from data from the Third National Health and Nutrition Examination Survey and the Framingham studies. These studies included data on patients with a BMI of ≤37.5 kg/m^2. We assumed a linear correlation between the BMI and these parameters (life expectancy, future costs, and quality of life) for the estimation of BMIs of 40–60 kg/m^2. The data on life expectancy have supported this linear relationship [40], but data on BMIs >45 kg/m^2 are limited. This could represent a conservative bias if the outcomes for patients with greater BMIs are worse than the linear projection we assumed. Furthermore, the probabilities and costs that underlie this model were not BMI or age specific, because few reports have suggested that the probabilities and costs are related to BMI or age. However, if these probabilities and costs are associated with advancing BMI or age, the model might have underestimated the effect of these on patients with advanced BMI or age. Also, the implication of this bias would be difficult to assess. In this study, we considered the relationship between obesity and 5 chronic conditions: hypertension, hypercholesterolemia, type 2 diabetes mellitus, coronary heart disease, and stroke. The results of previous research [41] have suggested that these conditions account for approximately 85% of the total economic burden of obesity. This could also represent a conservative bias, because other co-morbid conditions not considered in this model might be reduced by weight loss. Finally, although our model incorporated the complications of surgery in the usual-care cost calculation, the rates of these complications could vary between sites and would be difficult to assess accurately in a modeled analysis.

Conclusion

Our modeled CEA showed that both operative interventions for morbid obesity, LAGB and LRYGB, were cost-effective at <$25,000, and LAGB was more cost-effective than LRYGB for all the base-case scenarios.

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

References

[1] Mokdad A, Serdula M, Dietz W, Bowman B, Marks J, Koplan J. The continuing epidemic of obesity in the United States. JAMA 2000; 284:1650–1.

[2] Finkelstein EA, Fiebelkorn IC, Wang G. National medical spending attributable to overweight and obesity: how much, and who's paying? Health Aff (Millwood). 2003;Jan–Jun(Suppl W3):219–26.

[3] McTigue KM, Harris R, Hemphill B, et al. Screening and interventions for obesity in adults: summary of the evidence for the U.S. Preventive Services Task Force. Ann Intern Med 2003;139:933–49.

[4] Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004;292:1724–37.

[5] Craig BM, Tseng DS. Cost-effectiveness of gastric bypass for severe obesity. Am J Med 2002;113:491–8.

[6] Thompson D, Edelsberg J, Colditz G, Bird A, Oster G. Lifetime health and economic consequences of obesity. Arch Intern Med 1999;159:2177–83.

[7] Suter M, Bettschart V, Giusti V, Heraief E, Jayet A. A 3-year experience with laparoscopic gastric banding for obesity. Surg Endosc 2000;14:532–6.

[8] O'Brien PE, Brown WA, Smith A, McMurrick PJ, Stephens M. Prospective study of a laparoscopically placed, adjustable gastric band in the treatment of morbid obesity. Br J Surg 1999;86:113–18.

[9] Kellum J, DeMaria E, Sugerman H. The surgical treatment of morbid obesity. Curr Probl Surg 1998;35:791–858.

[10] De Luca M, de Werra E, Formato A, et al. Laparotomic vs laparoscopic lap-band: 4-year results with early and intermediate complications. Obes Surg 2000;10:266–8.

[11] Dargent J. Laparoscopic adjustable gastric banding: lessons from the first 500 patients in a single institution. Obes Surg 1999;9:446–52.

[12] Freeman JB, Kotlarewsky M, Phoenix C. Weight loss after extended gastric bypass. Obes Surg 1997;7:337–44.

[13] Smith SC, Goodman GN, Edwards CB. Roux-en-Y gastric bypass: a 7-year retrospective review of 3,855 patients. Obes Surg 1995;5: 314–18.

[14] Fobi MA, Lee H, Igwe D Jr, Stanczyk M, Tambi JN. Prospective comparative evaluation of stapled versus transected silastic ring gastric bypass: 6-year follow-up. Obes Surg 2001;11:18–24.

[15] Howard L, Malone M, Michalek A, Carter J, Alger S, Van Woert J. Gastric bypass and vertical banded gastroplasty—a prospective randomized comparison and 5-year follow-up. Obes Surg 1995;5: 55–60.

[16] Capella JF, Capella RF. The weight reduction operation of choice: vertical banded gastroplasty or gastric bypass? Am J Surg 1996;171: 74–9.

[17] Balsiger BM, Kennedy FP, Abu-Lebdeh HS, et al. Prospective evaluation of Roux-en-Y gastric bypass as primary operation for medically complicated obesity. Mayo Clin Proc 2000;75:673–80.

[18] MacLean L, Rhode B, Forse R, Nohr R. Surgery for obesity—an update of a randomized trial. Obes Surg 1995;5:145–50.

[19] Fox SR, Oh KH, Fox K. Vertical banded gastroplasty and distal gastric bypass as primary procedures: a comparison. Obes Surg 1996; 6:421–5.

[20] Schauer P, Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes after laparoscopic Roux-en-Y gastric bypass for morbid obesity. Ann Surg 2000;232:515–29.

[21] Kalfarentzos F, Dimakopoulos A, Kehagias I, Loukidi A, Mead N. Vertical banded gastroplasty versus standard or distal Roux-en-Y gastric bypass based on specific selection criteria in the morbidly obese: preliminary results. Obes Surg 1999;9:433–42.

[22] Sugerman H, Starkey J, Birkenhauer R. A randomized prospective trial of gastric bypass versus vertical banded gastroplasty for morbid obesity and their effects on sweets versus non-sweets eaters. Ann Surg 1987;205:613–24.

[23] Chapman AE, Kiroff G, Game P, et al. Laparoscopic adjustable gastric banding in the treatment of obesity: a systematic literature review. Surgery 2004;135:326–51.

[24] Flum DR, Dellinger EP. Impact of gastric bypass operation on survival: a population-based analysis. J Am Coll Surg 2004;1994: 543–51.

[25] Jones KB Jr. Experience with the Roux-en-Y gastric bypass, and commentary on current trends. Obes Surg 2000;10:183–5.

[26] Higa K, Boone K, Ho T, Davies O. Laparoscopic Roux-en-Y gastric bypass for morbid obesity: technique and preliminary results of our first 400 patients. Arch Surg 2000;135:1029–33.

[27] Toppino M, Morino M, Bonnet G, Nigra I, Siliquini R. Laparoscopic surgery for morbid obesity: preliminary results from SICE registry (Italian Society of Endoscopic and Minimally Invasive Surgery). Obes Surg 1999;9:62–5.

[28] Angrisani L, Alkilani M, Basso N, et al. Laparoscopic Italian experience with the Lap-Band. Obes Surg 2001;11:307–10.

[29] Drug Topics Red Book. Montvale, NJ: Medical Economics Company; 2003.

[30] Gallager S, Banasiak M, Gonzalvo J, et al. The impact of bariatric surgery on the Veterans Administration healthcare system: a cost analysis. Obes Surg 2003;13:245–8.

[31] Flum D, Salem L, Broeckel Elrod J, Dellinger E, Cheadle A, Chan L. Early mortality among Medicare beneficiaries undergoing bariatric surgical procedures. JAMA 2005;294:1903–8.

[32] Jan J, Hong D, Pereira N, Patterson E. Laparoscopic adjustable gastric banding versus laparoscopic gastric bypass for morbid obesity: a single-institution comparison study of early results. J Gastrointest Surg 2005;9:30–9.

[33] Clegg AJ, Colquitt J, Sidhu MK, Royle P, Loveman E, Walker A. The clinical effectiveness and cost-effectiveness of surgery for people

with morbid obesity: a systematic review and economic evaluation. Health Technol Assess 2002;6:1–153.

[34] O'Brien P, McPhail T, Chaston T, Dixon J. Systematic review of medium-term weight loss after bariatric operations. Obes Surg 2006; 16:1032–40.

[35] Pories W, Swanson M, MacDonald K. Who would have thought it? An operation proves to be the most effective therapy for adult-onset diabetes mellitus. Ann Surg 1995;222:339–50.

[36] Pope G, Finlayson S, Kemp J, Birkmeyer J. Life expectancy benefits of gastric bypass. Surg Innovat 2006;13:265–73.

[37] Jan J, Hong D, Bardaro S, July L, Patterson E. Comparative study between laparoscopic adjustable gastric banding and laparoscopic gastric bypass: single-institution, 5-year experience in bariatric surgery. Surg Obes Relat Dis 2007;3:42–51.

[38] Dixon J. Survival advantage with bariatric surgery: report from the 10th International Congress on Obesity. Surg Obes Relat Dis 2006;2:585–6.

[39] Jensen C, Flum D. The costs of nonsurgical and surgical weight loss interventions: is an ounce of prevention really worth a pound of cure? Surg Obes Relat Dis 2005;1:353–7.

[40] Fontaine KR, Redden DT, Wang C, Westfall AO, Allison DB. Years of life lost due to obesity. JAMA 2003;289:187–93.

[41] Nguyen N, Goldman C, Rosenquist C, et al. Laparoscopic versus open gastric bypass: a randomized study of outcomes, quality of life, and costs. Ann Surg 2001;234:279–89.