The American Journal of Medicine®

Changes in Lipid Profile of Obese Patients Following Contemporary Bariatric Surgery: A Meta-Analysis

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ABSTRACT

BACKGROUND: Although metabolic surgery was originally performed to treat hypercholesterolemia, the effects of contemporary bariatric surgery on serum lipids have not been systematically characterized.

METHODS: MEDLINE, EMBASE, and Cochrane databases were searched for studies with ≥ 20 obese adults undergoing bariatric surgery (Roux-en-Y gastric bypass [RYGBP], adjustable gastric banding, biliopancreatic diversion [BPD], or sleeve gastrectomy). The primary outcome was change in lipids from baseline to 1 year after surgery. The search yielded 178 studies with 25,189 subjects (preoperative body mass index 45.5 ± 4.8 kg/m^2) and 47,779 patient-years of follow-up.

RESULTS: In patients undergoing any bariatric surgery, compared with baseline, there were significant reductions in total cholesterol (TC; −28.5mg/dL), low-density lipoprotein cholesterol (LDL-C; −22.0 mg/dL), triglycerides (−61.6 mg/dL), and a significant increase in high-density lipoprotein cholesterol (6.9 mg/dL) at 1 year ($P < .00001$ for all). The magnitude of this change was significantly greater than that seen in nonsurgical control patients (eg LDL-C; −22.0 mg/dL vs −4.3 mg/dL). When assessed separately, the magnitude of changes varied greatly by surgical type ($P_{interaction} < .00001$; eg, LDL-C: BPD −42.5 mg/dL, RYGBP −24.7 mg/dL, adjustable gastric banding −8.8 mg/dL, sleeve gastrectomy −7.9 mg/dL). In the cases of adjustable gastric banding (TC and LDL-C) and sleeve gastrectomy (LDL-C), the response at 1 year following surgery was not significantly different from nonsurgical control patients.

CONCLUSIONS: Contemporary bariatric surgical techniques produce significant improvements in serum lipids, but changes vary widely, likely due to anatomic alterations unique to each procedure. These differences may be relevant in deciding the most appropriate technique for a given patient.

 • *The American Journal of Medicine (2016) 129, 952-959*

KEYWORDS: Bariatric surgery; Cholesterol; Lipids; Meta-analysis; Obesity

The original impetus for the development of metabolic surgery was the treatment of hypercholesterolemia. 2015 marked the 50th anniversary of Buchwald's report of partial ileal bypass as an effective intervention for treating hypercholesterolemia,[1] and the 25th anniversary of the publication of the initial results of the randomized trial testing the procedure's efficacy—Program On the Surgical Control of the Hyperlipidemias (POSCH).[2] This procedure achieved marked reduction of cholesterol absorption and, correspondingly, serum cholesterol in the prestatin era,[3] eventually resulting in reduced cardiovascular death in patients with history of myocardial infarction.[2]

Bariatric surgery has since evolved to 4 dominant procedures (biliopancreatic diversion [BPD], Roux-en-Y gastric bypass [RYGBP], adjustable gastric banding, and

Funding: This was an unfunded study.

Conflict of Interest: CR-F is a consultant for Apollo Endosurgery. All other authors have no relevant disclosures.

Authorship: All authors had access to the data and contributed sufficiently to writing the manuscript to be included as authors.

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http://dx.doi.org/10.1016/j.amjmed.2016.02.004

sleeve gastrectomy), ranging from largely malabsorptive to completely restrictive, regarded as the most effective therapies for treating obesity. The procedures have shown significant beneficial effects beyond weight reduction, including resolution of dyslipidemia.[4] Although thousands of reports of contemporary bariatric surgical techniques have been published, changes in serum lipids beyond the period of early, rapid weight loss are not well characterized. With this meta-analysis, we sought to describe the effects of contemporary bariatric surgical procedures on serum lipids of obese patients at 1 year and more after surgery.

CLINICAL SIGNIFICANCE

- Contemporary bariatric surgery improves lipid parameters at 1 year following surgery compared with baseline and nonsurgical controls.
- Changes in total cholesterol and low-density lipoprotein cholesterol do not differ from those of nonsurgical controls at last follow-up beyond 1 year.
- Changes in all major serum lipid parameters differ greatly by procedure type.
- There are few data on the effects on lipid profile of the currently most commonly performed bariatric procedure — sleeve gastrectomy.

METHODS

Data Sources and Searches

Following Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines, we searched PubMed/MEDLINE, EMBASE, and Cochrane databases from inception through April 2015. With a trained librarian, we created comprehensive searches for the concepts of bariatric surgery and lipid profiles (**Supplementary Table 1**, available online), without language, publication date, or study design limitations.

Study Selection

Studies 1) involving $\geq$ 20 obese adults undergoing RYGBP, adjustable gastric banding, sleeve gastrectomy, or BPD; 2) reporting data on lipid profile at baseline and follow-up; and 3) reporting follow-up for at least 1 year, were included. Studies including nonobese subjects or combining data from subjects undergoing disparate or novel procedures were excluded.

Data Extraction and Quality Assessment

Using standardized data forms, 2 authors (SPH, AP) assessed the full text of initially nonexcluded articles to determine if average total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides, or high-density lipoprotein cholesterol (HDL-C) values, and measures of variance, were presented for subjects at baseline and at least 1 year following surgery. Average lipid values lacking variance were not included in analyses. If subject duplication was discovered, the report containing the largest number of subjects was included.

Outcomes

Our principal summary measure was difference in mean lipid value (TC, LDL-C, triglycerides, HDL-C) of the sample prior to and after (1 year and last reported follow-up value) bariatric surgery.

Data Synthesis and Statistical Analysis

Using RevMan version 5.3 (Cochrane, Copenhagen), we performed random-effects modeling of mean differences in a factorial fashion by lipid component and surgical technique/control subjects not undergoing surgery.[5] Data were analyzed at 1 year and longest reported follow-up beyond 1 year. Heterogeneity was assessed using I^2 statistics.[6] Funnel plots were visually assessed for suggestion of publication bias.

Our primary analysis was a comparison of mean difference in lipid values from baseline at 1 year in patients undergoing bariatric surgery. Our secondary analyses included comparisons of mean change of each lipid parameter in 1) the surgical cohort and nonsurgical controls at 1 year and beyond 1 year, and 2) the 4 individual contemporary bariatric surgical techniques at 1 year and beyond 1 year.

Sensitivity analyses included assessments of mean change in lipid parameters 1) by procedure, stratified by study design (randomized, prospective, retrospective); and 2) in studies excluding vs those not excluding the use of lipid-lowering medications. Differences in subgroups were assessed using a test for interaction, with P-value $< .05$ considered significant.

RESULTS

Of 2908 articles identified from our database search, 180 articles (178 separate studies: 11 randomized trials, 93 prospective observational studies, 74 retrospective analyses) met inclusion criteria (**Figure 1**).

The 178 studies reported on 25,189 patients with 47,779 patient-years of follow-up. At the time of surgery, subjects were 40.7 $\pm$ 4.8 years of age and body mass index was 45.5 $\pm$ 4.8 kg/m^2. Mean follow-up across all studies was 27.9 months. Eighty-eight studies reported data beyond 1 year (mean 47.5 months). **Supplementary Table 2** (available online) presents composite characteristics of subjects described in reports of each surgical procedure. **Supplementary Table 3** (available online) lists each study included in the meta-analysis.

Total Cholesterol

In surgical subjects, there was a significant reduction in mean TC at 1 year compared with baseline ($P < .00001$,