



Effect of Roux-en-Y gastric bypass surgery on ventricular function and cardiac risk factors in obese patients: a systematic review

Alireza Abdollahi Moghaddam (MD)¹, Ali Jangjoo(MD)², Fereshteh Ghaderi (MD)¹, Majid Erfanzadeh (MD)^{*1}

¹Department of Cardiology, Imam Reza Hospital, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

²Surgical Oncology Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

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ABSTRACT

Introduction: Weight gain and obesity are two important public health problems, which are associated with many diseases such as cardiovascular disorders. Various policies such as bariatric surgery have been proposed for the treatment of morbid obesity.

Methods: PubMed and Scopus were searched thoroughly with the following search terms (roux-en-y gastric bypass surgery) AND (ventricular function, OR cardiac risk factors OR heart)) AND (BMI OR body mass index) to find the articles in which the effect of roux-en-Y gastric bypass (RYGB) surgery had been evaluated in severely obese patients.

Result: Out of 120 articles which were found in PubMed, and 28 records which were found in Scopus, only 18 articles fully met the inclusion criteria. Out of 2740 participants in the included studied, 1706 were patients with body mass index (BMI) over 40 kg/m² who had undergone RYGB surgery, and 1034 were control participants. Results of the studies showed that RYGB surgery could reduce BMI, and cardiac risk factors, and improve diastolic function, systolic and diastolic blood pressures, and aortic function, postoperatively.

Discussion: Obesity is associated with increased risk of cardiovascular diseases, impaired cardiac function, and hypertension. It is shown that RYGB surgery reduces the serum level of biochemical markers of cardiac diseases. Cardiac structure, parasympathetic indices of autonomic function, coronary circulatory function, hypertension, epicardial fat thickness, and ventricular performance improve after bariatric surgery.

Conclusions: It is concluded that RYGB surgery is an effective strategy to improve ventricular function and cardiac risk factors in morbid obese patients.

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Introduction

Weight gain and obesity are two major public health problems of new decade, especially in the industrialized countries and developing world that directly and indirectly impose a considerable financial burden on the national health system and society. Prevalence of the disease, which is consid-

ered to be mainly due to the industrialization of societies, has rapidly increased globally over the past decades (1). According to the World Health Organization (WHO), obesity is defined as the increase in body mass index (BMI) greater than 30 kg/m², while overweight is defined as a BMI of 25

***Corresponding author:** Majid Erfanzadeh.

Department of Cardiology, Imam Reza Hospital, School of Medicine, Mashhad University of Medical Science, Mashhad, Iran.

E-mail: majiderfanzadeh@gmail.com

Tel: 09155228978

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to 30 (2). Morbid obesity is also defined as a BMI over 40, or over 35, if accompanied by obesity-related comorbidity (1). Studies showed that the prevalence of obesity has almost doubled among the adults over the last four decades from 13.4% in 1960 to 35.1% in 2005 only in United States (1).

Obesity is not only a risk factor for systemic hypertension, since more than 50% of systemic hypertension in patients is due to obesity; it might be considered as the major leading cause of hypertension (3). On the other hand, reports showed that an increase in BMI is strongly associated with increased risk of cardiovascular disease, hypertension, type 2 diabetes, sleep apnea, hyperlipidemia, osteoarthritis, cancer, and death (4-6). It is shown that obesity could be considered as an independent risk factor for death, since it could reduce life expectancy up to 22%, resulting in 12 years of life lost in adults (7). The mechanism of the development of heart failure in obese patients is not fully understood; however, it is likely that changes in lipid and glucose metabolism have positive effects on left ventricular function both in animal models and in human (5).

So far, various approaches such as diet and drug therapy, exercise and physical activity, lifestyle changes and weight-loss surgery have been proposed for the treatment of morbid obesity, each have their strengths and weaknesses. Nowadays, surgical therapy has become a choice method for the treatment of morbid obesity, since the treatment regimen and medical therapies are ineffective in the long-term treatment of obesity (8). Roux-en-Y gastric bypass (RYGB) surgery as a minimally invasive technique and the most commonly performed operation is one of the most effective bariatric surgical techniques for the treatment of morbid obesity, which is considered as the gold standard for bariatric surgery (9,10). Therefore, in this study, we systematically review the effects of gastric bypass surgery on the improvement of ventricular function and cardiovascular risk factors.

Methods

Literature search strategy

PubMed and Scopus were systematically searched to find the articles in which the effect of RYGB surgery had been evaluated in obese patients with BMI higher than 40 kg/m². Literature search was conducted with the following search terms (roux-en-y gastric bypass surgery) AND (ventricular function, OR cardiac risk factors OR heart)) AND (BMI OR body mass index) to find the articles in English language using the key terms, "roux-en-y gastric bypass surgery", "BMI" and "cardiac function" in the title, keywords, and abstract till 1 March 2015. Relevant articles were

selected by two reviewers independently and used for data extraction. The reference list of the relevant articles was also searched manually to include other relevant articles and minimize the possibility of any missing data.

Study selection

There was no time limitation for the selection of the articles. Only articles in English language were included in the study to minimize any misinterpretation of data in further processes of data extraction. Clinical trials, cross-sectional, case-controls, case reports, and prospective cohort studies were included in this literature review. Review articles and meta-analysis were omitted in the first step of article selection process. Moreover, papers were excluded if they were unrelated to the purpose of this study, or if surgical techniques other than RYGB surgery have been used for the treatment of morbid obesity. Inclusion criteria were papers in which the effects of gastric bypass surgery on ventricular function and cardiovascular risk factors had been studied in obese patients with BMI over 40 kg/m². Duplicated and irrelevant papers were omitted in the first step by reviewing the titles, keywords, and abstracts of papers. Full text of the relevant documents was fully reviewed and used for data extraction.

Data synthesis

Data including the name of the first author, country, publication date, study design, and concluded results were extracted and tabulated based on the main purpose of this study. All available data including total number of participants and patient characteristics were obtained as possible. Extracted data were categorized based on the results reporting the effects of RYGB surgery on ventricular function and cardiovascular risk factors. All processes of data extraction and study selection were performed by two independent reviewers; in addition, data synthesis was based on the recommendation of PRISMA 2009 (11).

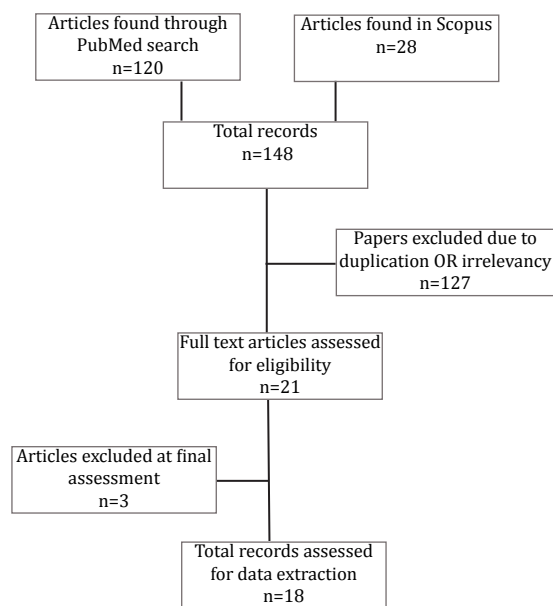
Results

Search results

Out of 120 article found in PubMed search, and 28 records found in Scopus, only 38 articles seemed to be related to the purpose of this study. Seventeen records were omitted due to duplication, subject or language irrelevancy. Additionally, three papers were also excluded because the BMI of studied patients were less than 40 kg/m². After careful revision of the articles, only 18 papers fully met the inclusion criteria for further assessment; hence, full text of included articles

were collected, and the data were extracted based on the main purpose of this study. Figure 1 shows step by step selection process of included articles.

Figure 1. Flowchart of the study selection



Description of the included studies

The total numbers of participants were 2740 that were studied for the evaluation of the relationship between RYGB surgery, ventricular function and cardiac risk factors in patients with morbid obesity. Of them, 1706 were obese patients with BMI over 40 kg/m² who had undergone RYGB surgery, and 1034 were control participants with or without morbid obesity who had not undergone gastric bypass surgery. The age, gender and other demographic data had not been reported in some studies and more than half of the patients were female. The number of studied participants varied from 2 patients in a case report to 423 obese patients. The duration of postoperative follow-up varied from 1 month to 10 years among the studies.

Study results

Results of studies showed that RYGB surgery could significantly reduce the weight and BMI, postoperatively. It was also shown that cardiac risk factors, diastolic function, systolic and diastolic blood pressures, and aortic function improved after surgery. Results of included studies also showed that baroreflex sensitivity (BRS), epicardial fat thickness, left ventricular (LV) performance, coronary circulatory function, and heart rate variability (HRV) indices improved at long-term follow-up. Analysis of the data showed that ventricular function has improved due to RYGB surgery; as well the cardiac risk factors reduced

postoperatively in obese patients with BMI>40 kg/m². Moreover, according to reported data in the reviewed papers, and by comparison of data between RYGB surgical patients and nonoperative controls, all cardiopathologic markers and other causative factors of cardiac associated disease significantly improved at long-term follow-up in patients who had undergone RYGB surgery. Therefore, it could be concluded that weight loss by RYGB surgery might be a powerful and permanent intervention to reduce the occurrence of myocardial infarction or other cardiac-associated diseases and death due to the morbid obesity.

Discussion

Obesity is associated with a significant increase in the risk of cardiovascular diseases such as impaired aortic function and diastolic indices, hypertension, and coronary heart disease (15,19,23). It is also associated with diseases such as diabetes and dyslipidemia (30). Several strategies and interventions are suggested to treat patients with morbid obesity, but among the suggested items, RYGB surgery has attracted more attentions and is now considered as the method of choice and the gold standard of bariatric surgery.

Results show that RYGB surgery reduces the serum level of biochemical cardiac risk factors, particularly C-reactive protein and coronary artery calcium (CAC) score, the marker of coronary atherosclerosis (165,31). Serum level of hemoglobin A1C and cardiac structure significantly improve in severely obese patients after bariatric surgery (32). Findings also show that the risk of cardiovascular diseases and heart attack is significantly lower in severely obese patients who have undergone RYGB surgery (14,18,29). As well, it is shown that all parasympathetic indices of autonomic function increase postoperatively. Moreover, RYGB surgery has a satisfactory effect on cardiovascular autonomic function, coronary circulatory function, hypertension, epicardial fat thickness, and ventricular performance. Moreover, RYGB surgery minimizes the requirement of antihypertensive drugs in morbid obese patients at long-term follow-up (28,32).

Therefore, according to aforementioned and based on data reviewed in this study, RYGB surgery is an effective and sustained weight loss strategy that reduces BMI to normal level and improves cardiovascular and cardiac autonomic function. However, a comprehensive, comparative and methodological study is suggested to design to evaluate the efficacy of all interventions and strategies on sustained weight loss and their independent effect on BMI and cardiac functions at long-term follow-up.

Table 1. Characteristics of literatures included in this review

NO	Author Country Reference	Year	Study type (Follow-up) ®	Number of participants	BMI pre and postop- eratively (kg/m ²)	Factors examined*
1	McCloskey USA (12)	2007	RS (6 months)	14	50.8- 36.8	CF, LVF
2	Ikonomidis Greece (13)	2007	PS (36 months)	60 patients, 20 controls	48.68-32	AF, BP, LVMI, LVF
3	Maser USA (14)	2007	PCS (12 months)	21	48-34.3	CAF, S/DBP, HbA1c
4	Vogel USA (15)	2007	RS (17 months)	109	49-36	BP, CF
5	Williams USA (16)	2007	PS (12 months)	356	47-31	BP, HbA1C, BCRF
6	Ristow USA (17)	2008	CR (2 years)	2	43- 23 and 56- 37	L/RVF, CF
7	Kligman USA (18)	2008	RS (10-year)	101	46.9- 28.7 at 1 year follow-up	S/DBP, CF
8	Hinojosa USA (19)	2009	RS (12 months)	95	47-NM©	S/DBP, CF
9	Lind Sweden (20)	2009	(12 months)	19 patients, 19 controls	43.8- 31.1	S/DBP, HR
10	Garza USA (21)	2010	RS (3.6 years)	57 patients, 57 controls	49- 35	L/RVF, L/RVMI, L/ RMP
11	Owan USA (22)	2011	PS (2-Year)	423 patients, 733 controls	47.9-32.2	HR, LVMI, RVF, CF
12	Valezi Brazil (23)	2011	PCS (1 year)	43	41.8-28.4	HR, S/DBP,
13	Wasmund USA (24)	2011	RS (2 years)	153 patients, 188 controls	47-31	HR, HbA1C, S/DBP
14	Maser USA (25)	2013	PS (6 months)	32	51-37	S/DBP, HbA1C, HR
15	Kokkinos Greece (26)	2013	PS (6 months)	14	47.9-34.5	S/DD, LVMI, PB, LVP, CAF
16	Quercioli Switzerland (27)	2013	PS (22 months)	18	45-30	CCF, BP, BCRF
17	Aftab Norway (28)	2014	PS (5 years)	184 patients	46.5-33	BP, CF
18	Oberbach Austria (29)	2014	PCS (12 months)	5 patients, 17 controls	63-36.4	S/DBP, BCRF

®RS: Retrospective study, CR: Case report, CC: Case-control study, PBOS: Prospective, blinded observational study, PCS: Prospective cohort study, PCS: Prospective study; * CF: Cardiac function, L/RVF: Left/right ventricular function, AF: Aortic function, BP: Blood pressure, CAF: Cardiac autonomic function, S/DBP: Systolic/diastolic blood pressure, BCRF: Biochemical cardiovascular risk factors, HR: Heart rate, L/RVMI: Left/right ventricular mass index, L/RMP: Left/right myocardial performance, S/DD: Systolic/diastolic diameters, LVP: Left/right ventricular performance, CCF: coronary circulatory function. © NM: Not mentioned.

Conclusion

Based on the results obtained in this study, it is concluded that ventricular function and cardiac risk factors improve in morbid obese patients after RYGB surgery. Moreover, the serum level of biochemical markers of cardiac disease improve postoperatively.

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Conflict of Interest

The authors declare no conflict of interest.

References

- Noria SF, Grantcharov T. Biological effects of bariatric surgery on obesity-related comorbidities. *Can J Surg*. 2013;56:47-57.
- Organization WH. Obesity and Overweight. Fact Sheet No. 311. September 2006. Online document at: www.who.int/mediacentre/factsheets/fs311/en/index.html Accessed September 2010;13.
- Braunwald E, Bonow RO. Braunwald's heart disease : a textbook of cardiovascular medicine. Philadelphia: Saunders; 2012.
- Wilson PW, D'Agostino RB, Sullivan L, et al. Overweight and obesity as determinants of cardiovascular risk: the Framingham experience. *Arch Intern Med*. 2002;162:1867-1872.
- Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA*. 2003;289:76-79.
- Krauss RM, Winston M, Fletcher BJ, et al. Obesity : impact on cardiovascular disease. *Circulation*. 1998;98:1472-1476.
- Fontaine KR, Redden DT, Wang C, et al. Years of life lost due to obesity. *JAMA*. 2003;289:187-193.
- Sjostrom L, Lindroos AK, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med*. 2004;351:2683-2693.
- Steinbrook R. Surgery for severe obesity. *N Engl J Med*. 2004;350:1075-1079.
- Rubino F. Bariatric surgery: effects on glucose homeostasis. *Curr Opin Clin Nutr Metab Care*. 2006;9:497-507.
- Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals Intern Med*. 2009;151:W-65-W-94.
- McCloskey CA, Ramani GV, Mathier MA, et al. Bariatric surgery improves cardiac function in morbidly obese patients with severe cardiomyopathy. *Surg Obes Relat Dis*. 2007;3:503-507.
- Ikonomidis I, Mazarakis A, Papadopoulos C, et al. Weight loss after bariatric surgery improves aortic elastic properties and left ventricular function in individuals with morbid obesity: a 3-year follow-up study. *J Hypertens*. 2007;25:439-447.
- Maser RE, Lenhard MJ, Irgau I, et al. Impact of surgically induced weight loss on cardiovascular autonomic function: one-year follow-up. *Obesity (Silver Spring)*. 2007;15:364-369.
- Vogel JA, Franklin BA, Zalesin KC, et al. Reduction in predicted coronary heart disease risk after substantial weight reduction after bariatric surgery. *Am J Cardiol*. 2007;99:222-226.
- Williams DB, Hagedorn JC, Lawson EH, et al. Gastric bypass reduces biochemical cardiac risk factors. *Surg Obes Relat Dis*. 2007;3:8-13.
- Ristow B, Rabkin J, Haeusslein E. Improvement in dilated cardiomyopathy after bariatric surgery. *J Card Fail*. 2008;14:198-202.
- Kligman MD, Dexter DJ, Omer S, et al. Shrinking cardiovascular risk through bariatric surgery: application of Framingham risk score in gastric bypass. *Surgery*. 2008;143:533-538.
- Hinojosa MW, Varela JE, Smith BR, et al. Resolution of systemic hypertension after laparoscopic gastric bypass. *J Gastrointest Surg*. 2009;13:793-797.
- Lind L, Zethelius B, Sundbom M, et al. Vasoreactivity is rapidly improved in obese subjects after gastric bypass surgery. *Int J Obes*. 2009;33:1390-1395.
- Garza CA, Pellikka PA, Somers VK, et al. Structural and functional changes in left and right ventricles after major weight loss following bariatric surgery for morbid obesity. *Am J Cardiol*. 2010;105:550-556.
- Owan T, Avelar E, Morley K, et al. Favorable changes in cardiac geometry and function following gastric bypass surgery: 2-year follow-up in the Utah obesity study. *J Am Coll Cardiol*. 2011;57:732-739.
- Valezi AC, Machado VH. Morphofunctional evaluation of the heart of obese patients before and after bariatric surgery. *Obes Surg*. 2011;21:1693-1697.
- Wasmund SL, Owan T, Yanowitz FG, et al. Improved heart rate recovery after marked weight loss induced by gastric bypass surgery: two-year follow up in the Utah Obesity Study. *Heart Rhythm*. 2011;8:84-90.
- Maser RE, Lenhard MJ, Peters MB, et al. Effects of surgically induced weight loss by Roux-en-Y gastric bypass on cardiovascular autonomic nerve function. *Surg Obes Relat Dis*. 2013;9:221-226.
- Kokkinos A, Alexiadou K, Liaskos C, et al. Improvement in cardiovascular indices after Roux-en-Y gastric bypass or sleeve gastrectomy for morbid obesity. *Obes Surg*. 2013;23:31-38.
- Quercioli A, Montecucco F, Pataky Z, et al. Improvement in coronary circulatory function in morbidly obese individuals after gastric bypass-induced weight loss: relation to alterations in endocannabinoids and adipocytokines. *Eur Heart J*. 2013;34:2063-2073.
- Aftab H, Risstad H, Sovik TT, et al. Five-year outcome after gastric bypass for morbid obesity in a Norwegian cohort. *Surg Obes Relat Dis*. 2014;10:71-78.
- Oberbach A, Neuhaus J, Inge T, et al. Bariatric surgery in severely obese adolescents improves major comorbidities including hyperuricemia. *Metabolism*. 2014;63:242-249.
- Batsis JA, Romero-Corral A, Collazo-Clavell ML, et al. Effect of weight loss on predicted cardiovascular risk: change in cardiac risk after bariatric surgery. *Obesity (Silver Spring)*. 2007;15:772-784.
- Priester T, Ault TG, Davidson L, et al. Coronary calcium scores 6 years after bariatric surgery. *Obes Surg*. 2015;25:90-96.
- Liang Z, Wu Q, Chen B, et al. Effect of laparoscopic Roux-en-Y gastric bypass surgery on type 2 diabetes mellitus with hypertension: a randomized controlled trial. *Diabetes Res Clin Pract*. 2013;101:50-56.