



Changes in Fat Intake, Body Fat Composition and Intra-Abdominal Fat after Bariatric Surgery

Heesook Lim^{1,2}, Gui Ae Jeong^{2,3}, Gyu Seok Cho^{2,3}, Min Hee Lee⁴, Soonkyung Kim^{5*}

¹Department of Clinical Nutrition, Soonchunhyang University Bucheon Hospital, Bucheon 420-767, South Korea

²Bariatric Surgery Center, Soonchunhyang University Bucheon Hospital, Bucheon 420-767, South Korea

³Department of Surgery, Soonchunhyang University Bucheon Hospital, Bucheon 420-767, South Korea

⁴Department of Radiology, Soonchunhyang University Bucheon Hospital, Bucheon 420-767, South Korea

⁵Department of Food Sciences & Nutrition, Soonchunhyang University, Asan 336-745, South Korea

Bariatric surgery is considered to be the effective treatment alternative conducted over the lifetime for reducing weight in patients with clinically morbid obesity. For many patients, the benefits of weight loss, including decreases in blood glucose, lipids, and blood pressure as well as increase in mobility, will outweigh the risks of surgical complications. But patients undergoing bariatric surgery have the least risk for long-term diet-related complications as reported in several studies. Thus, with an increasing number of severely obese patients undergoing bariatric surgery, the multidisciplinary healthcare system will need to be managed continuously. Many nutrition support specialists will need to become familiar with the metabolic consequences for the frequent monitoring of nutrition status of the patients. South Korea has a very short history with bariatric surgery, and relatively few studies have been conducted on bariatric surgery. Therefore, the objective of this report was to compare the nutrient intake, weight loss, body fat composition, and visceral fat before and after the bariatric surgery.

Key Words: Bariatric surgery, Obesity, Dietary fats, Intra-abdominal fat

***Corresponding author** Soonkyung Kim

Address Department of Food Sciences & Nutrition, Soonchunhyang University, 22 Soonchunhyang-ro, Sinchang-myeon, Asan 336-745, South Korea

Tel +82-41-530-1261 **Fax** +82-41-530-1264

E-mail soon56@sch.ac.kr

Received June 12, 2014

Revised June 23, 2014

Accepted June 24, 2014

© 2014 The Korean Society of Clinical Nutrition

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Introduction

Morbid obesity is a serious social problem that decreases the quality of life while increasing the mortality and morbidity rates compared to healthy individuals. In South Korea, as the number of severely obese patients has been increasing each year, the number of subjects undergoing bariatric surgery is also increasing [1]. Bariatric surgery is a very popular option for western obese patients, and it is known to have many positive effects on weight loss and changes in metabolic indices [2]. In order to adapt to sudden changes in dietary quantity and to prevent nutritional imbalance after the surgery, specialized nutritional management is essential. Nutrition research on patients undergoing bariatric surgery is rarely conducted in Korea [3]. Although investigation continues into dietary contributors to obesity, excess energy intake, and, particularly, increased amounts of fat may promote obesity because fat is

the most energy dense [4]. But some studies have focused on calorie intake and nutritional deficiency. Thus, we report a case with reviews of literature investigating the changes in fat intake, body fat, and abdominal fat before and after the bariatric surgery.

Case

A 51-year-old man who had an excavator managing job at a construction field, as a head of the household of a multicultural family, had been steadily gaining weight since his 30s. The patient suffered from a herniated disc, gonarthrosis, and sleep apnea as his weight reached 106 kg. He lost approximately 13 kg through exercising during 1 year prior to the surgery. When the weight loss slowed down, he visited the Bariatric Surgery Center at Soonchunhyang University at Bucheon Hospital in June 2013 for a surgical consult. At the time of the surgery, his weight was 93.0 kg and BMI was 35.8 kg/m², which was corresponding to severe morbid obesity. Medical comorbidities included fatty liver and hyperlipidemia.

The patient underwent laparoscopic sleeve gastrectomy on July 11, 2013. He followed up at the hospital before surgery, 1 month, 3 months, and 6 months after the obesity surgery. He underwent examinations for anthropometry, body component, blood test, and dietary survey on each visit. Abdominal computed tomography (CT) was performed 6 months before and

after the surgery. Dietary counseling included nutritional assessment, changes in eating behavior, nutrient considerations, weight-loss strategies, motivation, telephone consultation, and nutrition diagnosis. All physicians and a professional nutritionist provided patient education on every visit along with the feedback the test results.

Changes in the patient's anthropometry, body fat, and blood test measurements during the 6 months following the surgery are shown in Table 1. The patient's weight decreased by approximately 20 kg from 93 kg to 73.3 kg, close to his target weight of 70 kg. His body fat decreased from 32.4 kg to 22.2 kg, and body fat percentage decreased from 35.5% to 33.0%. His waist circumference decreased by approximately 20 cm from 114 cm to 93.4 cm. His liver function test decreased to normal levels, which was proven by the decrease in aspartate aminotransferase level to 17 IU/L and an alanine aminotransferase level to 19 IU/L at 6 months after the surgery. His triglyceride level decreased from 215 mg/dL to 104 mg/dL at 6 months after the surgery, while high-density lipoprotein cholesterol level increased from 39 mg/dL to 56 mg/dL.

The abdominal CT scans before the surgery and 6 months after the surgery are shown in Figure 1. The area of the fat has been represented by the green color. The area of subcutaneous fat of patient decreased 28.3% from 293.7 cm² (A) to 210.5 cm² (B) after operation. While the area of visceral fat decreased 59.0% from 317.8 cm² (C) to 130.4 cm² (D), showing remark-

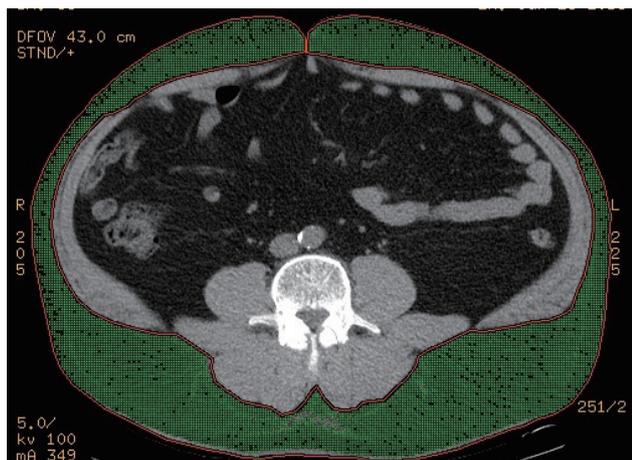
Table 1. Changes of anthropometric and biochemical data of the patient before and after sleeve gastrectomy

Variables	Preoperative	Postoperative [1 month]	Postoperative [3 months]	Postoperative [6 months]
Weight, kg	93.0	81.8	78.1	73.3
BMI, kg/m ²	35.8	32.0	30.5	28.6
Body fat, kg	32.4	27.1	24.4	22.2
Body fat, %	35.3	33.1	31.2	33.0
Lean mass, kg	54.1	50.1	49.3	49.0
WC, cm	114.0	107.8	100.1	93.4
AST, IU/L	39.0	24.0	19.0	17.0
ALT, IU/L	64.0	35.0	25.0	19.0
Total cholesterol, mg/dL	207.0	190.0	214.0	200.0
Triglyceride, mg/dL	215.0	164.0	120.0	104.0
LDL cholesterol, mg/dL	135.0	145.0	153.0	141.0
HDL cholesterol, mg/dL	39.0	36.0	43.0	56.0

BMI: body mass index, WC: waist circumference, AST: aspartate aminotransferase, ALT: alanine aminotransferase, LDL: low-density lipoprotein, HDL: high-density lipoprotein.

Dietary Fat and Body Fat after Bariatric Surgery

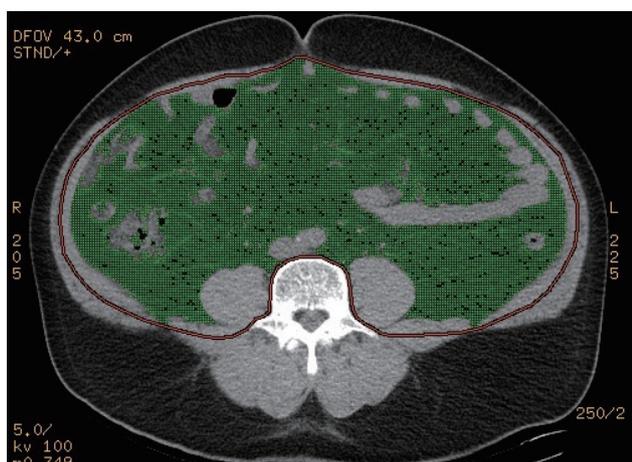
A. Before operation



B. 6 months after operation



C. Before operation



D. 6 months after operation

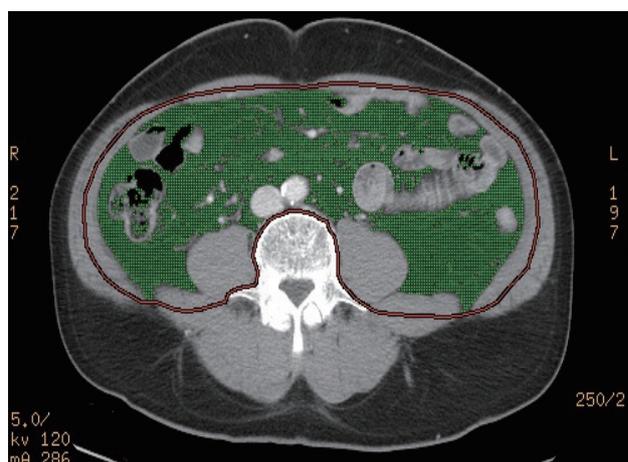


Figure 1. Changes of body fat on abdominal CT scan. CT scanning for measuring fat area was performed with subject in the supine position, at the lumbar vertebra 4-5 level. Subcutaneous fat area (A, B) and visceral fat area (C, D) of the patient before and after surgery were represented by the green color.

able improvement compared the change of area subcutaneous fat. The visceral-to-subcutaneous fat ratio (VSR) was changed from 1.08 to 0.62 and remained stable after the surgery.

The patient's nutrient intake was investigated using a food recording method and was analyzed using a specialized nutrition analysis program (CAN program ver. 3.0, The Korean Nutrition Society, 2005). The major nutrient intake and fat types are shown in Table 2. Prior to the surgery, the patient consumed excessive amounts of alcohol and meat nearly every day during the week, while his weekend diet mainly consisted of fast food, fried chicken, and fruit. The patient also expressed that he had difficulty of controlling his gluttony. During the first month after the surgery, the patient consumed

rice liquid, porridge, and high-protein powder before returning to a regular diet. Three months after the surgery, the patient was able to control his meal portions. As a result, the patient's caloric intake, which was approximately 3,700 kcal before the surgery, was reduced to approximately 900 kcal 6 months after the surgery; and his intake of carbohydrate, protein, and fat also showed dramatic decreases. Cholesterol intake was decreased from 578 mg to 121 mg after the surgery; and his intake of total fatty acid, monounsaturated fatty acid, and polyunsaturated fatty acid was also decreased noticeably. The intake ratio of total fatty acid to monounsaturated fatty acids to polyunsaturated fatty acids showed a positive change with 1:1.1:0.9 at 6 months after the surgery.

Table 2. Changes of major nutrient intake and fat intake distribution of the patient before and after sleeve gastrectomy

Variables	Preoperative	Postoperative [1 month]	Postoperative [3 months]	Postoperative [6 months]
Calorie, kcal	3737.7	614.4	782.2	890.6
Carbohydrate, g	544.7	65.7	110.4	148.9
Protein, g	132.8	48.3	44.2	49.0
Fat, g	125.3	17.6	18.2	11.0
CHO : PRO : FAT, %	57 : 14 : 29	43 : 31 : 26	56 : 23 : 21	67 : 22 : 11
Cholesterol, mg	578.6	77.6	115.8	121.3
TFA, g	70.7	13.1	12.7	8.1
SFA, g	32.2	4.0	5.2	3.2
MUFA, g	23.9	7.6	4.7	2.8
PUFA, g	14.6	1.5	2.8	2.1
SFA : MUFA : PUFA, %	1.3 : 1.0 : 1.6	1.8 : 0.9 : 0.3	1.1 : 1.2 : 0.9	1 : 1.1 : 0.9

CHO: carbohydrate, Pro: protein, TFA: total fatty acids, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids.

After the surgery, the patient no longer had sleep apnea, and no complications or eating disorder were observed during the follow-up care. Moreover, the patient's family members were satisfied and were very supportive to accommodate to his changed body type and lifestyle after the surgery. The patient is still maintaining the effort to keep his current weight by controlling his food intake and exercising.

Discussion

With the increase in obesity and the development of laparoscopic techniques, the frequency of bariatric surgery has increased. The bariatric surgery was first implemented in the 1950s to treat obesity. In this procedure, the sleeve gastrectomy leaves the antrum intact while eliminating the fundus and the main part of the stomach to maintain a normal GI pathway [5]. In the cases abroad, when food intake and lifestyle adjustment accompanied the surgery, significant weight loss of 25–75 kg was observed within 2 years after the surgery [6]. According to Han and Kim [7], patients after sleeve gastrectomy showed weight loss at an average of 20 kg after 6 months and a total of 25 kg within 12 months after the surgery. It is recommended to keep an accurate measurement of the body fat and intra-abdominal fat after the surgery [8]. The study by Weiss et al. [8] revealed a 32% decrease in subcutaneous fat and 35% decrease in visceral fat in patients 6 months after surgery. Furthermore, a numerous studies showed that the obesity surgery improve various health complications such as

type 2 diabetes, hypertension, hyperlipidemia, and sleep apnea [9]. In this study, we observed a decrease of 20 kg in weight 6 months after the surgery, with decrease in waist circumference, and improvement in blood lipid tests, as well as a greater decrease in visceral fat compared to subcutaneous fat.

After the bariatric surgery is performed, multi-faced and specialized nutritional management is important [10]. Bothe et al. [11] recommended a daily intake of 800–1,200 kcal to maintain a long-term weight control and reported that the frequent consumption of small amounts along with slow eating habits are necessary to prevent dumping syndrome after the surgery. Moreover, the ingestion of pureed foods for the first 1–2 weeks after the surgery and soft foods there after is recommended to ensure a gradual adjustment. To prevent deficiencies in vitamins and minerals such as calcium, vitamin D, iron, and folic acid, the balanced nutrition and the intake of supplemental nutrition are necessary depending on the patient [12]. The importance of lifestyle changes and continuous management is emphasized to prevent the weight regain. Also, such managements decrease the patients' risk of metabolic diseases [13].

The patient in our study had good compliance during the meal adjustment and controlling period after the surgery. The total energy intake, fat intake, and saturated fatty acid consumption were decreased while polyunsaturated fatty acid consumption was increased. Compared to the study by Kim et al. [14] in Korea, the energy intake of our patient was higher at 6 months after the surgery than the patients who underwent

Dietary Fat and Body Fat after Bariatric Surgery

laparoscopic Roux-en-Y gastric bypass, and it was lower than the patients who underwent laparoscopic adjustable gastric banding. But the exact comparison is difficult due to the different surgical methods. A high-fat diet has increased visceral fat accumulation, and whole body and muscle insulin resistance [15]. We evaluated fat mass changes with reduction of fat intake after bariatric surgery. However, this study has several limitations to consider including the smaller sample size and absence of significant difference analysis.

Our patient continued controlling his nutritional intake for weight maintenance even after he reached his target weight. The continuous nutritional guidance is necessary to prevent a long-term malnutrition. Furthermore, subspecialized studies on patients undergoing bariatric surgery are needed, and further efforts are required for the development of a manual for professional nutritional guidelines specific to each surgical method.

Conflict of interest

We declare that we have no conflict of interest.

Acknowledgement

This work was supported by the Soonchunhyang University Research Fund.

References

1. Heo YS, Kwon JW, Lee HJ, Choi JE, Song HJ, Oh SH, Lee JY, Kim YJ, Kim SM, Park DJ, Park JM, Lee SK, Han SM, Shim KW, Lee YJ. The clinical effectiveness and economic analysis of bariatric surgery for severe obesity. Seoul: National Evidence-based healthcare Collaborating Agency; 2012.
2. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrback K, Schoelles K. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004;292:1724-37.
3. Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon MM, Heinberg LJ, Kushner R, Adams TD, Shikora S, Dixon JB, Brethauer S. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient-2013 update: cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery. *Obesity* 2013;21 Suppl 1:S1-27.
4. Corella D, Arnett DK, Tucker KL, Kabagambe EK, Tsai M, Parnell LD, Lai CQ, Lee YC, Warodomwicht D, Hopkins PN, Ordovas JM. A high intake of saturated fatty acids strengthens the association between the fat mass and obesity-associated gene and BMI. *J Nutr* 2011;141:2219-25.
5. Consensus Development Conference Panel. NIH conference. Gastrointestinal surgery for severe obesity. *Ann Intern Med* 1991;115:956-61.
6. Douketis JD, Macie C, Thabane L, Williamson DF. Systematic review of long-term weight loss studies in obese adults: clinical significance and applicability to clinical practice. *Int J Obes (Lond)* 2005;29:1153-67.
7. Han SM, Kim WW. The 3-year results of laparoscopic sleeve gastrectomy for the treatment of Korean morbid obesity. *J Korean Surg Soc* 2007;73:400-5.
8. Weiss R, Appelbaum L, Schweiger C, Matot I, Constantini N, Idan A, Shussman N, Sosna J, Keidar A. Short-term dynamics and metabolic impact of abdominal fat depots after bariatric surgery. *Diabetes Care* 2009;32:1910-5.
9. Bult MJ, van Dalen T, Muller AF. Surgical treatment of obesity. *Eur J Endocrinol* 2008;158:135-45.
10. Marcason W. What are the dietary guidelines following bariatric surgery? *J Am Diet Assoc* 2004;104:487-8.
11. Bothe A Jr, Bistran BR, Greenberg I, Blackburn GL. Energy regulation in morbid obesity by multidisciplinary therapy. *Surg Clin North Am* 1979;59:1017-31.
12. Schweiger C, Weiss R, Berry E, Keidar A. Nutritional deficiencies in bariatric surgery candidates. *Obes Surg* 2010;20:193-7.
13. Sjöström L, Lindroos AK, Peltonen M, Torgerson J, Boucharde C, Carlsson B, Dahlgren S, Larsson B, Narbro K, Sjöström CD, Sullivan M, Wedel H; Swedish Obese Subjects Study Scientific Group. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med* 2004;351:2683-93.
14. Kim HJ, Namgung SA, Hong JI, Mok HJ. A study on the standards of medical-nutritional-education by the type of bariatric surgery in morbid-obesity patients. *J Korean Diet Assoc* 2010;16:178-87.
15. Kim JY, Nolte LA, Hansen PA, Han DH, Ferguson K, Thompson PA, Holloszy JO. High-fat diet-induced muscle insulin resistance: relationship to visceral fat mass. *Am J Physiol Regul Integr Comp Physiol* 2000;279:R2057-65.