Metabolic and Psychosocial Effects of Minimal Invasive Gastric Banding for Morbid Obesity

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Obesity is considered a primary risk factor for cardiovascular disease and related mortality. The current study aimed to investigate the efficacy of minimal invasive gastric banding (GB) surgery for reducing caloric intake in morbid obesity, and to analyze the effects of weight loss on body composition and metabolic and psychosocial outcomes. Twenty-six adult severely obese patients (mean body mass index [BMI], 48.1 kg/m^2; range, 42 to 56) underwent adjustable silicone laparoscopic GB. Nine additional obese patients who declined surgery were treated with metformin (2 g daily) and served as a small additional group (BMI, 50.5 kg/m^2; range, 41 to 68). Presurgery and 17 ± 2.2 months postoperatively, body composition (fat mass [FM], lean body mass [LBM], body water) and serum parameters (lipids, glucose, thyrotropin-stimulating hormone [TSH]) were determined. Quality of life (QoL) was evaluated by a standardized self-rating questionnaire (Short Form-36 [SF-36]), and supplemented by measures of physical complaints and psychological distress. After GB, weight loss was 21 ± 14.9 kg (14%, *P* < .001). It was associated with a decrease in FM by 14 ± 8.6 kg (18%, *P* < .001), LBM by 4 ± 2.7 kg (5%, *P* < .001), body water by 4 ± 3.4 L (7%, *P* < .01), systolic blood pressure by 16 ± 26.3 mm Hg (10%, *P* < .05), total cholesterol by 0.69 ± 1.29 mmol/L (12%, *P* < .05), and low-density lipoprotein cholesterol (LDL-C) by 0.38 ± 0.39 mmol/L (10%, *P* < .05). Highly significant interactions between surgery and time were noted for weight (*P* < .005), BMI (*P* < .005), and FM (*P* < .007, analysis of variance [ANOVA]). Preoperatively, 14 of 26 patients (54%) had high fasting blood sugar levels (type 2 diabetics) and 11 (42%) had impaired glucose tolerance, whereas postoperatively, for baseline glucose levels a trend to decrease was noted. Neither malabsorption nor anemia was observed. QoL improved after GB; in particular, physical functioning and well being increased (*P* < .01), and somatic complaints (eg, dyspnea and heart complaints, pain in legs and arms) markedly decreased (*P* = .008). In the metformin group, neither relevant weight loss nor a significant decrease of biochemical values was observed. Minimal invasive GB is a successful therapeutic tool for reducing FM in morbidly obese patients. Weight loss resulted in improved metabolic parameters, suggesting a lowered atherogenic risk.

THE World Health Organization (WHO) defined obesity for adults as having a body mass index (BMI) of ≥ 30 kg/m^2 and morbid obesity of BMI ≥ 40 kg/m^2.[1] Obesity is characterized by high accumulation of body fat resulting from an imbalance between energy intake and energy expenditure. Prevalence of obesity increases worldwide and, in Europe, the average rate of obese adults approximates 25%.[2,3] The growing prevalence of obesity is a major public health concern, due to the increased risk of morbidity and mortality.[4] A BMI ≥ 30 kg/m^2 is internationally recognized as cut-off point for defining health risks.[5] Obesity is a primary risk factor for type 2 diabetes, hypertension, and cardiovascular diseases.[6,7] Moreover, obesity often leads to occupational, social, and psychological discrimination. Its etiology is related to both environmental[8] and genetic factors.[9]

Treatment of obesity includes dietary intervention, increased exercise, pharmacotherapy, and behavioral modification. However, long-term results after conservative treatment of morbid obesity are unsatisfactory, showing a relapse rate of nearly 90%, whereas surgery is more efficient.[10,11] Surgical treatment of obesity resulted in long-term weight loss that was associated with reduced medication for diabetes and cardiovascular disease.[12] Surgery also caused a reduction of sick leave and disability pension, as compared to controls.[13] Although various operative techniques are used to reduce food intake, three main surgical procedures are performed: gastric banding (GB), gastric bypass, and gastroplasty.[14,15] GB is the preferred surgical method in Europe, since it is more beneficial than gastroplasty or jejunoileal bypass, with laparoscopic placement producing fewer complications than open procedures.[16,17]

Although GB has been applied for many years, longitudinal follow-up with measurements of metabolic parameters in relation to body composition are scarce. Moreover, longitudinal studies in extremely obese patients dealt with postoperative changes in body weight or BMI,[18-24] whereas changes in fat mass (FM) were rarely assessed.[25] Clinically, the amount of FM is important for development of obesity and cardiovascular disease rather than overweight per se. Overweight due to elevated muscle mass may not be clinically relevant in this context. The same holds true for loss in overweight. As obesity is characterized by excess FM, and successful surgical treatment results in its loss, pre- and postoperative determination of both fat as well as lean body mass (LBM) in obese patients seems crucial. Moreover, there are few data regarding physical functioning after GB.[26] Therefore, our main objectives were (1) to evaluate the efficacy of GB in reducing FM, and (2) to analyze the effects of weight loss on both metabolic and cardiovascular parameters, as well as on quality of life (QoL) of severely obese patients.

MATERIALS AND METHODS

This prospective study included 35 adult patients who were treated for morbid obesity. Twenty-six patients (18 females) underwent laparoscopic GB. The remaining 9 patients (6 females) rejected surgery and

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Submitted December 11, 2002; accepted July 2, 2003.

Presented in part at the 46th Annual Meeting of the German Endocrine Society, March 2002.

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0026-0495/03/5212-0013$30.00/0

doi:10.1016/j.metabol.2003.07.008

Table 1. Baseline Characteristics of 35 Severely Obese Patients Before Treatment

Character	Gastric Banding Group* (n = 26)			Metformin Group† (n = 9)		
	Mean	SD	Range	Mean	SD	Range
Age (yr)	39.0	9.38	22-57	42	8.19	33-55
Weight (kg)	143.3	20.5	112.5-185.0	150.6	33.1	121.0-216.0
Height (m)	1.72	0.08	1.61-1.89	1.72	0.07	1.65-1.86
BMI (kg/m^2)	48.1	4.24	42.1-56.5	50.5	9.21	41.3-68.2

*Laparoscopic gastric banding surgery.
†Treated with metformin 2 g daily.

were included as a small additional group. They were treated with metformin (2 g daily); they declined additional therapy with orlistat due to high costs of treatment (150 Euro per month; $165 US). Demographic data of surgically and medically treated patients are shown in Table 1.

GB was performed only in patients in whom diet and treatment with orlistat and/or metformin have been unsuccessful. Inclusion criteria for GB patients was BMI greater than 40 kg/m^2, whereas exclusion criteria were presence of cancer, Cushing's disease, type 1 diabetes, severe cardiovascular and gastrointestinal diseases (eg, malabsorption, chronic inflammatory bowel disease), depressive disorders, pregnancy, and obsessive consumption of sweets. All patients preoperatively performed standard 24-hour dexamethasone suppression and oral glucose tolerance tests (OGTTs). Pre- and postoperatively, body composition, metabolic, cardiovascular, and quality-of-life parameters were examined. All examinations were performed in agreement with the recommendations of the Declaration of Helsinki.

Gastric Banding

GB creates a segmentation of the stomach and reduces patients' capacity of food intake. It constructs a proximal gastric pouch whose outlet is a Y-shaped limb of small bowel of varying lengths (Fig 1). For the laparoscopic technique, 5 trocars are needed. As a first step, a balloon-tipped orogastric tube with a calibrated balloon at the tip is inserted in the stomach. Preparation of the lesser curvature is initiated with ultracision, starting at the equator level of the orogastric tube. Dissection is then resumed to the left hiatus crus. A tunnel is created behind the stomach, joining the 2 dissected areas. A Greenstein retractor is passed through the tunnel and graps one end of the prosthesis. An adjustable silicone gastric band is looped around the stomach and closed. Slipping of the band is prevented by a few stitches. Finally, an implantable reservoir is fixed on the left anterior rectus sheath.

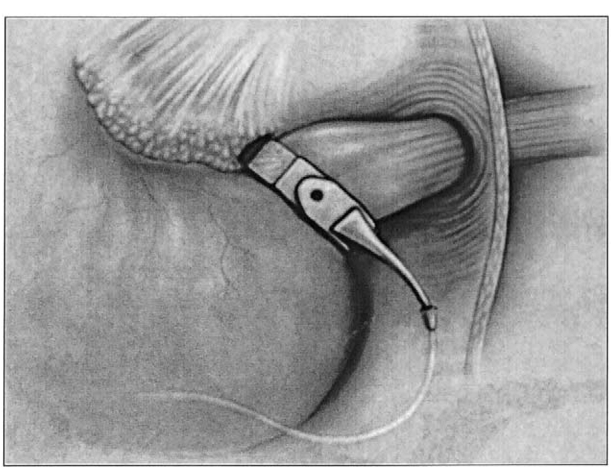

Fig 1. Proximal location of the adjustable silicone gastric band, which is looped around the stomach and subsequently closed. This proximal gastric pouch reduces patient's capacity of food intake.

Body Composition

Body weight (kg) and height (m) of the patients were measured with a scale (Seca, Kurz, Schifferstadt, Germany) and wall-mounted stadiometer, respectively. BMI was calculated as weight divided by height squared (kg/m^2). Body composition was determined using a noninvasive, inexpensive, and easy to perform technique which is valid in severe obesity when specific prediction equations are applied.[27,28] A tetrapolar multifrequency bioimpedance analyzer working at 800 μA (model BIA 2000-M, Data Input, Frankfurt, Germany) was used. After measuring the resistance values at 5 and 50 kHz, FM (kg), LBM (kg), total body water (TBW, L), extracellular and intracellular water (ECW and ICW, L) were determined. LBM was estimated using the sex-specific equations of Gray et al,[28] which are valid up to 59% body fat. FM was calculated as weight minus LBM, whereas TBW, ECW, and ICW were calculated using prediction equations of the manufacturer.[29]

Metabolic Parameters

Serum cholesterol (mmol/L) and triglycerides (mmol/L) were measured by CHOD-PAP and GPO-PAP tests, respectively. The enzymatic clearance assay was used for the in vitro quantitative measurement of low-density lipoprotein cholesterol (LDL-C, mmol/L), and the elimination enzymatic assay was performed for the in vitro quantitative determination of high-density lipoprotein cholesterol (HDL-C, mmol/L). TSH (mU/L) was measured with the help of the luminescent immunoassay (LIA). K^+ (mmol/L) was determined using ion-selective electrode (ISE). Hexokinase was used to quantify glucose (mmol/L). Fasting and 1- and 2-hour serum glucose levels (mmol/L) were measured after performing a 100-g OGTT. Blood pressure was determined using a sphygmomanometer (Erka, Chemnitz, Germany).

Quality of Life and Physical Functioning

QoL, physical complaints, and psychological distress of the patients were assessed by means of three standardized self-rating questionnaires. The Short Form-36 (SF-36) Questionnaire developed by a WHO group[30] and adapted to Germans[31] comprises 36 items referring to 8 health domains (physical functioning, role limitations-physical, body pain, general health perceptions, vitality, social functioning, role limitations-emotional, and psychological well being). The SF-36 is a widely used instrument that has been translated into more than 40 languages. The German Giessen Questionnaire (*Giessener Beschwerdebogen*, GBB)[32] measures 4 domains of physical complaints by means of 67 items given on a 5-point Likert scale (heart complaints, fatigue, stomach trouble, pain in legs and arms, and an overall index). Reference values representative for the German population are available, and the patients' scores can be compared with those of several thousand healthy persons. The Symptom Checklist-90 Revised (SCL-90-R),[33] as a German version,[34] is a multidimensional inventory that measures various dimensions of psychological distress (somatization, obsession/compulsion, insecurity, depression, anxiety, aggressiveness, phobic anxiety, paranoid thinking, and psychoticism). The SCL Global Severity Index (GSI) gives an overall estimate for psychological distress.

Statistics

Statistical analyses were performed with the help of the SPSS/PC software package for MS Windows, release 8.0 (SPSS Inc, Chicago, IL). For interval data, results are expressed as mean and standard deviation (SD). Raw values of the SF-36 and GBB questionnaires were transformed into age- and gender-specific z values as described by Hardt et al.[35] A z value of $0/-1/+1$ indicates that the patient's score is identical with/1 SD below/1 SD above the age- and gender-specific general population value. Pre- and postoperative differences in variables were analyzed by means of Student's paired t tests for interval data and by Wilcoxon's matched-pairs signed-rank test for ordinal measures (variables referring to QoL). The t tests were applied, when distributions of variables approximate normal curves, as checked by use of Kolmogorov-Smirnov tests. Correlation coefficients were calculated to examine whether change in weight or fat loss is associated with improvement in risk factors. A 2×2 analysis of variance (ANOVA) with 1 between-subject factor (surgery yes/no) by 1 within-subject factor (time) was performed in order to evaluate whether the changes in the risk factors vary by group and time as well as the interaction between the two. An α value of .05 was set as the limit of statistical significance (2-tailed).

RESULTS

Metformin Group

The 9 obese patients receiving metformin showed neither relevant decrease in body weight, BMI, and FM (Table 2), nor improvement of their metabolic parameters. Four patients gained weight (0.4 to 4.6 kg), 1 lost 1.5 kg, and in the remaining 4 no changes were noted.

Table 2. Body Composition, and Hemodynamic and Biochemical Data in the Metformin Group

Parameter	Before	After Treatment*
Weight (kg)	161.3 ± 36.3	163.1 ± 36.9
BMI (kg/m²)	54.0 ± 9.56	54.7 ± 9.43
FM (kg)	86.7 ± 21.5	88.9 ± 20.9
FM (%)*	53.7 ± 4.87	54.6 ± 4.53
LBM (kg)	74.6 ± 18.9	74.2 ± 19.3
LBM (%)*	46.2 ± 4.87	45.4 ± 4.53
TBW (L)	61.2 ± 18.2	60.6 ± 18.2
TBW (%)*	37.7 ± 4.69	36.8 ± 4.31
ECW (L)	22.9 ± 5.52	22.6 ± 5.42
ICW (L)	38.2 ± 12.7	38.0 ± 12.9
ECW/ICW ratio	0.61 ± 0.06	0.61 ± 0.07
Systolic blood pressure (mm Hg)	174.0 ± 28.8	168.0 ± 37.0
Diastolic blood pressure (mm Hg)	100.0 ± 25.5	94.0 ± 6.52
Heart rate (bpm)	85.2 ± 6.26	80.0 ± 6.32
Serum cholesterol (mmol/L)	5.56 ± 1.18	5.62 ± 1.03
LDL-C (mmol/L)	3.44 ± 1.55	3.58 ± 1.08
HDL-C (mmol/L)	1.46 ± 0.45	1.28 ± 0.25
Serum triglycerides (mmol/L)	1.41 ± 0.32	1.70 ± 0.57
Fasting plasma glucose (mmol/L)	4.83 ± 0.87	5.97 ± 2.54

NOTE. Values are means ± SD.

Abbreviations: BMI, body mass index; ECW, extracellular water; FM, fat mass; HDL-C, high-density lipoprotein cholesterol; ICW, intracellular water; LBM, lean body mass; LDL-C, low-density lipoprotein cholesterol; TBW, total body water.

*Calculated as a percentage of body weight. After treatment with metformin 2 g daily, body composition and laboratory data showed minimal variations. Because of small sample size (n = 9), no statistical tests were performed.

Surgical Results

Operating time for GB ranged from 50 to 180 minutes (mean, 104 minutes). Hospital stay was 2 to 9 days (mean, 4 days). There was no operative mortality. Revision has been necessary in 3 patients (12%) in order to perform pouch revision and/or to take off nutritional remainders. Further side effects were not observed. All patients had standard dietary advice. No medical treatment was given after GB. Patients did not undergo cosmetic surgery subsequent to weight loss. Costs for the pouch and the hospital stay amounted to approximately 4.000 Euro ($4,400 US) per patient.

Preoperative Baseline Characterization of the GB Group

Table 3 lists values of preoperative body composition, metabolic, and QoL characteristics of the obese patients: 14 patients (54%) were hypertensive, 21 (81%) had elevated serum lipid concentrations (cholesterol > 5.20 mmol/L, LDL-C > 3.9 mmol/L, and/or triglycerides > 2.3 mmol/L). All patients had normal TSH values. Fasting glucose was elevated in 14 (54 %) patients (type 2 diabetics), impaired glucose tolerance was noted in 11 (42%), and the remaining 4% were normal. In the subjects with impaired glucose tolerance, mean (SD) baseline glucose was 4.8 mmol/L (0.8); it was 12.9 mmol/L (2.7) and 9.7 mmol/L (1.9), respectively, 1 and 2 hours after glucose intake. In all patients, dexamethasone test was normal. Compared to controls, QoL was in all 8 subscores below the reference value (Fig 2). The lowest scores were observed for physical functioning and role limitations–physical. Furthermore, all physical complaints were high, ie, the patients suffered from dyspnea and heart complaints, pain in legs and arms, stomach trouble, and fatigue. Finally, 3 patients (12%) had increased psychic complaints (Table 2).

Postoperative Changes in the GB Group

Mean follow-up was 17 ± 2.2 months. Body composition, blood pressure, laboratory values, QoL, and physical functioning of the GB patients significantly improved at follow-up (Table 3). Loss in body weight after surgery was observed in all patients, and most showed a continuous weight loss. In 2 patients, a short-term weight gain was noted due to a revision of the pouch. More than 50% of the patients (14 of 26) lost more than 20 kg of weight (20 to a maximum of 60 kg), 7 lost more than 10 kg, and the remaining 5 patients less than 10 kg. Mean weight clearly declined (−14% of preoperative value) as did mean BMI (14%). The observed weight loss was mainly due to a reduction in FM (18%), whereas smaller decreases occurred for LBM (5%) and TBW (7%). Loss in body water was attributable to both ICW (7%) and ECW (6%), and no significant change in the ECW/ICW ratio was noted. Weight loss was also associated with significant decreases of systolic blood pressure (10%), total cholesterol (12%), and LDL-C (10%). Postoperatively, triglycerides (5%) and fasting glucose

Table 3. Anthropometrical, Body Composition, Laboratory, and Quality-of-Life Data in the Morbidly Obese Patients Submitted to Minimal Invasive, Adjustable Silicone Laparoscopic Gastric Banding

Parameter	Preoperative	Postoperative	*P* Value†
Weight (kg)	143.3 ± 20.1	122.6 ± 22.2	<.001
BMI (kg/m²)	48.1 ± 4.24	41.2 ± 6.33	<.001
FM (kg)	77.6 ± 16.3	63.4 ± 16.9	<.001
FM (%)*	51.2 ± 6.45	47.3 ± 7.10	<.001
LBM (kg)	73.8 ± 13.8	69.8 ± 12.5	<.001
LBM (%)*	48.8 ± 6.45	52.7 ± 7.10	<.001
TBW (L)	58.5 ± 14.2	54.5 ± 11.8	.002
TBW (%)*	38.6 ± 7.61	41.2 ± 7.64	.003
ECW (L)	22.1 ± 5.18	20.8 ± 4.51	.033
ICW (L)	36.4 ± 9.31	33.7 ± 7.60	.001
ECW/ICW ratio	0.61 ± 0.06	0.62 ± 0.07	.396
Systolic blood pressure (mm Hg)	156.8 ± 27.6	141.2 ± 12.8	.027
Diastolic blood pressure (mm Hg)	94.4 ± 16.9	90.3 ± 7.80	.344
Heart rate (bpm)	79.0 ± 10.9	75.6 ± 8.15	.259
Serum cholesterol (mmol/L)	5.93 ± 1.40	5.24 ± 0.90	.035
LDL-C (mmol/L)	3.82 ± 1.24	3.43 ± 1.15	.026
HDL-C (mmol/L)	1.41 ± 0.26	1.24 ± 0.06	.108
Serum triglycerides (mmol/L)	1.72 ± 0.71	1.64 ± 0.68	.632
TSH (mU/L)	1.38 ± 0.76	1.27 ± 0.52	.489
Serum potassium (mmol/L)	4.41 ± 0.52	4.46 ± 0.31	.661
Fasting plasma glucose (mmol/L)	7.43 ± 4.78	5.79 ± 2.09	.180
GBB–fatigue (scores)	60.8 ± 10.6	46.9 ± 11.9	.025
GBB–stomach trouble (scores)	59.6 ± 17.2	52.2 ± 15.9	.036
GBB–pain in legs and arms (scores)	63.7 ± 15.2	51.5 ± 16.7	.012
GBB–heart complaints (scores)	53.8 ± 10.7	46.1 ± 8.00	.021
GBB–global index (scores)	62.7 ± 14.3	48.9 ± 15.4	.008
Symptom Checklist (SCL): GSI (scores)	0.65 ± 0.40	0.43 ± 0.58	.168

NOTE. Values are means ± SD.

Abbreviations: BMI, body mass index; ECW, extracellular water; FM, fat mass; GBB, Giessen Questionnaire; GSI, Global Severity Index; HDL-C, high-density lipoprotein cholesterol; ICW, intracellular water; LBM, lean body mass; LDL-C, low-density lipoprotein cholesterol; TBW, total body water.

*Calculated as a percentage of body weight. †Differences between preoperative *v* postoperative values were tested for statistical significance by using Student's paired *t* tests for interval data and by Wilcoxon's matched-pairs signed rank test for ordinal data (GBB, SCL) (2-tailed).

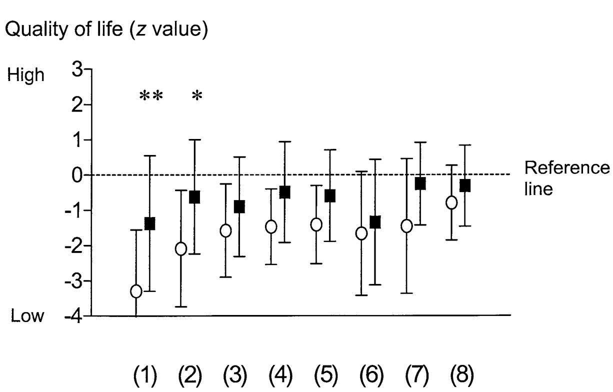

Fig 2. Health-related QoL in morbidly obese patients before (○) and after (■) minimal invasive gastric banding, as assessed by the SF-36. Compared to a reference population (zero line), means and SD values for (1) physical functioning, (2) role limitations–physical, (3) bodily pain, (4) general health perceptions, (5) vitality (energy/fatigue), (6) social functioning, (7) role limitations–emotional, and (8) emotional well-being were poor prior to surgery. All values markedly improved postoperatively. *P < .05, **P < .01.

levels decreased mildly. Significant interactions between group and time showed that the surgical group lost more weight and had a greater decrease in FM over time than the metformin group. The metformin group had higher heart rates at both sessions than did the surgical group (ANOVA, Table 4). Changes in heart rate significantly varied by group (surgery *v* metformin), and highly significant interactions between surgery and time were also noted for weight, BMI, and FM. Correlation analyses also indicated positive associations between loss in FM and decrease of both diastolic blood pressure (r = 0.41) and total cholesterol (r = 0.36), but due to small sample size, they did not reach statistical significance. Neither malabsorption nor anemia or hypocalcemia were observed.

All 8 domains referring to QoL improved, significantly for physical functioning and role limitations–physical (Fig 2). Physical complaints of the patients markedly decreased (eg, pain in legs and arms, dyspnea, and heart complaints, Table 3). After surgery, there also was a clear trend for an amelioration of psychological complaints.

DISCUSSION

Although minimal invasive GB has been applied for years, longitudinal follow-up with measurements of metabolic and

Table 4. Between-Subject Effects (surgery yes/no), Within-Subject Effects (time), and Interaction Between Them With Respect to Variation in Clinical Parameters (2 × 2 ANOVA)

Parameter	Between-Subject Effects (surgery)		Within-Subject Effects (time)		Interaction Surgery × Time	
	F	*P* Value	*F*	*P* Value	*F*	*P* Value
Weight (kg)	0.014	.909	8.229	.028	18.80	.005
BMI (kg/m²)	0.002	.965	7.363	.035	19.21	.005
Fat mass (kg)	0.067	.805	4.141	.088	15.78	.007
Systolic blood pressure (mm Hg)	0.631	.457	2.133	.194	0.684	.440
Diastolic blood pressure (mm Hg)	0.154	.709	0.334	.584	0.027	.874
Heart rate (bpm)	13.23	.011	3.350	.117	0.097	.766
Serum cholesterol (mmol/L)	0.826	.398	1.945	.213	1.369	.286
LDL-C (mmol/L)	1.573	.256	2.381	.174	1.501	.266
HDL-C (mmol/L)	0.256	.631	4.278	.084	3.206	.124
Serum triglycerides (mmol/L)	0.000	.983	2.690	.152	0.747	.421
Fasting plasma glucose (mmol/L)	0.003	.958	0.991	.358	1.104	.334

cardiovascular parameters has been rarely performed. This study demonstrates during a continuous follow-up of morbidly obese patients the advantages of GB with respect to body composition and QoL. GB led to substantial reduction in body weight within nearly 2 years, which was mainly attributable to loss of FM. Weight loss was associated with both a decrease in serum lipids and blood pressure lowering the risk factors for cardiovascular morbidity, as well as with a relevant amelioration of physical functioning of the obese patients.

This study further showed that GB offers several advantages as compared to conservative treatment. Patients taking metformin did not lose weight and serum lipids did not improve. In this group and due to high costs of treatment, patients also rejected intake of orlistat. On the other hand, GB reduces the patients' capacity of food intake; the subjects eat more slowly and learn an early feeling of satiety. This occurs under the premise that the GB technique does not permanently modify anatomy of the stomach and is completely reversible. The laparoscopically implanted band can be removed any time without organ damage keeping stomach and upper intestine in their anatomical and functional integrity. Several studies have demonstrated the low complication rate and high efficacy of GB.[20,23,36-37] Here also, and based on clinical outcome parameters and the documented follow-up, we demonstrate both beneficial metabolic effects as well as the low-risk profile of GB. However, a larger sample of laparoscopically treated patients should be involved and documented. Therefore, we intend to gather further data in order to investigate long-term metabolic effects of GB. In Australia, a 3-year follow-up of 60 patients for treatment of morbid obesity has shown that GB is effective in long-term weight loss.[22]

Body Composition

In contrast to previous reports,[19-24] the current report offers for the first time a detailed and differentiated description of changes in body composition (especially FM and LBM) and health-related somatic symptoms and QoL after GB. In this context, we found that most weight loss is mainly due to reduction in FM. The proportion of fat to lean loss is 78% versus 22%, very close to the expected proportions and not showing any excess loss of LBM. This is relevant since the primary aim of weight loss is to reduce excessive FM, whereas LBM should be preserved. For determination of body composition we used bioelectrical impedance analysis, a noninvasive, easy to perform, and inexpensive technique that was well accepted by the obese patients—contrary to more sophisticated techniques like magnetic resonance imaging or underwater weighing. As performed in this study, bioimpedance analysis is valid for determining FM and LBM in severe obesity when specific prediction equations are applied.[27,28] Moreover, we have validated this technique in German population groups[38] and successfully applied in patients with metabolic diseases.[39] Using magnetic resonance imaging in 6 extremely obese women, Busetto et al[25] also observed after GB a preferential loss of the visceral fat as compared with the total and subcutaneous FM. Furthermore, since obesity is often characterized by an expansion of the water compartment, we found that weight loss is accompanied by a significant decrease in TBW. This is due to a decrease in ECW and ICW, whereas the water ratio remains unchanged after surgery. This is in agreement with Mazariegos et al[18] who determined body water compartments by isotopic dilution.

Metabolic and Cardiovascular Parameters

In our GB patients, a 14% decrease in weight was associated with a 10% decrease in systolic blood pressure. Fried and Peskova[40] also found in GB patients a significant decrease of blood pressure at 1-year follow-up, and Wylezol et al[21] reported that of 3 morbidly obese patients only 1 remained hypertensive 4 months after GB. Further, weight loss in GB patients resulted in significant decreases of serum total and LDL-C, a finding also noted at four months follow-up by Wylezol et al.[21] In comparison, Stieger et al[19] showed that cholesterol levels normalized in 30 patients (57%) and improved in 20 (38%) at 6 months follow-up. These beneficial metabolic changes have a positive economic impact.[12] Long-term intentional weight loss has been associated with reduced medication and medication costs for diabetes and cardiovascular disease. Regarding the relationship between weight/fat loss and cardiovascular factors, overweight and particularly obesity should now be added to the list of risk factors for the development of heart failure.[41,42] This risk cannot be fully explained by accompanying conditions such as hypertension or diabetes, but it is probable that other physiological and metabolic abnormalities that accompany a high BMI may play a role. In multivariate models, BMI emerged as an independent predictor of left ventricular hypertrophy, which leads on the long run to heart failure.

Quality of Life and Physical Functioning

Fast postoperative recovery, few wound infections, and decreased somatic complaints after GB allowed enhanced motility and physical performance of the patients. Improvement also occurred in those subjects with high levels of psychological complaints. These factors mainly led to increased physical functioning and well-being, and to a notable amelioration of QoL. Karlsson et al[43] also demonstrated that poor QoL was improved after surgery, whereas minor fluctuations in QoL occurred in conventionally treated patients. As in the "Swedish Obese Subjects" study,[12,13] we expect a positive economic impact since reduction in physical complaints and improvement of physical functioning may enable our patients to return quickly to normal activities and to daily work.

In conclusion, GB is a successful minimal invasive tool for reducing fat mass in severely obese patients where conservative therapies have failed. This technique was characterized by a low complication rate and a short hospital stay. We have shown that beneficial metabolic and psychosocial effects accompany weight loss. Thus, one can assume that lower comorbidity and improved ability to work may reduce health care costs. Therefore, this endoscope technique offers an attractive low-risk alternative treatment for carefully selected and followed patients with morbid obesity. A multidisciplinary team with a clearly defined postoperative care concept may obtain best results.

ACKNOWLEDGMENT

We are most indebted to S. Bauer, N. Werner, F. Mattes, MD, and P. Heinzelmann, MD, Departments of Medicine I and Abdominal Surgery, Gutenberg University Hospital, for data collection. This study contains parts of the doctoral thesis of S. Bauer.

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