Clinical Nutrition 38 (2019) 1773–1781

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Willing to go the extra mile: Prospective evaluation of an intensified non-surgical treatment for patients with morbid obesity

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ARTICLE INFO

Article history:
Received 13 February 2018
Accepted 22 July 2018

Keywords:
Obesity
Non-surgical treatment
Very low-calorie diet
Gastric balloon
Multicomponent treatment

SUMMARY

Background & aims: Bariatric surgery has been well established and considered the treatment of choice in morbid obesity. However, some patients refuse surgery because long-term effects have not been fully elucidated, quality of life might change and lifelong supplementation with vitamins and trace elements may be required. Our aim was to exhaust non-surgical treatment modalities and to evaluate such an intensified treatment alternative.

Methods: A total of 206 patients (mean age = 46 years; BMI = 49 kg/m^2) enrolled since 2013 into a non-surgical multimodality obesity treatment program covered by major health insurances were prospectively evaluated over a three year period. The 12-month treatment course comprised 57 h cognitive-behavioral therapy, 53.5 h physical exercise training, and 43.5 h nutritional therapy offered in small groups. Weight loss was induced by a formula-based, very low-calorie diet for 12 weeks in combination with a gastric balloon. The primary outcome was relative weight loss (RWL). Secondary outcome measures were waist-to-hip ratio, blood pressure, antihypertensive drug treatment, anti-diabetic medication, HbA1c, and quality of life.

Results: 166 Patients (81%) completed treatment. Mean (±SD) weight loss after 12 months for women and men were 28.8 kg (±14.7) and 33.7 kg (±19.5), respectively, among completers. RWL was 21.9% (±10.0) and excess weight loss (EWL) was 46.9% (±22.2), whereas intention-to-treat analysis revealed a RWL of 20.0% (±10.4) and an EWL of 42.9% (±22.9). Weight loss was accompanied by improved quality of life, lowered HbA1c values, and a significantly reduced need of antihypertensive and diabetes medications over the study period. Three year follow-up data from the first 78 patients (76% follow-up rate) revealed a RWL of 13% (±13.1) and an EWL of 27.2% (±28.8). The majority of patients (51%) maintained a RWL of 10% or more, and 44% had an EWL > 30%.

Conclusions: In patients with morbid obesity, an intensified non-surgical multimodality treatment program may achieve significant and sustained weight loss accompanied by improvement of disease markers as well as quality of life for at least three years.

1. Introduction

The increase in prevalence of obesity and comorbidities has become a considerable challenge and burden for the health care systems globally [1]. The apparent lack of success in patients with obesity to achieve and maintain healthy weight by traditional dietary restriction and physical exercise training has led to the current adoption of surgical approaches as the mainstream and standard of treatment to obtain sustained weight loss and therefore improvement with regard to comorbidities. At present, surgery is

Abbreviation: EWL, Excess weight loss; HbA1c, Hemoglobin A1c; ITT, Intention-to-treat analysis; RWL, Relative weight loss; PP, Per-protocol approach; QoL, Quality of life; SF-36, Short-Form-36; T2DM, Type 2 diabetes mellitus; VLCD, Very low-calorie diet; WHR, Waist-to-hip ratio.

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https://doi.org/10.1016/j.clnu.2018.07.027

recommended as the treatment of choice for morbidly obese patients with BMI > 40 kg/m^2 and in those having concomitant morbidity with BMI > 35 kg/m^2 provided that the goals could not be achieved otherwise [2].

Surgically induced weight loss results from the reduction of gastric volume and/or altered food passage following "sleeve" gastrectomy and Roux-en-Y gastric bypass [1–3]. In addition to mechanical limitations of food intake resulting in malabsorption, surgery is also considered to have a metabolic effect. It is unclear whether these changes are a direct result of the surgical intervention or rather a consequence of altered food intake because of the mechanical limitations. Significant clinical improvements of diabetes have been demonstrated in observational and randomized trials comparing metabolic surgery with conventional medical treatment [4,5]. Long-term follow-up studies have shown a significant decrease in cardiovascular risk with a reduced number of deaths from cardiovascular diseases and lowered incidence of cardiovascular events in obese patients undergoing bariatric surgery. Significant changes include improved control of systolic blood pressure and lowering of serum hemoglobin A1c (HbA1c) and low-density lipoprotein cholesterol levels to normal values [4,6]. Bariatric surgery is related to an acceptable rate of surgical morbidity and a very low mortality rate (<20% and <0.5%, respectively) [3,7]. However, severe complications have also been reported including intestinal failure – even with the need for visceral transplantation –, increased incidence of suicide, self-harm, and depression with the need for hospitalization [8,9]. There is also general agreement that long-term follow-up of changes in eating behavior and lifestyle after surgery is required [10], as well as monitoring of potential procedure-related deficiencies in vitamins and minerals, possibly lifelong supplementation of micronutrients and trace elements [11].

Numerous studies on treatment of obesity have been published, primarily focusing on the different procedures and techniques of bariatric surgery; however, only a few trials have attempted to exploit conservative approaches in intensifying and optimizing non-surgical treatment strategies to induce weight loss. Results from the Louisiana Obese subjects study and others raised the question whether obesity management may also be effective in a non-surgical setting [12,13].

The National Institute for Health and Care Excellence (NICE) guidelines for the management of obesity (2014) consider "multicomponent interventions the treatment of choice" and the indication for bariatric surgery "if all appropriate non-surgical measures have been tried but the person has not achieved or maintained adequate, clinically beneficial weight loss." [14] The aim of this prospective investigation was to evaluate the effectiveness of an intensified multicomponent obesity treatment program that utilizes all currently available non-surgical treatment options over the course of three years.

2. Methods

Results presented in this study derive from a non-surgical, multidisciplinary weight loss program established since 2013. This program is offered to morbidly obese patients and covered by major health insurances in the states of Saxony and Thuringia, Germany. The data presented were acquired between July 2013 and October 2017. Subject enrollment and prospective clinical evaluation of these patients was started after approval of the study by the Ethical Review Board of the Saxonian Medical Association (EK-B-07/10-1). Prior to inclusion, informed consent was obtained from every patient. The program comprises of five phases:

(1) 4–7 days of in-patient treatment consisting of the initiation of a formula-based, very low-calorie diet (VLCD, 800 kcal per day) plus the implantation of a gastric balloon; (2) six months of weekly out-patient treatment course comprising a full-day group therapy that includes sessions of cognitive-behavioral therapy, nutritional therapy, medical assessments and exercise training to promote substantial lifestyle changes; (3) five months of monthly full-day group therapy sessions focusing on maintaining the achieved changes; (4) one week of 5 consecutive full-day group meetings to foster long-term weight maintenance focusing on relapse prevention and management; and (5) a 5-year follow-up care plan that comprises mandatory annual checkups including several offers designed to maintain the accomplished changes.

2.1. Intervention program

The intervention program is comprised of various intensified, non-surgical treatment modalities for patients with advanced obesity (BMI > 40 kg/m^2 or BMI > 35 kg/m^2 with associated comorbidities) (Fig. 1). The concept of an "intensified" multi-modal approach originated from a previous program that was in use for over six years. The program revealed promising results of a non-surgical treatment alternative that was based on a very low-calorie diet (VLCD) combined with gastric balloon implantation and followed by weekly multidisciplinary consultation [15]. Exclusion criteria for balloon implantation were severe pangastritis, gastric ulcer, or axial hiatal hernia. Patients dependent on anticoagulant medication were also not considered for balloon implantation.

In cooperation with the local health care insurances, several modifications were made, including the implementation of closed-group meetings, the reduction of group-size to 6–8 members, the extension of multimodal treatment sessions to 8 h per day (full-day), the implementation of a closing maintenance week, and the introduction of a five-year care plan (follow-up) with annual checkups and psychological re-evaluations. A detailed description of the treatment and follow-up care can be found in the supplement (suppl. 1). The costs for the treatment were covered by the health insurance as a complementary service for rehabilitation. Patients only had to purchase the VLCD at their own expense.

2.2. Study population

From July 2013 until August 2015, a total of 390 patients who contacted our center were invited to an introductory presentation in which a staff member introduced them to the offered non-surgical weight loss program (Fig. 2). Patients were typically referred to our center by their general physician, their health insurance, other patients, newspaper articles or the hospital's webpage. Thereafter, 297 patients made appointments to be evaluated for the program. The evaluation comprised of a physical and a psychological examination. At this time patients also received information about surgical treatment options.

The inclusion criteria comprised of an age between 18 and 70 years, a BMI > 35 kg/m^2 with associated comorbidities, or a BMI > 40 m^2, without any comorbidities. Exclusion criteria were bedridden status, cardiac or pulmonary insufficiency class III/IV according to the New York Heart Association, malignant disease, pregnancy or lactation, or a binge eating disorder. Patients with severe, unstable, or untreated mental disorders such as mood disorders, personality disorders, and substance-related disorders were also declined and referred to psychiatric treatment and medical therapy. After initial assessment, eligible candidates who developed severe cardiopulmonary disease, diagnosed with malignancy or found pregnant before program begins were also excluded. Overall, 206 patients were enrolled into the program (Table 1). Of the 91 patients excluded, the most common reasons for exclusion were formal reasons (n = 41) and psychological

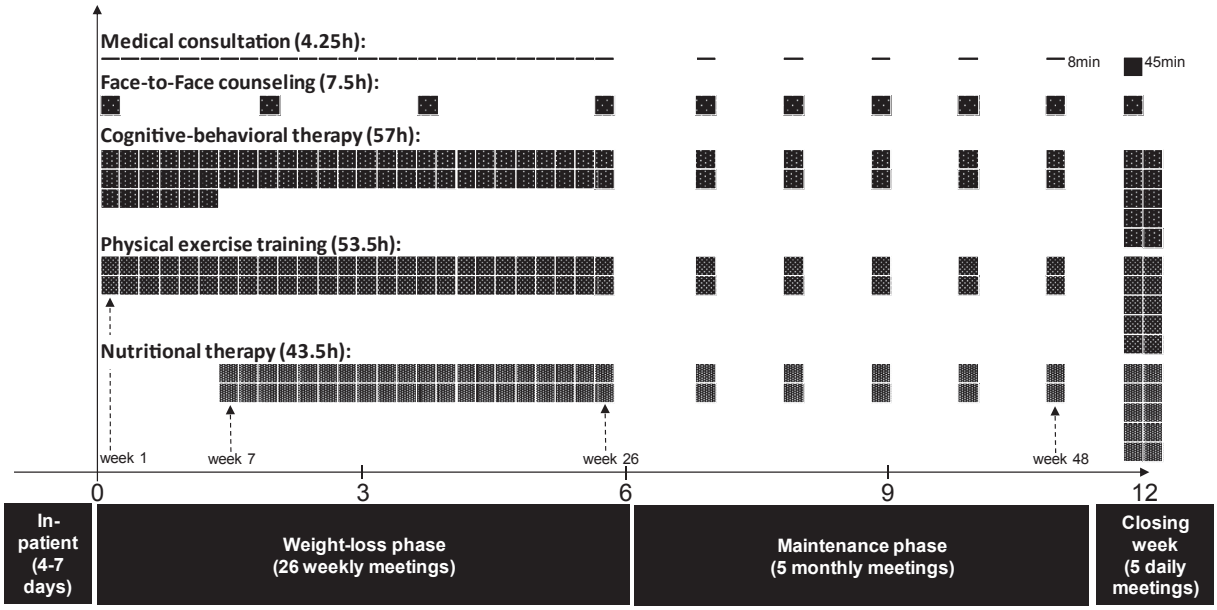

Fig. 1. Schematic illustration of the 12 months intervention. After completion of an initial medical check-up for comorbidities, initiation of the formula-based, very low-calorie diet, and implantation of a gastric balloon all of which performed in an in-patient setting, multimodality treatment was provided as a full-day group therapy (8am–4pm) consisting of various therapy sessions, which begins as a weekly event and later shifted to a monthly basis. Each of the different modules (shown as shaded blocks) represented specified therapy sessions given in units of 45 min per group meeting. In the final week, a 5-day consecutive full-day "intensive" therapy course was held with the intention to foster the patients with strategies for long-term weight maintenance and also to prepare them for the five-year follow-up care following the completion of the 12-month treatment program.

reasons (n = 39, Fig. 2). When applicable, those excluded because of psychological reasons were given recommendations for other treatments (e.g. psychotherapy) before they could re-apply for the program at a later time.

Prior to the start of the program, written informed consents were obtained from the participants, which included approval of personal data usage for anonymous scientific evaluations. The baseline characteristics of the 206 patients enrolled are shown in Table 1. The initial mean (±SD) weight was 137 kg (±27.2), BMI was 48.7 kg/m^2 (±7.46). 74 patients (35.9%) did not receive a gastric balloon according to the exclusion criteria (see Suppl. 1).

2.3. Instruments

Body weight (Kern MTS 300K100M scale, Min, 2 kg, Max. 300 kg, e = 0,1 kg; Kern & Sohn GmbH, Balingen, Germany) and blood pressure of the non-dominant arm (Boso medicus uno, Bosch & Sohn GmbH & Co KG, Jungingen, Germany) were assessed weekly.

Functional exercise capacity (6-min walk test), physical working capacity (PWC-130 cycle test; Motion relax 800 med, max. 500 W, max. 250 kg, Emotion Fitness GmbH & Co KG, Hochspeyer, Germany), health-related quality of life (Short-Form-36, SF-36), and the waist-to-hip ratio (WHR) were assessed at the first weekly meeting (0 months), at the last weekly meeting (6 months), during the closing maintenance week (12 months), and every 12 months post-therapy.

In patients diagnosed with type 2 diabetes mellitus (T2DM) prior to inclusion, glycated hemoglobin (HbA1c) and their prescribed antidiabetic medications (number of agents and dosages) were recorded at each study time point. T2DM remission was defined as medication discontinuation and HbA1c $\leq$ 6% [5]. Reduced medication was defined as lowered dosages, lowered number of prescribed agents, or a change from insulin to oral antidiabetic drugs.

2.4. Primary and secondary outcomes

The primary outcome was successful relative weight loss (RWL). A successful non-surgical treatment for obesity has been defined by the Institute of Medicine of the National Academies (1995) [16], i.e., a 12 months RWL of more than 5% in at least 50% of the participants, and more than 10% in at least 20% (intention-to-treat analysis).

Secondary outcomes were a decrease of the obesity-related risk factors hypertension, diabetes, WHR, and an improvement in quality of life (QoL).

2.5. Statistical analysis

The outcomes of the intervention program were evaluated according to a per-protocol approach (PP) as well as an intention-to-treat analysis (ITT) using the last-observation carried forward method. The follow-up data were analyzed using the PP approach. Patients who later received surgical treatment were excluded from subsequent follow-up analyses.

Statistical analysis was performed using SPSS. Univariate analyses were performed and expressed as mean and SD (weight-related measures, blood pressure, WHR, SF-36) or median and range (HbA1c). Variables involved with changes over time were tested by using the General Linear Model (GLM) with Bonferroni corrected pairwise comparisons, the *t*-Test for related samples, or the Wilcoxon Signed Rank Test if the variables were not normally distributed (verified using the Kolmogorov–Smirnov Test). Group differences were tested by using *t*-Test (baseline differences) or, if variables were not normally distributed, the Mann–Whitney and Kruskal–Wallis test. Effect sizes for QoL were computed as Cohen's d. All analyses were restricted to subjects with complete data on all variables required for a particular analysis. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Adherence to the program

Of the 206 patients enrolled into the study, 187 patients (91%) completed at least six months of therapy and 166 (81%) finished the 12-month program (Fig. 2). The two main reasons for drop outs were either a lack of compliance/adherence (n = 15) or job-related

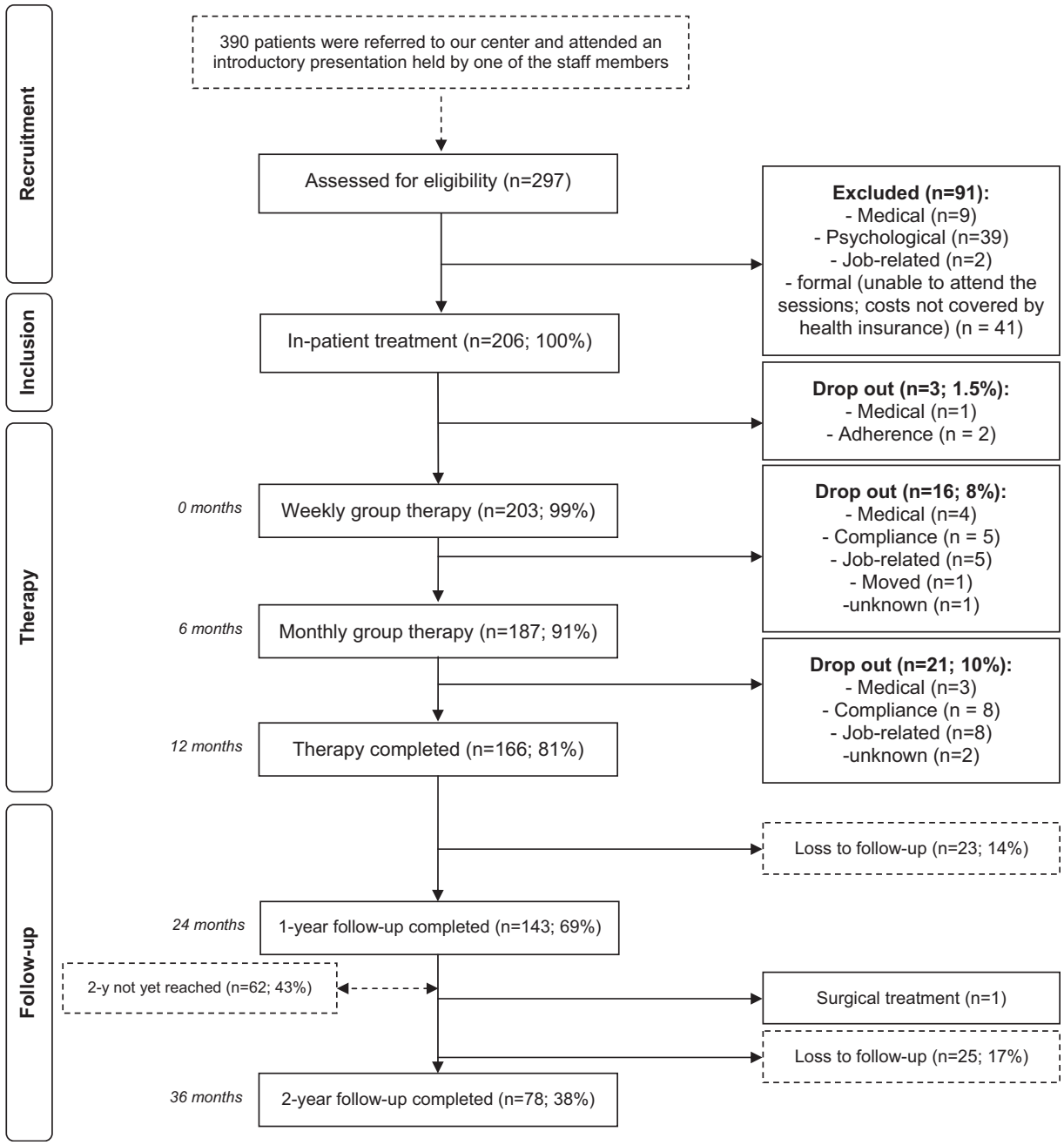

Fig. 2. Flowchart of patients.

Table 1
Study population baseline characteristics.

n	206
Sex (m: f)	72: 134
Age (years)	45.7 (12.4) [18–71]
Education < 12 yr	76%
Weight (kg)	137 (27.2) [89–250]
BMI (kg/m^2)	48.7 (7.46) [36–79]
Excess weight (kg)	66.8 (22.86) [27–171]
Excess weight (%)	47.5 (7.71) [30–68]
Waist-to-hip ratio	1.02 (0.09) [0.77–1.21][a]
Blood pressure systolic (mm Hg)	141.6 (17.0) [101–205]
Blood pressure diastolic (mm Hg)	90.4 (10.4) [55–120]
N with T2DM (%)	77 (37.4%)

Continuous variables are presented as mean (SD) [min–max].
[a] N = 155. T2DM = Type 2 diabetes.

causes (e.g., beginning a new full time job; n = 13) (Fig. 2). Of the 166 patients who completed the treatment program, 143 patients attended the annual checkup at 24 months after inclusion (1-year follow-up), which corresponded to a follow-up rate of 86%. Of the 103 patients who were eligible for the annual checkup at 36 months after inclusion (2-year follow-up), 78 patients completed the checkup, which corresponded to a follow-up rate of 76%.

3.2. Balloon-related side effects

Gastric balloon implantation was performed in 133 patients (133/206 = 65%) during the time of inpatient treatment. However following the first weeks after implantation (median 21.5 days; min. 3, max. 36), severe vomiting occurred in 14 patients (10%),

requiring the removal of the balloon. Within 36 days after study start, the group with a gastric balloon implanted was thus reduced to 119 patients, while those without balloon had increased to 87 patients. At the end of the 6-month weekly treatment, the balloon was removed in all patients.

3.3. Weight loss and WHR

The PP analysis at 12 month revealed a weight loss of 30.5 kg with RWL and EWL at values of 21.9% and 46.9% respectively (Table 2). A successful RWL (i.e., ≥10%) was achieved in 86% of the patients (Table e-1). The ITT analysis revealed a mean weight loss of 27.8 kg (SD ±16.6), RWL of 20.0% (±10.4), and EWL of 42.9% (±22.9) with a successful RWL achieved in 79% of patients. Temporal changes of BMI from enrollment to follow-up at 3 years are shown in Fig. 3.

At follow-up we found a weight loss of 23.8 kg after 1 year and 18.5 kg after 2 years, with 71% and 51% of the patients maintaining a RWL ≥10%, respectively (subgroup analyses see supplementary Tables e-2 and e-3). The mean percent weight gain after therapy completion was 7.5% (SD ±7.2; min–max −11.2–38.93) at 24 months, and 14.7% (±12.5; −7.9–57.7) at 36 months (relative to body weight at 12 months).

We found no significant effect of gastric balloon on RWL at any time point (with balloon vs. without balloon: 12 months 22.4% (SD ±9.66) vs. 21.0% (±10.9), p = .395; 24 months 16.9% (±12.1) vs. 17.3% (±12.3), p = .867; 36 months 12.5% (±13.2) vs. 13.8% (±13.3), p = .677).

The WHR in men (N = 55; mean 1.08 SD ±0.059) was higher compared to those of women (N = 100; 0.98 ±0.086; p < .0001). However, comparable reduction was evident in both groups after 12 months (p < .0001; sex × time: p = .864). In men, the WHR remained stable between 12 months (1.01 ±0.08) and 24 months (1.02 ±0.07; p = .089). Interestingly, in women a further decrease in WHR was evident between 12 (0.92 ±0.09) and 24 months (0.89 ±0.09; p < .05). The proportion of men with a WHR <1 increased from 7% at baseline to 51% at 12 months and 40% at 24 months. The proportion of women with a WHR <0.85 increased from 5% at baseline to 21% at 12 months and 32% at 24 months.

3.4. Hypertension

After 12 months, the mean systolic (133.2 mmHg SD ±13.1) and diastolic blood pressures (85.9 ±8.53) were both significantly reduced compared to baseline values (142 ±17; 90.4 ±10.4). Furthermore, the proportion of patients treated with antihypertensive drugs was decreased from 77% at baseline to 58% (Fig. 3 and Fig. e-1). More specifically, 30% (ITT: 25%) of those patients who were treated with antihypertensive drugs at baseline could discontinue their medications and 36% (ITT: 30%) could reduce the number of prescribed agents.

At the 1-year follow-up, a significant reduction of blood pressure was still evident with respect to the systolic (136 mmHg ±16.5; p < .05), but not with the diastolic blood pressure (88.3 mmHg ±11.3; p = .203). The proportion of patients treated with antihypertensive drugs was 61%. Of those patients who were treated with antihypertensive drugs at baseline, 27% (ITT: 19%) could discontinue treatment and 36% (ITT: 25%) could reduce the number of prescribed agents. At the 2-year follow-up, a similar significant reduction was evident with respect to the systolic pressure (138 mmHg ±13.3; p < .05), but not with the diastolic blood pressure (91.8 mmHg ±8.67; p = .197). The proportion of patients treated with antihypertensive drugs was 66%. Of those patients who were treated with antihypertensive drugs at baseline, 23% (ITT: 12%) could discontinue treatment and 33% (ITT: 17%) could reduce the number of prescribed agents.

3.5. Diabetes

At study inclusion, 37% (n = 77) of the enrolled patients had a diagnosis of T2DM with a median HbA1c value of 6.7% (min–max = 5.2–12.2). A 45.5% remission rate was evident at the end of the 12-month treatment program (i.e., remission in 25 out of the 55 T2DM patients who completed the program). Another 40% (N = 22) of these patients were prescribed reduced medication. HbA1c levels (median = 5.6%, min–max = 4.7–10.3) were significantly lower compared to that of baseline values (p < .001). The mean reduction of HbA1c was −1.40% (Fig. e-1).

At the 1-year follow-up, the remission rate was 37.7% (i.e., 20 out of 53 patients with a T2DM diagnosis at inclusion) and reduced medication was prescribed to another 15% (N = 8). The HbA1c (5.7%, 4.9–11.0) remained below baseline (p < .001). At the 2-year follow-up, 23 patients out of the 77 patients with a T2DM diagnosis at inclusion were evaluated. Seven met the criterion for remission and another three were prescribed reduced medication. The median HbA1c was 6.6% (5.0–11.4; p < .112) and the mean reduction of HbA1c was −0.84% (Fig. 3).

3.6. Quality of life (QoL)

At study inclusion, the largest deviations in aspects of the SF-36 when compared to reference data were found with respect to

Table 2
Body weight change in the course of the 12 months therapy and 2 years follow-up care.

		Months after inclusion				
		0	6	12	24	36
		Therapy			Follow-up	
N		206	187	166	143	78*
Weight (kg)	mean (SD)	137 (27.2)	107 (23.6)	107 (24.0)	112 (24.8)	119 (27.2)
	Min–Max	89–250	65–193	58.1–198.9	62–198	62–210
BMI (kg/m^2)	Mean (SD)	48.7 (7.5)	38.0 (6.93)	38.2 (7.32)	40.3 (8.15)	42.6 (8.53)
	Min–Max	36–79	25–61	23.6–62.8	25–64	25–68
Weight loss (kg)	Mean (SD)		30.3 (12.9)	30.5 (16.6)	23.8 (19.1)	18.5 (19.5)
	Min–Max		5–82	−5.9–95.5	−16–94	−18–76
RWL (%)	Mean (SD)		22.0 (7.82)	21.9 (10.0)	17.1 (12.1)	13.0 (13.1)
	Min–Max		3–44	−5.3–48.6	−14–49	−16–47
EWL (%)	Mean (SD)		47.4 (18.6)	46.9 (22.2)	36.5 (25.9)	27.2 (28.8)
	Min–Max		7–97	−13.6–107.4	−38–101	−43–99

EWL = excess weight loss; RWL = relative weight loss; BMI = Body mass index.
* One patient excluded because bariatric surgery was performed.

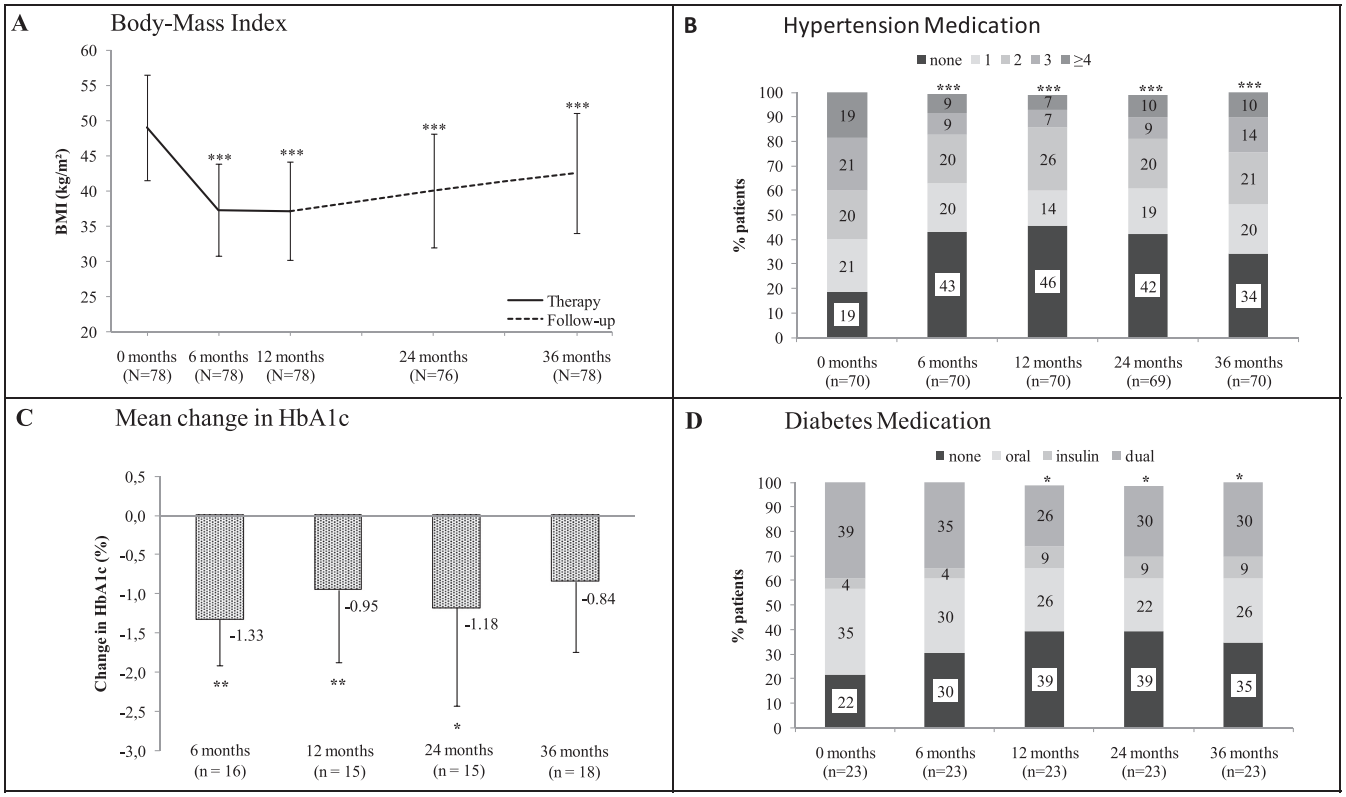

Fig. 3. Changes in body mass, measures of diabetes control and hypertension control from baseline to 3 years. Shown are the mean BMI (±SD) (Panel A), the distribution of patients with respect to the number of prescribed antihypertensive drug agents (Panel B), the mean change in HbA1c level (±95% CI) (Panel C), and the distribution of patients with respect to the prescribed diabetes medication. To illustrate longitudinal changes the analysis was restricted to patients who were available at the 36-months follow-up (Panel A and B) and who were also diagnosed with T2DM at baseline (Panel C and D). For whole data analyses see Fig. e-1. Statistical significance for comparison to baseline is indicated for each time point (*: $p < .05$; **: $p < .01$; ***: $p < .001$).

Physical Functioning (57% of the reference value) and Physical Role Function (69%) (Table 3). At the end the of 12-month treatment, all aspects of QoL were found to be significantly improved. Large or medium sized improvements were evident with respect to Physical functioning (Cohen's d = 1.11), Vitality (0.95), and General Health Perception (0.61).

At the 1-year follow-up, significant improvements were still evident in 6 out of 8 aspects of the SF-36 (Table 3). At the 2-year follow-up a large effect on Physical functioning (d = 0.84) as well as effects on General Health Perception (0.37), Vitality (0.30), and Bodily Pain (0.26) were found.

3.7. Bariatric surgery

Six patients underwent bariatric surgery (gastric bypass n = 2, sleeve resection n = 4) after sustained weight regain during the follow-up period. In one case surgery was performed at 34 months and data from this patient was excluded from the 2-year follow-up

Table 3
Health related quality of life (Short Form 36).

	Months after inclusion					
	0	6	12	24	36	
	Therapy			Follow-up		*Reference*[a]
	196	168	155	130	70	
Physical functioning	51.0 (27)	79.0 (24)***	81.6 (23)***	77.2 (25)***	71.1 (27)***	*88.70*
Physical role functioning	58.2 (42)	80.8 (33)***	76.5 (39)***	73.4 (39)*	66.7 (43)	*84.62*
Bodily Pain	51.0 (29)	64.8 (29)***	65.0 (28)***	62.0 (29)**	56.8 (29)*	*66.36*
General Health Perceptions	52.0 (18)	66.2 (19)***	65.1 (21)***	64.5 (20)***	58.8 (21)**	*67.00*
Vitality	45.6 (18)	64.5 (19)***	63.5 (21)***	59.6 (21)***	53.0 (21)*	*59.80*
Social role functioning	73.8 (27)	85.2 (23)***	85.5 (22)***	83.3 (26)	81.6 (25)	*85.93*
Emotional role functioning	73.2 (40)	83.4 (33)**	82.9 (34)*	81.0 (36)**	81.2 (38)	*88.68*
Mental health	66.5 (18)	75.8 (17)***	75.4 (19)***	74.2 (19)†	72.4 (20)	*71.48*

Values are provided as mean (SD). Statistical significance for comparison to baseline was tested by using the t-Test for related samples (†: $p < .10$; *: $p < .05$; **: $p < .01$; ***: $p < .001$).

[a] Reference data was computed by using age and sex-corrected data from a national health survey (Ellert U. Bellach B. M. (1999) Der SF-36 im Bundes-Gesundheitssurvey – Beschreibung einer aktuellen Normstichprobe. Gesundheitswesen 61. Sonderheft 2:184–190).

analysis. In the other cases, surgery was performed after the end of the observational period of the present report (i.e., between 37 and 43 months after inclusion).

4. Discussion

Consent exists that obesity is a multifactorial lifelong disease with a genetic predisposition requiring a multidisciplinary approach for understanding and management [1,10,14]. Due to disappointing results for conservative dietary and medical approaches to achieve and maintain considerable weight loss and improvement of comorbidity, bariatric surgery has become a standard of care for morbid obesity.

The long-term results of the Scandinavian SOS trial revealed a decreased overall mortality with a reduced number of cardiac deaths [6]. Clear improvements of type 2 diabetes were observed in retrospective as well as randomized studies [5,17–20] and have led to a recent recommendation for metabolic surgery by international diabetes organizations [21].

However, as a mechanistic approach surgery may be inappropriate for handling the psychological aspects of food intake-behavior associated with morbid obesity, and clinically important complications such as nutritional deficiencies are possible. Based on clinical experience in upper gastrointestinal cancer surgery, it can be expected that the metabolic effects of surgery may be transient as well. Long-term treatment success will depend on sustained changes in eating behavior and lifestyle, both of which are correlated with psychological factors such as adequate coping with stress, self-monitoring, motivation for healthy eating and physical activity, self-efficiency, and social support [22,23]. Intensive behavioral therapy plays an important role in promoting these changes [24].

Furthermore, the superiority of bariatric surgery in observational and even randomized controlled data is biased by the lack of an appropriate control group treated with a non-surgical multicomponent program as requested by the recent NICE guidelines [14]. Benefits of such programs including VLCD therapy have been shown in previous studies [12,13,25]. The therapy utilized in our study included the use of a similar VLCD, added by the restrictive effects of a gastric balloon, and accompanied by intensified group therapy comprised of dietary, psychological, and exercise modules, conducted in small groups of 6–8 patients. The program also included a structured follow-up care that met recent recommendations for weight loss maintenance [1].

We prospectively evaluated this intensified intervention over the course of three years. All of our patients enrolled were potential candidates for bariatric surgery according to present indication criteria (mean BMI 49 kg/m^2) but came forth with a strong determination to seek for a non-surgical weight loss treatment option. An average weight loss of 22.0% was achieved six months after inclusion. Furthermore, the weight loss of 30.5 kg sustained over a period of 12 months (RWL 21.9%, EWL 46.9%) and was associated with significant improvements of hypertension, T2DM and QoL. The health-related QoL improved for almost all the components of the SF-36. At follow-up, we could show that 17.1% and 13.0% weight loss could be maintained after 24 and 36 months respectively.

The present program clearly met the criteria of a successful non-surgical treatment for obesity as defined by the Institute of Medicine of the National Academies (1995) [16], i.e., a 12 months weight loss of more than 5% in at least 50% of the participants and more than 10% in at least 20% (intention-to-treat analysis) including a decrease of obesity related risk factors and an improvement in QoL. As there is now consensus on regarding morbid obesity as a chronic relapsing disorder, these criteria reflect short-term success only [26]. Criteria for long-term success still need to be defined, however, since it is well-known that even after bariatric surgery weight begins to regain after about 2 years, a follow-up duration of 5–10 years may be preferable [27,28].

Our data therefore suggests that intensification of a non-surgical treatment has the potential to improve key outcome parameters including weight loss, attrition rate, and weight maintenance in the short-term. The achieved weight loss in the present investigation confirms a previous multicenter study [13]. The overall weight loss is remarkable compared to the 5–8% weight loss following conventional lifestyle interventions [29]. In fact, the weight loss was almost comparable to that observed after sleeve gastrectomy [3,30]. After achieving the mile stone of an initial weight loss of 5–10%, metabolic functions improve and the priority may shift from body weight towards maintaining a healthy and satisfying lifestyle [31].

The attrition rate of 19% after 12 months in the present study can also be considered extremely low compared to previous reports that typically report rates between 31% and 56% in the course of a VLCD [13,29,32]. The follow-up rates of 86% and 76% after two and three years, respectively, suggest that a close bond between the patients and our multi-disciplinary team has developed with a long-lasting effect. Other studies reported rates between 20% and 71% [13,29,32]. Low attendance in follow-ups of many weight loss programs may be explained by a relapse with feelings of embarrassment and avoidance behavior. It is noteworthy that many patients in the present study attended the follow-ups regardless of weight regains.

The data also suggests that the provided follow-up care does not prevent a weight regain that typically follows after treatment ends [33–35], but it might reduce the amount of regained weight. More specifically, the revealed regain of 7.5% after 2 years and of 14.7% after 3 years, was slightly lower compared to previously published data (i.e., 2 y: 9%, 3 y: 15% [36]; 3 y: 22% [13]). Moreover, the present data was based on a much more inclusive follow-up cohort including data of more than 80% of therapy completers in contrast to e.g., less than 10% of the initial cohort [36]. However, to achieve long-term success a continued support seems to be pivotal in implementing specific strategies for weight maintenance [28]. In our study, support on a monthly basis seemed to be most appropriate for weight maintenance up to 2 years after treatment completion. It has yet to be shown that our strategy remains successful over a longer period. Results from the randomized Look AHEAD study are supportive of this belief by showing that nearly 40% of patients maintained a loss >10% under continuous behavioral weight loss counseling over the course of 8 years [37].

5. Limitations

The presented data is just observational, still short-term and lacked a control group. Patients who were not included in the program were not followed. However, randomized studies suffer from a considerable selection bias. Only a limited number of patients will usually agree to randomization [38,39]. Although our patients fulfilled the criteria for surgery, there was a high motivation to avoid surgery and “willingness to go the extra mile” which is also a matter of selection bias. However, a RWL <5% after 6 months may suggest “early failure” and recommendation for surgery, which was only given during follow-up care in the present study. Sustainability of weight loss has to be proven during further long-term follow-up with the goal of 10 years or longer. It should also be noted that this study was not designed to evaluate the cost-effectiveness of an intensified non-surgical treatment. The costs were covered by the health insurances and a next step will be to systematically compare different cost-optimized treatment options, especially with respect to the continuous nutritional, behavioral, and medical support required after surgical as well as non-surgical interventions.

6. Conclusion

It could be shown that "appropriate non-surgical measures" [14] may be offered to patients with morbid obesity in order to achieve significant weight loss and improvement of comorbidity over the course of three years. While change of lifestyle is definitely required with and without surgery [37], long-term weight maintenance for 10 years and longer remains to be an ongoing challenge [10,40–42] requiring continuous dietary and behavioral monitoring. Of course, the risk of failure to maintain weight loss is higher in a non-surgical multimodality treatment program. However, as a pragmatic study from Norway recently revealed, bariatric surgery may lower the risk of obesity-related comorbidities but at the same is associated with an increased risk for new complications [43]. In line with our results, we agree that this should be considered in the individual decision making process about the appropriate management of morbid obesity.

Statement of authorship

AW, study concept and design, interpretation of data, drafting manuscript.

MF, study design, analysis and interpretation of data, drafting manuscript.

NO, acquisition and interpretation of data, critical revision of manuscript for intellectual content.

GP, NW, and MA, data acquisition, critical revision of manuscript for intellectual content.

JK, IW, IS, interpretation of data, critical revision of manuscript for intellectual content.

SCB study concept, interpretation of data, critical revision of manuscript for intellectual content.

All authors have approved the final version of this manuscript.

Conflicts of interest

No conflicts of interest are present with respect to this paper.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The very low calorie diet (Optifast) is a Nestle product. A.W. received speaker's Fees from Nestle.

Acknowledgements

The authors appreciated with gratitude the great support of the health care insurances AOK Plus die Gesundheitskasse für Sachsen & Thüringen, IKK classic, Barmer Ersatzkasse, and others.

Special thanks to Dr. James Yaoming Shih (Taipei, Taiwan) for editing the manuscript.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.clnu.2018.07.027.

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