Road Running After Gastric Bypass for Morbid Obesity: Rationale and Results of a New Protocol

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Abstract

Background In recent years, the pandemic explosion of obesity has led to the definition of a pre-eminent therapeutic role for bariatric surgery, confining physical activity to a success parameter of surgery rather than a primary prevention measure. The aim of this study is to evaluate the role for aerobic physical activity (road running) in strengthening the metabolic and psychosocial effects of bariatric surgery.

Methods Ten patients who underwent gastric bypass for morbid obesity were submitted to an intensive program of road running training, aimed at completing a 10.5-km competition in September 2013. Inclusion criteria included age (<50), BMI (<35), suitability for sport activity, and good compliance. A cohort of 10 patients excluded for logistical issues were enrolled as a control group. During the training period, patients were submitted to biometrical, sport performance, cardiopulmonary, metabolic, and psychiatric evaluations.

Results Protocol adherence was 70%; no physical injury was registered among participants. More than weight loss (BMI 29.3 to 27.1), the runners experienced a redistribution of body mass with significant differences in fat percentage and waist/hip ratio. Participants had a significant running performance improvement and, differently from the controls, a significant amelioration of echocardiographic and cardiopulmonary parameters, predicting a reduction in cardiovascular risk. Psychiatric evaluation...
underlined a tendency to a reduction in anxiety, depression, and general psychopathology symptoms.

Conclusions Road running seems to have an important supporting role in boosting bariatric surgery results. The utilization of monitored and regulated training programs represents a fundamental prerequisite to achieving satisfactory results and patient compliance.

Keywords Obesity · Physical activity · Quality of life · Gastric bypass

Introduction

Bariatric surgery has become the most efficient and widely employed weapon against the pandemic explosion of obesity, thanks to its well-demonstrated effect on weight loss and comorbidity resolution [1, 2].

Conversely, the exponential increase in bariatric procedures all over the world during the last few decades, while delivering a lifeline for a great number of patients, has paradoxically represented a defeat rather than a victory in the fight against “globesity,” testifying to the failure of primary prevention measures (diet, physical activity).

Physical activity (PA), whose beneficial effects on health have been clearly demonstrated [3], could surely play an important role in preventing and treating obesity as well as in maintaining the results obtained by other means [4, 5].

Thus, while an increasing concern is growing as to the long-term effectiveness of bariatric procedures and redo surgery is becoming an increasing and dangerous reality [6], the role of PA in strengthening and/or stabilizing the benefits of bariatric surgery and preventing weight regain should be strongly reconsidered for in-depth investigation.

A recent review [7] underlined a positive relationship between exercise and weight loss after bariatric surgery, based only on observational, heterogeneous studies, with self-reported data on noncontrolled and standardized PA.

The aim of this study is to prospectively evaluate the effects of an intensive and controlled program of road running training on a cohort of patients submitted to Roux-en-Y gastric bypass (RYGBP) for morbid obesity, investigating possible benefits for weight loss maintenance and, above all, physical and psychological health outcomes.

Materials and Methods

This study is a nonrandomized prospective controlled pilot trial on a selected cohort of post-bariatric patients involved in a strongly structured and challenging program of PA.

In September 2012, we started a multidisciplinary selection aiming to enroll 10 participants for the study.

Patients previously submitted to laparoscopic RYGBP at our institution, in a phase of weight loss stabilization (1–3 years after surgery), who met the general and biometrical inclusion criteria (Table 1) were asked if they are willing to be introduced into the protocol and submitted for a physical evaluation by a sport physician.

Among the candidates judged to be fit for running, a multidisciplinary “bariatric panel” (cardiologist, endocrinologist, psychiatrist, and surgeon) finally selected 10 patients who took part in the study, evaluating the level of compliance and motivation based on clinical follow-up data.

Ten patients presenting similar suitability for the protocol, but excluded because of “logistic” problems (distance from the center/family or working problems), were enrolled as a control group.

Since the vast majority of potential candidates were female (90%), we decided to exclude males from the study.

Multidisciplinary Evaluation

All the participants were submitted to serial (baseline, midterm, final) multidisciplinary evaluations, which include the following:

- Sport functional/performance assessment: exercise electrocardiogram (ECG), spirometry
- Cardiological assessment: transthoracic color Doppler echocardiography (TTCDE), cardiopulmonary exercise testing (CPET)
- Neurophysiological assessment: heart rate variability (HRV) analysis in time domain and frequency domain with photoplethysmography (Portapres®)
- General medical assessment: biometric measurements, dual-energy X-ray absorptiometry (DEXA), blood and urine tests
- Psychiatric assessment: presence of major psychiatric disorders (Structured Clinical Interview for Axis I Disorders (SCID-I)) [8], depression and anxiety levels (Hamilton Rating Scales for Depression and Anxiety; Ham-D, Ham-A) [9, 10], levels of general psychopathology (Symptom Checklist-90-General Severity Index (SCL-90- General Severity Index (SCL-

Table 1 Inclusion criteria

| Procedure: Roux-en-Y gastric bypass |
| Age of <50 years |
| Time from surgery of 12 months–3 years |
| BMI of <35 or 35–40 if currently decreasing |
| Medical qualifying examination for physical activity |
| Good level of compliance and motivation (multidisciplinary evaluation) |
| “Logistic” availability |
Training Program

In November 2012, the participants started a 10-month personalized training program managed by three professional personal trainers and supervised by a sport physician. The plan included three guided 1-h sessions/week, adding a self-managed workout during the last period, and was divided into two quarterly periods and one 4-month period (Table 2). Depending on weather conditions, patients were trained in indoor or outdoor road running from the beginning; treadmill running was avoided. Any additional self-managed aerobic activity (swimming, bicycling) was encouraged but not included in the protocol.

Particular attention was paid to functional overload and injury prevention by means of posture, proprioceptive, and stretching exercises.

During the training, physiatric assistance as well as specialized nutritional counseling were guaranteed to all the participants.

Performance Assessment

To evaluate the level of training, participants were submitted every 3 months for the Cooper test [14]. It is a simple and cheap test which measured the distance run on a flat surface at a constant speed in a 12-min period. Results are defined as very good, good, average, bad, or very bad, taking age and gender into consideration.

End of the Protocol

Participation in the 10.5-km competition on September 8 (Cariparma Running 2013) was considered as the protocol goal, and patients not participating in it were considered as dropouts.

Data Analysis

All the data collected from multidisciplinary evaluation were analyzed in order to assess the modifications after protocol adhesion and to investigate the possible advantages compared to the control group.

Statistical analysis was performed using software package SPSS 18.0 (SPSS Inc., IBM). The Mann–Whitney test for two independent variables and the Wilcoxon rank-sum test for two paired variables were used for preliminary data evaluation of continuous variables. Analysis of variation of anthropometric and cardiopulmonary variables in $t_0–t_1$ period between cases and controls was performed utilizing the Mann–Whitney test, comparing the mean ranks of the percent variation. A difference with $p<0.05$ was considered statistically significant.

The study was approved by the institutional review board, and informed consent was obtained from all participants.

Results

Demographic and Anthropometric Data

Thanks to the inclusion criteria, group characteristics were similar (Table 3), with a higher mean age for the cases (43.1 vs 39.1; $p=0.05$). Regarding anthropometric baseline data, the runners presented a slightly higher waist/hip ratio (0.91 vs 0.86; $p=0.14$), while mean weight and BMI were similar.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Training plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductory period</td>
<td>General preparation</td>
</tr>
<tr>
<td>Duration (months)</td>
<td>3</td>
</tr>
<tr>
<td>Plan</td>
<td>Fitness walking (alternation of slow walking, 55–65 % of max. HR, and fast walking, 65–75 % of max. HR)</td>
</tr>
<tr>
<td>Aim</td>
<td>To educate, stimulate, and motivate the group to do motor activity, prevent the dropout rate, and make workouts fun</td>
</tr>
</tbody>
</table>

HR heart rate
None of the patients presented an obesity-related comorbidity in treatment.

**Protocol Adherence**

Seven participants (70%) completed the training program by taking part in the 10.5-km competitive run. The three participants not completing the protocol dropped out respectively at the end of the introductory period (1) and in the middle of the general preparation period (2), all owing to “motivational” problems. No important physical injury or health problem (more than a 2-week stop) was registered among the participants, except for symptomatic cholelithiasis which imposed a 3-week stop during the general preparation period for a competition completer.

**Anthropometric Variation**

As reported in Table 4, the runners showed a higher, albeit not significant, weight loss than the controls (BMI 29.3 to 27.1 vs 30.1 to 29.81; \( p = 0.31 \)), losing significantly more at waist circumference (94 to 90 vs 91 to 91; \( p = 0.001 \)) than at hip circumference, resulting in a significant waist/hip ratio difference (0.88 to 0.86 vs 0.86 to 0.87; \( p = 0.029 \)). DEXA showed a significant reduction in fat percentage for the runners (34 vs 33; \( p = 0.001 \)), significantly higher than in the controls (\( p = 0.001 \)), and, unlike the controls, a concomitant lean mass increase (50,238 to 51,844) (Fig. 1).

**Performance Assessment**

All participants presented an important improvement at the Cooper test (Fig. 2), passing from a mean distance of 1050 to 1798.3 m at the end of the training (mean improvement percentage, 71.3%; best, 97.1%). The best performance at competition (10.5 km) was 1.08 min and 13 s (pace, 6.29/km).

**Cardiopulmonary Assessment**

Heart rate (HR) at rest showed a tendency to a reduction in the runners (68 vs 61; \( p = 0.077 \)) (Table 5), differently from the controls, while arterial blood pressure stayed in the normal range in both groups.

Regarding TTCDE data (Table 5), left ventricular mass (LVM) showed a significant reduction in the cases (89.4 vs 78.7; \( p = 0.015 \)), differently from the controls, in which there was an increase, resulting in a significant difference between the groups (\( p = 0.026 \)).

Among CPET data (Table 5), VO2 max (the maximum oxygen uptake that can be utilized during maximal exercise, assessing aerobic physical fitness) significantly increased in the runners (\( p = 0.004 \)), differently from the controls, with a significant difference between the groups (\( p = 0.005 \)). The runners had a higher improvement in peak HR under exercise, resulting in a significant difference compared with the control group in HR competence (expressing the percentage of HR increase during the maximum effort compared with that of the rest rate) (\( p = 0.037 \)).

VO2/WR slope (oxygen uptake-to-work rate relationship), testing the cardiocirculatory efficiency, showed a significant improvement in the runners (\( p = 0.000 \)), who presented significantly better results than the controls (\( p = 0.029 \)).

**Neurophysiological Assessment**

The runners showed a tendency to a higher global spectral power (frequency domain) of HRV (1454 vs 901; \( p = 0.12 \)), testing the autonomic nervous system response, although the difference did not result as being significant.

**Laboratory Data**

No significant variation in the hematological values was encountered between cases and controls (Table 6).
The runners presented a better trend in total cholesterol (TC), HDL cholesterol (HDLC), and triglyceride (TG).

Psychiatric Assessment

No patients received any psychiatric diagnosis either at baseline or follow-up according to the SCID-I. With regard to the other psychopathological and psychological variables examined from baseline to follow-up, patients showed a decrease in Ham-A and Ham-D scores (3.33 vs 0.67 and 5.33 vs 1, respectively) as well as a decrease in general psychopathology as assessed by the SCL-90-GSI (0.25 vs 0.18). In addition, at follow-up, patients reported a higher satisfaction with the bariatric procedure received than at baseline and an improvement in quality of life regarding general health. However, the limited sample size precluded the detection of statistically significant differences between baseline and follow-up.

Discussion

Together with diet, PA represents the most physiological and healthiest barrier against overweight and obesity growth [3–5].

It is somewhat surprising that, although its importance seems theoretically evident also for patients submitted to bariatric procedures [15, 16], the usefulness of PA in potentiating the effects of bariatric surgery has not yet been clearly demonstrated and its precise role has not been defined.

As recently reported [7, 17], the few studies investigating PA in post-bariatric patients are all observational and heterogeneous, based on questionnaires on a self-reported, non-definite, and non-standardized PA, reporting exercise as an outcome parameter.

The reasons for this shortcoming are probably related to the difficulties in follow-up management and to the poor compliance of post-bariatric patients.

In fact, since a multidisciplinary support, preceding and following bariatric procedures, is crucial for a “complete” and durable result for the patients [18, 19], extremely poor patient compliance results as being one of the most important causes of failure after bariatric surgery [20], making the follow-up management extremely problematic and discouraging.

To our knowledge, our study is the first longitudinal prospective trial on a standardized and monitored post-bariatric PA that attempts to overcome such impairments by involving a great number of professionals for a relatively low number of patients. Such a small sample, while appearing to be a limit for statistical power, probably represented the only chance to guarantee the protocol; in fact, limiting the drop rate to 30% was likely the best reward for our efforts.
Running as PA protocol was chosen mainly because it is a healthy aerobic activity [21]; is easy to practice, train, and monitor, and is not expensive, representing an intriguing challenge for people who have even lost the habit of walking. On the other hand, the necessity to prevent overload injuries required maximal care during the training and imposed a specific selection on recruiting, which undoubtedly represents a selection bias. The final competition, being a hard and fascinating target, was planned as a strongly motivating tool. From this point of view, maximizing the organizational and motivational aspects in order to achieve an undoubtedly ambitious goal, this pilot study does not claim to represent an easily reproducible model, and our results should be confirmed on larger populations involved in less-demanding models.

The first important achievement of the protocol was to make all the completers able to run: indeed, nearly all the runners progressed from a “very bad” Cooper level to an “average” level (57%) or a “good” level (28.5%); the only one remaining at a very bad level had an 86% distance improvement and a satisfying performance at the race, alternating walking and running. The carefully structured and supervised training program contributed to the avoidance of any kind of physical injuries.

With respect to weight loss, at a distance from the intervention when the weight tends to stabilize (controls), the runners appear to experience once more a decrease trend in BMI, as reported by observational studies [7, 17] with a significant reduction in waist circumference and waist/hip ratio. However, the most relevant anthropometric finding is a different weight loss pattern for the runners: the significantly higher fat percentage reduction expresses a trend to both fat mass decrease and lean mass increase (Fig. 1). The importance of free fat mass preservation after bariatric surgery has been properly underlined [22] as well as the role that exercise can play in this direction during significant weight loss [23]: our data support the idea that a controlled PA could help bariatric patients in losing weight in a “healthier” [24] way.

Moreover, data obtained from cardiopulmonary assessment showed that a monitored and structured training program can induce favorable structural and functional modifications, possibly able to reduce the risk of future cardiovascular events. Literature data, indeed, demonstrated that PA can modify some ECG [25], echocardiographic [26, 27], and

![Fig. 1 Fat mass and lean mass variation in the groups](image1)

![Fig. 2 Cooper test performance variation](image2)
<table>
<thead>
<tr>
<th></th>
<th>Cases</th>
<th></th>
<th>Controls</th>
<th></th>
<th>Mean difference case–control of $t_0$–$t_1$% variation</th>
<th>$p$</th>
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<tbody>
<tr>
<td></td>
<td>$n=7$</td>
<td></td>
<td>$n=10$</td>
<td></td>
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<tr>
<td><strong>Echocardiogram</strong></td>
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<td></td>
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<tr>
<td>HR (bpm)</td>
<td>68 (64–74)</td>
<td>61 (58–72)</td>
<td>0.077</td>
<td>74 (70–98)</td>
<td>74 (70–98)</td>
<td>0.661</td>
</tr>
<tr>
<td>SIV (mm)</td>
<td>9.1 (7.0–11.0)</td>
<td>7.9 (7.0–9.0)</td>
<td>0.093</td>
<td>8.3 (7.5–11.0)</td>
<td>8.7 (7.0–11.0)</td>
<td>0.314</td>
</tr>
<tr>
<td>PP (mm)</td>
<td>9.2 (7.0–12.0)</td>
<td>7.9 (7.0–9.0)</td>
<td>0.081</td>
<td>8.6 (7.0–9.0)</td>
<td>7.7 (6.5–9.0)</td>
<td>0.094</td>
</tr>
<tr>
<td>EDD (mm)</td>
<td>47 (38–54)</td>
<td>49 (43–52)</td>
<td>0.476</td>
<td>47 (39–52)</td>
<td>48 (44–53)</td>
<td>0.367</td>
</tr>
<tr>
<td>LVM (g)</td>
<td>89.4 (61.0–111.0)</td>
<td>78.7 (63.0–93.6)</td>
<td>0.015</td>
<td>83.5 (61.7–98.0)</td>
<td>86.2 (77.0–98.0)</td>
<td>0.521</td>
</tr>
<tr>
<td>EAr</td>
<td>1.33 (1.20–1.78)</td>
<td>1.52 (1.16–1.90)</td>
<td>0.132</td>
<td>1.34 (0.96–1.70)</td>
<td>1.37 (1.02–1.80)</td>
<td>0.859</td>
</tr>
<tr>
<td>EF (%)</td>
<td>60 (55–68)</td>
<td>61 (54–68)</td>
<td>0.711</td>
<td>60 (54–70)</td>
<td>58 (54–68)</td>
<td>0.201</td>
</tr>
<tr>
<td>TAPSE (mm)</td>
<td>26.5 (20.0–37.0)</td>
<td>28.5 (21.0–34.2)</td>
<td>0.618</td>
<td>25.4 (19.0–34.0)</td>
<td>25.9 (23.0–30.0)</td>
<td>0.858</td>
</tr>
<tr>
<td><strong>Exercise test</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Power</td>
<td>129 (105–150)</td>
<td>134 (100–170)</td>
<td>0.383</td>
<td>110 (95–115)</td>
<td>108 (95–115)</td>
<td>0.576</td>
</tr>
<tr>
<td>VO$_2$ max (ml/min/kg)</td>
<td>22.1 (18.5–23.5)</td>
<td>28.2 (21.6–31.0)</td>
<td>0.004</td>
<td>19.9 (17.2–22.9)</td>
<td>20.1 (17.0–24.0)</td>
<td>0.698</td>
</tr>
<tr>
<td>% predicted</td>
<td>78 (66–101)</td>
<td>120 (95–139)</td>
<td>0.000</td>
<td>80 (57–98)</td>
<td>81 (57–102)</td>
<td>0.706</td>
</tr>
<tr>
<td>VO$_2$ AT (ml/min/kg)</td>
<td>19.5 (14.5–22.4)</td>
<td>21.8 (15.7–23.4)</td>
<td>0.115</td>
<td>16.3 (12.3–19.7)</td>
<td>16.6 (12.3–18.3)</td>
<td>0.661</td>
</tr>
<tr>
<td>HR peak (bpm)</td>
<td>134 (125–160)</td>
<td>144 (122–163)</td>
<td>0.296</td>
<td>145 (137–157)</td>
<td>147 (138–155)</td>
<td>0.650</td>
</tr>
<tr>
<td>HR competence (bpm)</td>
<td>97.48 (68.92–146.15)</td>
<td>141.53 (108.23–190.48)</td>
<td>0.023</td>
<td>117.08 (75.95–185.45)</td>
<td>112.06 (84.00–150.00)</td>
<td>0.780</td>
</tr>
<tr>
<td>HRR (bpm)</td>
<td>30 (7–38)</td>
<td>34 (28–41)</td>
<td>0.332</td>
<td>35 (28–42)</td>
<td>37 (35–38)</td>
<td>0.457</td>
</tr>
<tr>
<td>VE/VCO$_2$ slope</td>
<td>28.2 (25.0–31.3)</td>
<td>29.3 (25.7–33.3)</td>
<td>0.417</td>
<td>33.4 (25.3–40.3)</td>
<td>34.2 (23.8–44.9)</td>
<td>0.390</td>
</tr>
<tr>
<td>VO$_2$/WR slope</td>
<td>8.9 (8.0–9.3)</td>
<td>11.7 (10.4–14.0)</td>
<td>0.000</td>
<td>9.2 (7.7–10.8)</td>
<td>10.0 (7.7–12.4)</td>
<td>0.305</td>
</tr>
</tbody>
</table>

HR heart rate, SIV interventricular septum, PP posterior wall of the left ventricle, EDD end-diastolic diameter, LVM left ventricular mass, EAr E/A ratio, EF ejection fraction, TAPSE tricuspid annular plane systolic excursion, VO$_2$ max maximum oxygen volume uptake, VO$_2$ AT oxygen volume uptake at anaerobic threshold, HRR heart rate reserve, VE/VCO$_2$ ventilation vs carbon dioxide production slope, VO$_2$/WR oxygen volume uptake vs work rate slope
CPET [25] parameters in training subjects, especially when obese, along with yielding a metabolic improvement [28]; from this perspective, the finding in our study population of a lower LVM, a higher chronotropic competence during the exercise, a higher maximal aerobic exercise capacity, and an improvement in cardiovascular efficiency indexes could reasonably amount to a better cardiovascular outcome for those patients [29–31], if maintained over time.

Our lab data also appear to strengthen the beneficial role of PA on post-bariatric patients’ metabolism: the favorable trend in lipid profile in the runners, if confirmed in larger samples, suggests that, at a phase of weight loss stabilization, the above mechanisms could act as a complementary tool in potentiating the long-term mortality reduction yielded by bariatric surgery [2].

Similarly, this study suggests that engaging in a post-bariatric road running program may positively impact patients’ psychological well-being, as indicated by a sharp (although statistically not significant) reduction in anxiety, depression, and general psychopathology symptoms. PA also seemed to augment patients’ perception of effectiveness and satisfaction regarding the bariatric procedure received as well as of their general health status. If confirmed by future research, these results might indicate that post-bariatric PA may play an important role in fostering these patients’ psychological adjustment and quality of life, which is to be considered as a major objective of bariatric surgery, beyond “simple” weight reduction and improvement in related physical comorbidities.

One of the most laudable and ambitious aims of bariatric surgery, indeed, should be to recover obese people not only from an “anthropometric” point of view, but mainly as self-motivated and reliable people.

From this point of view, a structured and monitored PA postsurgical training could be a perfect tool to stabilize or even ameliorate the beneficial effects of surgery, but only if it produces an efficient and durable lifestyle change in the patients.

Conclusions

When organized in structured and motivating protocols, aerobic PA seems to exert positive effects on physical and psychological health along with good compliance in small groups of carefully monitored post-bariatric patients. Further studies should confirm the reproducibility of this model and its results on larger populations and longer periods.

Conflict of Interest Dr. Federico Marchesi, Dr. Giuseppina De Sario, Dr. Valeria Reggiani, Dr. Francesco Tartamella, Dr. Stefano Cecchini, Dr. Renato Costi, Dr. Giovanni Guareschi, Dr. Gianfranco Beltrami, Dr. Chiara De Panfilis, Dr. Elisabetta Dall’Aglio, Dr. Matteo Ricco’, and Dr. Valerio Brambilla have no conflicts of interest or financial ties to disclose.
References


Informed consent was obtained from all individual participants, for whom identifying information is included in this article.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.