



Mini-Review

Is Bariatric Surgery a Way of Doping for Obese Subjects?

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Abstract

Physical fitness and overweight are generally considered incompatible, while weight-loss is easily associated with health and fitness. Indeed, aerobic exercise capacity (best reflected by the maximal oxygen consumption, VO_{2peak}) is recognized as a strong fitness indicator and a powerful predictor of mortality in different populations. VO_{2peak} and exercise efficiency are known to be reduced in sedentary obese subjects. Associated to the mechanical difficulty of exercising with excessive body weight, dyspnea and fatigue are the current symptoms reported by obese subjects. Weight loss therefore seems like a solution to overcome exercising difficulties in order to achieve a more active and healthier lifestyle. As a radical and effective intervention, bariatric surgery allows a dramatic reduction in body weight and is also known to be associated to an improvement of daily activity levels and quality of life. However not all patients reach their therapeutic target, especially regarding physical fitness, and most still complain of asthenia. The present review therefore aims to explore the question of the link between a dramatic weight reduction, typically observed after bariatric surgery, and the VO_{2peak} . While weight-bearing efforts, often present in daily life, are obviously easier when fat mass reduction occurs after bariatric surgery, an excessive reduction in muscle mass loss would lead to a functional deficit and/or affect absolute VO_{2peak} or the dyspnea threshold. Current expert opinion therefore recommend to include the bariatric surgery patients in a hematologic and nutrition follow-up associated to adequate exercise training, starting before and lasting after bariatric surgery.

Keywords: Bariatric surgery; Exercise capacity; Obesity, Oxygen uptake, VO_{2max}

Introduction

Aerobic Exercise Capacity and Obesity

Physical fitness and overweight are generally considered incompatible. Poor aerobic exercise capacity in morbidly obese subjects has been attributed to a reduced cardio-vascular function [1,2] and a low muscular oxidative capacity [3,4]. However, the impact of obesity on exercise performance is complex because multifactorial and highly dependent on individual lifestyle. Nevertheless, some physiological differences have previously been highlighted. When compared to normal-weighted subjects, obese subjects may exhibit lower maximal workload but associated to unchanged aerobic exercise capacity, best reflected by peak exercise oxygen consumption (VO_{2peak}) [5,6]. This is possible because metabolism and oxygen uptake (VO_2) at a given workload is increased in relation to higher body mass and/or basal metabolic rate. This observation also suggests that obese subjects experience

exacerbated hyperpnea at low exercise intensities associated to an early dyspneic threshold, often perceived as disabling [7]. This profile is particularly observable in sedentary obese subjects with very low levels of muscular strength and endurance [8]. Indeed, poor physical fitness is a key factor in the vicious circle of sedentary lifestyle with the consequence of routine task limitation and leading to a restricted lifestyle [9-11].

Physical fitness is not just a matter of performance but also a matter of health and survival. In the general population, physical activity levels and VO_{2peak} are related to (disability-free) life expectancy, with lower risk for premature death [12,13]. The prognostic power of VO_{2peak} has previously been demonstrated in different types of populations, including obese patients, emphasizing that a higher VO_{2peak} reduces health complications, healthcare consumptions and mortality [12]. Interestingly, numerous studies further indicate that VO_{2peak} is ahead of traditional risk factors and has been described as prognostically more important than adiposity [14]. This observation suggests the superiority of fitness than leanness for health issues. However, this public health message does not seem to be sufficiently conveyed

and it is clear that numerous obese patients undertake weight loss therapies rather than exercise training therapies in order to achieve a more active and healthier lifestyle [15,16].

Bariatric Surgery

Among the multioptional treatments for obesity, bariatric surgery is a generally safe and effective treatment option associated with rapid and profound weight loss, significant metabolic changes and decreased morbidity and mortality [17-20]. All current procedures are associated with substantial and durable weight loss, with percentage of excess weight loss ranging between 46-74% [21]. Regarding physical activity, surgically induced weight loss has been shown to be associated with numerous positive effects; reduced joint pain, increased daily physical activity level, enhanced walking capacity (as assessed by the 6-min walking test) and endurance exercise duration with positive effects on self-reported physical fitness and quality of life [22-24]. However, even after successful surgery, not all patients achieve desired clinical or exercise performance outcomes, with many still complaining about weakness, asthenia and dyspnea [25]. Previous studies indicated that severely obese patients can achieve remarkable exercise capacity performance improvement [26,27] with higher exercise economy [27-29] while others did not [25,30,31]. Indeed, all the previously reported enthusiastic results do not specifically indicate that the intrinsically aerobic exercise capacity is improved.

Aerobic Exercise Capacity After Bariatric Surgery

Aerobic exercise capacity is best assessed by a Cardio-Pulmonary Exercise Test (CPET) to measure the ventilatory threshold and VO_{2peak} [32]. CPET are classically performed either on a treadmill or a cyclo-ergometer. Previous studies evaluating the VO_{2peak} before and after bariatric surgery exposed controversial conclusions with either an increased [26,27], unchanged [24,28,30,31,33] or decreased VO_{2peak} [4,25,29,34-36]. The discrepancy results probably emerged from many inter-study differences such as: baseline population characteristics (Body Mass Index (BMI), age, sex, comorbidities, etc.), amount of weight loss, post-surgery testing time, CPET protocol (weight-bearing vs unweight-bearing ergometer, direct or indirect measurements of VO_{2peak} , etc.), surgical conditions (type of surgery, complications,...) and intervention strategies (exercise training program, diet, education, etc.). Moreover, the mode of expression of the VO_{2peak} results is not trivial (absolute VO_{2peak} or relative VO_{2peak} corrected for body weight or fat-free mass).

VO_{2peak} Relative to Body Weight

General consensus exists on the positive effect of bariatric surgery on VO_{2peak} when expressed relative to body weight (in mL/min.Kg) [4,24,25-31,33,36-38]. However, this observation better confirms the drastic fall of body mass after bariatric surgery than an increase of the intrinsic aerobic exercise capacity. Expressing the VO_{2peak} relative to body weight introduces a confounding factor when VO_{2peak} is compared in specific situations with body composition changes (e.g., growth, training, sickness, drugs, fat weight gain or loss) [39]. However, a higher VO_{2peak} relative to body weight is advantageous when performing body weight-bearing efforts due to less over-load and a probable enhanced mechanical efficiency. This is not negligible as this type of effort is frequent in daily life activities (e.g., walking, running, climbing stairs,...). Indeed, studies using CPET treadmill almost unanimously showed an increase in maximal running performance after bariatric surgery [26,27,33,36]. Relative VO_{2peak} is therefore non-negligible since it is also recognized as a strong predictor of mortality and functional impairment.

Absolute VO_{2peak}

Contrarywise, when VO_{2peak} is expressed in absolute value (l/min), no study reported an improved intrinsic aerobic exercise capacity after bariatric surgery. Numerous studies reported a significant drop [4,25,29,36-38,40] or a tendency to decrease [24,27,30,31,33,41]. Figure 1, from Dereppe et al. [25], illustrates a comparison of absolute and relative VO_{2max} before and 1 year after surgically induced weight loss in women. This figure emphasized the necessity to recommend the systematic mentioning of both expressions of VO_{2peak} in obesity studies.

Ventilatory Threshold

Figure 1 also illustrates the Ventilatory Threshold (VT1) level, representing the pure aerobic capacity of the subject. Exercising at intensities above the ventilatory threshold stimulates anaerobic metabolism with the consequence of an over-stimulation of the ventilatory response. This level of exercise therefore reflects the dyspnea threshold and is an indicator of the quality of life. In Figure 1 and other studies, VT1 was also found to be impaired after bariatric surgery [25,31,36], while others observed no or little changes [30,41]. An early VT1 associated to a high Respiratory Exchange Ratio (RER) at maximal exercise is also observable in patients with muscular deconditioning and anticipates the contribution of the anaerobic metabolism intervention during effort [42].

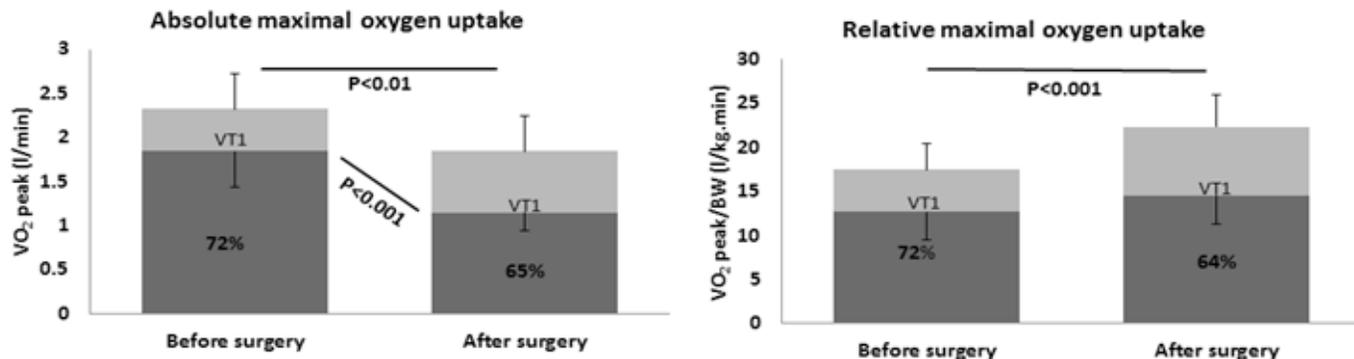


Figure 1: Comparison between the absolute and relative oxygen uptake below (day grey) and above (light grey) the Ventilatory Threshold (VTI) before and 1 year after surgically induced weight loss. The number in the columns indicate the percentage of oxygen uptake below the ventilatory threshold. This figure illustrates the impaired $VO_{2,max}$ and VTI after surgery. Figure from Dereppe et al. [25] with permission.

Anemia

Anemia is associated to numerous clinical conditions and is a potential aerobic exercise capacity limiting factor. Post-operative complications such as blood loss from the gastrointestinal tract or elsewhere, malabsorption or insufficient supplementation in iron, vitamin B9 and B12, essential for erythropoiesis, are the most frequent post-bariatric surgery causes of anemia [43,44]. Indeed, minimal hemoglobin concentration alteration, although the pathological anemic threshold definition is not reached after bariatric surgery [25], can lead to early anaerobic metabolism associated with ventilation stimulation, responsible for early dyspnea and reduced functional capacity and quality of life [45]. Recently, Dereppe et al. [25] observed a slight decrease in arterial oxygen content after bariatric surgery due to decreased post-surgical blood hemoglobin concentration in women. The impact of a slight post-surgery hemoglobin concentration reduction on aerobic exercise capacity is probably small but not negligible. This observation highlights the necessity to propose adequate dietary and hematological follow up after malabsorptive surgery.

Lean Mass Loss

Weight loss following bariatric surgery is mainly attributed to a decrease in fat mass, but however associated with lean mass loss adverse effect [4,27,30,33,35,46,47]. After bariatric surgery, 10 to 28% of the total body weight loss is attributed to muscle mass loss [48,49]. The underlying danger is sarcopenia when proteolysis provides a source of amino acids for metabolic cell functions [46]. Consequently, an excessive reduction in muscle mass would lead to a decrease in the body oxidative capacity affecting the level of the ventilatory threshold and, potentially, functional capacity.

Because $VO_{2,peak}$ is not directly dependent of fat mass but majorly influenced by fat free mass [50] some studies

reported $VO_{2,peak}$ relative to FFM [4,27,28,30,33]. Those studies consistently measured no deterioration of the muscular oxidative capacity after bariatric surgery [4,30,33]. Furthermore, several recent studies also indicated a possible enhancement of the muscular phosphorylation capacity, attributed to a positive mitochondrial remodelling after weight loss [51].

Exercise Rehabilitation

In our opinion, even in the context of a preserved oxidative muscular quality, muscular proteosynthesis needs to be stimulated with intense physical activity. This supports the crucial current idea that promoting adequate physical activity at sufficient intensity is necessary to overcome the muscle mass loss and reverse the sedentary vicious circle. It therefore seems important to add exercise training in parallel with adequate dietary (vitamin, protein intake, etc.) and hematological (Hb, etc.) follow-up.

Indeed, numerous studies recently showed that post-bariatric surgery patients involved in a structured physical activity elicits additional cardio-metabolic and muscular benefits [8,30,35,41,52-55]. Those studies and others have now demonstrated that an adequate exercise program is a feasible and effective adjunct therapy, on one hand to overcome fat free mass loss during the post-surgery weight reduction phase and on the other hand to increase the post-surgically reduced basal metabolism [30,51,56,57]. Although there is growing evidence of the importance of physical activity and exercise intervention after bariatric surgery, the best appropriate exercise prescription as part of the postsurgical guideline to enhance loss of body fat mass and maintaining lean body mass is still debated and remains to be identified [55].

Conclusions

In conclusion, the metabolic and health benefits of bariatric

surgery are associated with benefits on daily activity levels and body mass-bearing exercise performance. However, asthenia and dyspnea may persist. Indeed, previous studies showed that the ventilatory threshold and aerobic exercise capacity (absolute VO_2 peak) are not improved after surgically induced weight loss. Moreover, recent studies have found post-surgery hemoglobin and fat-free mass reduction associated to weight loss, negatively affecting the intrinsic aerobic exercise capacity of the patients. Therefore, recent literature recommends associating the hematologic and nutrition follow-up with an adequate program of exercise training, starting before and lasting after bariatric surgery.

Conflicts of Interest

The authors have no conflicts of interests to declare.

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