Ivana Nedeljkovic[1,2], Marko Banovic[1,2], Olga Arsenovic-Nedeljkovic[1], Snezana Polovina[2,3], Dejan Radenkovic[2,4], Miloš Bjelovic[2,4], Vladimir Žugić[2,5], Dragan Micic[2,3]

OBESITY AND CARDIOLOGY

Abstract

Introduction: Morbid obesity is associated with a number of ventilatory and cardiovascular disorders and increased risk for cardiovascular diseases, which can be improved by weight loss. Cardiopulmonary testing (CPET) is proposed for the objective evaluation of the effects of bariatric surgery in morbid obese patients.

Aim: To evaluate the change of CPET and hemodynamic parameters in patients treated with bariatric surgery.

Methods: We performed CPET in 250 morbid obese patients during for the preoperative assessment. We analyzed 50 patients (37 women, mean age 38±10 years) before and 6 months after bariatric surgery. All patients underwent CPET (treadmill, Bruce protocol) with expiratory gas analyses.

Results: The mean weight before treatment was 126.69 ±19.21kg, and BMI was 43.8 ± 5.4 kg/m2. Averaged body weight reduction was -29, 6 kg, and BMI -10 kg/m2 after 6 months follow-up, with significant difference in comparison to baseline values (43.8±5, 4 vs 33.9±14, 3; $p<0.0001$). CPET parameters showed increase in VO2 at ventilatory anaerobic threshold (17.86±3.44 vs 20.86±4.70; $p<0.0001$), Peak VO2 (20.79±3.63 vs 24.97±4.37; $p<0.0001$) and improvement of ventilatory efficacy VE/VCO2 slope (34.64±4.34 vs 24.74±3.39; $p<0.0001$), and PetCO2 confirming the improvement of cardiopulmonary function. Hemodynamic parameters were also improved with

[1] Cardiology clinic, CCS, School of medicine, Belgrade University, Višegradska 26, 11000 Beograd, e-mail: ivannanedeljkovic@yahoo.com.

[2] School of medicine, Belgrade University.

[3] Clinic of Endocrinology, Diabetes and Metabolic Disease, CCS.

[4] Clinic for Digestive Surgery, CCS.

[5] Clinic for Pulmonary Diseases, CCS.

decrease in resting heart rate ($p<0.0001$), resting and peak systolic ($p<0.0001$) and diastolic blood pressure ($p<0.0001$ and $p=0.002$). **Conclusion:** These results show significant relationship between weight loss and improvement of anaerobic capacity after bariatric treatment. CPET is shown to be a valuable and reliable tool for the objective assessment of functional improvement.

Key words: morbid obesity, bariatric surgery, cardiopulmonary test

Background and objectives

Obesity is one of the most serious health problems in the world and in our country, especially when it is known that the prevalence is rapidly increasing with significant reduction of the functional capacity and and increase of the risk for cardiovascular disease (CVD), so that weight loss (TT) impoves both funstional class and at the same time reduces the risk for CVD[1].

One of the most important procedure for treating morbid obesity is bariatric surgery. (2-5) So far, there has been no detailed examination of the effect of bariatric surgery on cardiopulmonary capacity, which is a significant predictor of mortality and morbidity in both the general population and obese[6]. The aim of our study was to investigate cardiopulmonary capacity before and after bariatric treatment of morbid obesity.

Methodology

The study was conducted in the Laboratory for cardiopulmonary testing, the Clinic for Cardiology, KCS. We analised 50 patients (37 women, 13 men, 38 ± 10 years of age with BMI 43.8 ± 5.4 kg / m2 scheduled for bariatric treatment of morbid obesity. All patients performed physical examination and ergospirometric examination before and six months after surgery. Patients with uncontrolled hypertension, ischemic heart disease, significant valvular disease, known chronic obstructive pulmonary disease or pulmonary limitation for test and syncope are excluded. All patients signed an informative consent before the test. Testing was approved by the KCS Ethics Committee.

Ergospirometry parameters and monitoring

The Shiller CS-200 system was used to analyze expiratory gases during CPET. Ergospirometry was performed with treadmill Bruce protocol. During the test, oxygen consumption (VO2) is continuously monitored and the consumption on the ventilation

anaerobic threshold (VAT) as well as the PeakVO2) is measured, along with monitoring of the ventilation parameters and breathing reserve (6,7,8).

12-channel ECG was monitored continuously and blood pressure measured at rest, during the test, and recovery. Indications for the test termination were: RER = 1.1, fatigue, sever chest pain, horizontal or downslopping ST depression / elevation> 1mm for 0.08 seconds after J point, hypertensive response to effort (240 / 120mmHg), hazardous rhythm disorders.

Results

We examined 50 patients with morbid obesity whose demographic data are shown in Table 1. A significant reduction in TT (Table 2) was registered 6 months after bariatric surgery. Reduction of TT was -29.6 kg, and BMI -10 kg / m2 after 6 months. The BMI index was maximally reduced by 21.8 kg / m2, but in some patients the increase was 3.6 kg / m2.

VO2 at the anaerobic threshold singificantly improved 6 months after surgery ($p < 0.001$) (Table 3). There was statistically significant increase in peak VO2, 6 months after surgery ($p < 0.0001$). Ventilatory efficacy also showed significant improvement. Bariatric surgery and significant weight reduction, together with lifestyle changes, led to significant haemodynamic improvement (Table 4).

Discussion

Chronic, morbid obesity induces significant changes in cardiovascular and pulmonary systems [1,9,10].

PeakVO2 is a precise indicator of cardiopulmonary capacity and patients with low consumption have a higher risk of surgical intervention [9,10]. Heniss et al. showed that patients with lower VO2 at the anaerobic threshold have a longer duration of hospitalization (9). Stegen et al. Have performed CPET in 15 patients with morbid obesity (BMI 43.0 kg / m2) before and 4 months after bariatric intervention. Patients who performed supervized training had better CPET results after 4 months of follow-up. Irrespective of this, bariatric intervention led to a significant reduction in TT [11]. In our study, weight loss after 6 months was 76% compared to baseline. Weight reduction was -29.6 kg, and BMI -10 kg / m2 after 6 months. This is consistent with important studies and can be explained by good postprocedural management of patients with lifestyle changes [12.13]

Conclusion

We can conclude that cardiopulmonary capacity is under significant influence of morbid obesity and is improved after weight reduction in patients treated with ba-

riatric surgery and that ergospirometry is an unavoidable noninvasive tool in precise assessment of patients before bariatric treatment.

References

1. Micić D i sar. Republička stručna komisija za izradu i implementaciju vodiča u kliničkoj praksi. Gojaznost: Nacionalni vodič za lekare u primarnoj zdravstvenoj zaštiti Ministarstvo zdravlja Republike Srbije, 2004.
2. Schauer PR., Ikramuddin S, Gourash W, Ramanathan R, Luketich J. Outcomes After Laparoscopic Roux-en-Y Gastric Bypass for Morbid Obesity. Annals of Surg 2000; 232 (4): 515–529.
3. Stegen S, Derave W, Calders P, Van Laethem C, Pattyn P. Physical Fitness in Morbidly Obese Patients: Effect of Gastric Bypass Surgery and Exercise Training. Obes Surg DOI 10.1007/s11695-009-0045-y
4. Pories WJ. Bariatric Surgery: Risks and Rewards. J Clin Endocrinol Metab. Nov 2008; 93(11 Suppl 1): S89–S96.
5. Serés L, López-Ayerbe J, Coll R, Rodríguez O, Manresa JM., Marrugat J, Alastrue A, Formiguerad X , Vallea V. Cardiopulmonary Function and Exercise Capacity in Patients With Morbid Obesity. Rev Esp Cardiol 2003; 56(6): 594–600.
6. Nedeljković I, Mazić S, Žugić V, Giga V, Dekleva M, Popović D, Stepanović J, Đorđević-Dikić A, Banović M, Beleslin B, Nedeljković M, Stojanov V, Radivojević N, Zdravković M, Vujisić-Tešić B, Petrović M, Obrenović-Kirćanski B, Kalimanovska-Oštrić D, Ostojić M. Klinička primena kardiopulmonalnog testa fizičkim opterećenjem u savremenoj kardiologiji i posebnim grupama bolesnika. Srce i krvni sudovi, 2012; 31(3): 166–173.
7. Guazzi M, Adams V, Conraads V, Halle M, Mezzani A, Vanhees L, Arena R, Fletcher G F., Forman DE., Kitzman DW., Lavie CJ., Myers Jonathan. EACPR/AHA Joint Scientific Statement .Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. Eur Heart J. 2012 Dec; 33(23): 2917–27.
8. Mezzani A, Agostoni P, Cohen-Solal A, Corra U, Jegierf A, Kouiding E, Mazich S, Meurine P, Piepoli M, Simon A,Van Laethem C,Vanhees L. Standards for the use of cardiopulmonary exercise testing for the functional evaluation of cardiac patients: a report trom the Exercise Physiology Section of the European Association for Cardiovascular Prevention and Rehabilitation. Europian Journal of Cardiovascular Prevention and Rehabilitation 2009; 56(6): 594–600.
9. Hennis P.J., Meale P.M., Hurst R.A., O Doherty A.F., Otto J., Kuper M., Harper N., Sufi P.A. Cardiopulmonary exercise testing predicts postoperative outcome in patients undergoing gastric bypass surgery. BJA Advance Access published July 18,2012.
10. Older P, Hall A, Hader R. Cardiopulmonary exercise testing as a screening test for preoperative management of major surgery in the elderly. Chest ,1999; 116: 355–362.

11. Stegen S, Derave W, Calders P, Van Laethem C, Pattyn P. Physical fitness in morbidly obese patients: effect of gastric bypass surgery and exercise training. Obes Surg 2011; 21(1): 61–70.
12. Jafri F, Krause KR, Chengelis DL, Moy J, Sandberg BA, Trivax JE, Alexander D, Kasturi, Syed MA, McCllough PA, Gallagher MJ, deJong AT, Keisha R. Cardiorespiratory Fitness and Short-term Complications After Bariatric Surgery. Chest 2006; 130: 517–525.
13. McCullough PA, Gallagher MJ, Dejong AT, Sandberg KR, Trivax JE, Alexander D, Kasturi G, Jafri SM, Krause KR, Chengelis DL, Moy J, Franklin BA. Cardiorespiratory fitness and short-term complications after bariatric surgery Chest 2006 ; 130(2): 517–25.

Table1. Demographic characteristics of the study population

		Raspon
Starost (god)	38 ± 10	20–61
Telesna težina (kg)	126,69 ±19,2	98–174
Telesna visina (cm)	171,1 ± 14,8	150–190
BMI (kg/m^2)	43,8 ± 5,4	33,3-56,6
Pol, ženski % (n)	74 (37/50)	/

Table 2. Body weight and BMI before and 6 months after bariatric surgery

	Before	After 6 months	p
Body weight (kg)	126,7 ± 19,2	97,1 ± 17,9	<0.0001
BMI (kg/m^2)	43,8 ± 5,4	33,9 ± 14,3	<0,0001

Table 3. VO2 and ventilatory response during the test before and 6 months after bariatric surgery

	Before	After 6 months	p
VO2 at VAT (ml/kg/min)	17,86 ± 3,44	20,86 ± 4,70	<0.0001
PeakVO2 (ml/kg/min)	20,79 ± 3,63	24,97 ± 4,37	<0,0001
VE/VCO2 slope	26,64 ± 4,34	24,74 ± 3,39	0,003

VO2 – oxygen consumption; VAT – ventilatory anaerobic treshold;
VE/VCO2 slope – ventilatory efficiecy.

Table 4. Blood pressure and heart rate during the test before and 6 months after bariatric surgery

	Before	After 6 months	p
Baseline HR (otk/min)	98,7 ± 12,2	88,01 ± 13,46	<0,0001
Max HR (otk/min)	179 ± 8	160 ± 17	NS
Baseline SBP (mmHg)	135 ± 14	131 ± 13	0,017
Max SBP (mmHg)	181 ± 26	162 ± 22	<0,0001
Baseline DBP (mmHg)	85 ± 8	80 ± 9	<0,0001
Max DBP (mmHg)	98 ± 12	92 ± 10	0.002

HR – heart rate; SBP – systolic blood pressure; DBP – diastolic blood pressure;