Impact of the Preoperative Risk and the Type of Surgery on Exercise Capacity and Training After Valvular Surgery

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Information on exercise capacity and training in patients who underwent valvular surgery is scarce. The aim of this study is to evaluate postoperative exercise capacity and functional improvement after exercise training according to the preoperative risk and type of surgery. In this prospective study, 145 patients who underwent aortic valve surgery (AVS) or mitral valve surgery (MVS) and who were referred for cardiac rehabilitation were stratified according to the preoperative risk (European System for Cardiac Operative Risk Evaluation [EuroSCORE]) and type of surgery (sternotomy vs ministernotomy or port access). Exercise capacity was evaluated at the start and end of cardiac rehabilitation. Postoperative exercise capacity and the benefit from exercise training were compared between the groups. Patients with a higher preoperative risk had a worse postoperative exercise capacity, with a lower load, peak VO_2, anaerobic threshold and 6-minute walking distance (all $p < 0.001$), and a higher VE/VCO_2 slope ($p = 0.01$). In MVS, port access patients performed significantly better at baseline (all $p < 0.05$), but in AVS, ministernotomy patients performed better than sternotomy patients with a concomitant coronary artery bypass graft ($p < 0.05$). Training resulted in an improvement in exercise capacity in each risk group and each type of surgery (all $p < 0.05$). This gain in exercise capacity was comparable for the EuroSCORE risk groups and for the types of surgery, for patients after AVS or MVS. In conclusion, exercise capacity after cardiac surgery is related to the preoperative risk and the type of surgery. Despite these differences in postoperative exercise capacity, a similar benefit from exercise training is obtained, regardless of their preoperative risk or type of surgery. **(Am J Cardiol 2014;113:1383−1389)**

Information on exercise capacity and exercise training in patients who underwent valvular surgery is scarce. Current literature suggests that exercise capacity does not recover spontaneously after aortic valve surgery (AVS) or mitral valve surgery (MVS).[1−3] This argues in favor of the need for cardiac rehabilitation. The primary aim of this study was to evaluate the difference in exercise capacity early after valvular surgery between patients with a low or high preoperative risk profile, assessed using the European System for Cardiac Operative Risk Evaluation (EuroSCORE). Similarly, the difference in postoperative exercise capacity was evaluated between patients after invasive versus minimal invasive surgery. The secondary aim was to assess whether the functional improvement after exercise training was affected by this preoperative risk profile or type of surgery.

Methods

One hundred and forty-five patients who underwent AVS (n = 72) or MVS (n = 73) for valvular regurgitation or stenosis and who were referred for cardiac rehabilitation between October 2007 and March 2012 were prospectively included. Patients with multivalvular disease were not eligible for inclusion, and neither were patients with transcatheter aortic valve implantation or mitraclip because of the fewer number of these procedures. Only patients with classic sternotomy, ministernotomy, or port access were considered for analysis. Combined coronary artery bypass graft (CABG) and valvular surgery was performed in 52 patients (36%). This study protocol was approved by the ethical committee of the 2 participating hospitals (AZ Maria Middelares Ghent and Onze-Lieve-Vrouw Hospital Aalst), and all patients gave informed consent. The clinical investigations were conducted according to the principles of the Declaration of Helsinki.

The EuroSCORE was used to assess the mortality risk in cardiac surgery. EuroSCORE I calculation consists of patient, cardiac, and operation-related factors and results in an additive and a logistic risk score.[4] According to the additive EuroSCORE, patients were divided into 3 risk groups.[5] A score of 0 to 2 was classified as a low-risk (n = 20), 3 to 5 as a medium-risk (n = 64), and >5 as a high-risk profile (n = 60). EuroSCORE was not calculated for 1 patient because of missing data on the left ventricular function. The decision

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Table 1
Clinical characteristics of the total patient group and patients who underwent AVS or MVS

Variable	Total Group (n = 145)	Mitral Valve Surgery (n = 73)	Aortic Valve Surgery (n = 72)	p Value
Age (yrs)	64 ± 10	64 ± 9	65 ± 12	0.696
Men	74	71	76	0.480
BMI (kg/m^2)	26 ± 4	25 ± 3	26 ± 4	0.128
LVEF (%)	64 ± 13	60 ± 15	67 ± 11	0.004
EuroSCORE risk profile				0.296
Low risk	14	18	10	
Medium risk	44	45	43	
High risk	42	37	47	
Type of valve disease				<0.001
Regurgitation	61	97	25	
Stenosis	39	3	75	
AVS/MVS				<0.001
Mechanical Prosthetic valve	17	4	30	
Bioprosthetic Valve	40	11	69	
Repair	43	85	1	
CABG	36	38	33	0.528
Type of surgery				<0.001
Sternotomy	58	55	63	
Ministernotomy	19	—	37	
Port access	23	45	—	
NYHA classification				0.990
I	69	70	68	
II	26	25	27	
III	5	5	5	
NT-proBNP (pg/ml)	565 (309−1,149)	686 (357−1,508)	476 (297−919)	0.225
Hypertension	50	45	54	0.281
Hyperlipidemia	40	44	36	0.342
Diabetes	12	4	19	0.004
Smoking	9	6	12	0.271
COPD	1	2	0	0.489
PAD	3	3	4	0.681
AF at start cardiac rehabilitation	13	12	14	0.781
Pacemaker	6	4	7	0.494
Medication				
β Blocker	88	82	94	0.022
ACE-I/ARB	37	34	39	0.562
Diuretics	26	29	22	0.366
Statins	49	44	54	0.213

Categorical variables are presented as percentages, normally distributed continuous variables are presented as mean ± SD, and non-normally continuous variables are presented as median (interquartile range).

ACE-I = angiotensin-converting enzyme inhibitor; AF = atrial fibrillation; ARB = angiotensin receptor blocker; BMI = body mass index; COPD = chronic obstructive pulmonary disease; LVEF = left ventricular ejection fraction; NT-proBNP = N-Terminal pro-brain natriuretic peptide; NYHA = New York Heart Association; PAD = peripheral arterial disease.

regarding the type of surgery (classic sternotomy vs ministernotomy or port access) was made by the cardiac surgeon on the basis of preoperative clinical data and anatomic status.

Cardiopulmonary exercise testing was performed 1 month (31 ± 16 days) after surgery on a cyclo-ergometer using a ramp protocol adapted to the patient's physical status. Ventilatory and respiratory gas measurements were obtained on a breath-by-breath basis using an Oxycon Pro spirometer (Jaeger−Viasys Healthcare, Germany). Heart rate was continuously registered by a 12-lead electrocardiogram, and blood pressure was noninvasively measured using a manual sphygmomanometer every 2 minutes during the exercise test. Patients exercised to the limits of their functional capacities established by a respiratory exchange ratio >1.15 or until the physician stopped the test because of adverse signs and/or symptoms, such as chest pain, dizziness, potentially life-threatening arrhythmias, significant ST segment displacement (≥1 mm), and marked systolic hypotension or hypertension. The maximal achieved load during incremental exercise was recorded. Peak oxygen consumption (peak VO_2) was defined as the mean of the last 30 seconds of peak exercise and was expressed as milliliter per minute per kilogram. The slope of the linear relation between VE (y axis) and VCO_2 (x axis), the VE/VCO_2 slope, was calculated by including all data points to the end of the exercise. The anaerobic threshold (AT) was defined as the exercise level at which ventilation starts to increase exponentially, relative to the increase in VO_2.[6] At the beginning of the exercise training program, a 6-minute walk