**Cardiopulmonary Exercise Testing in Patients with Repaired Ebstein’s Anomaly: A significant tool for description of outcomes in patients with a re evaluation**

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* **Financial Support:** No funding
* **Short Title:**
* **Subject Terms:** Ebstein’s anomaly, cardiopulmonary exercise test
* **Word Count: 289**
* **Number of References:**
* **Number of Tables: 1**
* **Number of Figures:**

Abstract

Introduction

Ebstein’s anomaly (EA) consists of displaced tricuspid leaflets, creating an atrialization of right ventricle and incompetence of the valve that will result in right ventricular dilatation. Cardiopulmonary exercise testing (CPX) has evolved as a technique that will not only help reveal the severity but also establish the prognosis of these patients.

Hypothesis

Describe the outcomes that occurred in repaired Ebstein’s up till April 2018 taken from the Integrated Stress Center database, including redo procedures performed to establish the role of CPX in decision-making for further therapy.

Methods

Mayo Integrated Stress Center database was queried from January 2011 to April 2018. Electrocardiographic and echocardiographic data were extracted from patient records to match the date of the CPX. Patients were divided by redo surgery versus continued follow-up after the CPX. T-tests were used for continuous variables and Pearson’s chi-squared tests for discrete variables. Logistic regression was used to identify significant predictors of redo surgery. Level of significance was P < .05.

Results

We identified 74 eligible patients of whom 26 (35%) had a redo procedure X=70.9 days after their last CPX. Patient characteristics are presented in Table 1 by redo status. Parameters that were statistically significantly different were: % predicted peak VO2 (p=0.04), peak VO2 <60% predicted (p=0.01), severe right ventricle dilatation (p=0.006) and severe tricuspid valve regurgitation (p=<.0001). Of patients with severe TVR, 19 of 25 (76%) were referred to surgery. Patients without severe TVR were further triaged by CPX: 7 of 17 (41%) of patients peak VO2 < 60% predicted were referred for surgery versus 1/30 (3%) with peak VO2 ≥ 60% predicted.

Conclusion

In our cohort of repaired Ebstein’s anomaly, severity of TR combined with low peak VO2 on CPX guided identification of candidates for redo surgery.

**Table 1.**

|  |  |
| --- | --- |
|  | **Repaired Ebstein’s** |
|  | **Redo surgery****n=26** | **Follow-up** **n=48** | **test, P** |
| **Age (years)** | X= 41.68 (21-71) | X=46.18 (24-58) | χ2 =1.60, 0.1138 |
| **Female** | 19(73%) | 33(69%) | χ2=0.0213, 0.8839 |
| **BMI kg/m2** | X= 27.14(20-35) | X=26.7(18.8-39) | t=0.38 , 0.7024 |
| **PFO** | 8(31%) | 16(33%) | χ2=----, 0.8012 |
| **ASD** | 11(42%) | 18(37%) | χ20.0765, 0.7821 |
| **Maze Procedure** | 9(34%) | 14(30%) | χ2=----, 0.7977 |
| **Beta Blocker** | 13(48%) | 19(41%) | χ2=0.3237, 0.5694 |
| **Digitalis** | 7(26%) | 7(15%) | χ2=-----, 0.3570 |
| **QRS length in msec** | X=152. 4(90-234) | X=136.3(70-214) | t=-2.09, 0.0396 |
| **RBBB** | 15(61%) | 31(66%) | χ2=0.7889, 0.3744 |
| **Pacemaker** | 4(15%) | 6(13%) | χ2=----, 1.0 |
| **Catheter ablation** | 3(11%) | 8(18%) | χ2=----, 0.7360 |
| **Symptom-limited** | 26(100%) | 44(96%) | χ2=0.0179, 0.8935 |
| **VO2 peak ml/kg/min** | X=19.53(10.8-29.10) | X=20.87(5.4-44.4) | t=0.93, 0.3572 |
| **% Predicted VO2 peak** | X=58.96(32-79%) | X=67.5(17-117%) | t=**2.05, 0.0437** |
| **Predicted VO2 Peak <60%** | 16(61%) | 13 (27%) | χ2**=6.0753, 0.0137** |
| **VE/VCO2 Nadir** | X=31.29(24-41) | X=30.12(22-38) | t=-1.30 , 0.1987 |
| **Peak RER** | X=1.18(0.99-1.38) | X=1.17(0.88-1.15) | t=-0.48, 0.6351 |
| **RV Severe dilatation** | 20(74%) | 20(42%) | χ2**=7.2917, 0.0069** |
| **Severe TVR** | 19(73%) | 7(15%) | $x^{2} $**22.5689, <.0001** |
| **RV Severe SysDx** | 11(42%) | 15(31%) | $x^{2} $0.6872, 0.4071 |
| **EF %**  | X=58.89%(45-68%) | X=61.54%(45-71%) | **T** 1.79, 0.0776 |

X=mean for T student; $x^{2}$= Chi square; BMI=body mass index; EF%= ejection fraction %; VO2 max=peak oxygen consumption in the test; VO2 max predicted= the percentage of VO2 they reach for a control with same gender and age; VO2 max Predicted <60%= if they VO2 % was below the 60% of the predicted by same age and gender control; VE/VCO2 nadir=the minute ventilation carbon dioxide production relationship; Peak RER= the maximum respiratory exchange ratio; RV = right ventricle; TVR=tricuspid valve regurgitation; QRS=QRS interval in ECG; RV severe SysDx = right ventricle severe systolic dysfunction; Sx =surgery; Beta Block=beta blocker; RBBB= right bundle branch block;PFO=patent foramen oval; ASD= atrial septal defect; Stop CPX for Symptoms= the patient stop the cardiopulmonary exercise test because any symptom like fatigue.