International Journal of Cardiology xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Additive and independent prognostic role of abnormal right ventricle and pulmonary hypertension in mitral-tricuspid surgery

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ARTICLE INFO

Article history:
Received 15 August 2017
Received in revised form 15 September 2017
Accepted 10 November 2017
Available online xxxx

Keywords:
Right ventricular function
Mitral valve surgery
Echocardiographic assessment
Pulmonary hypertension
Right ventricle

ABSTRACT

Objective: To evaluate the additive and independent prognostic value of abnormal right ventricle (aRV) and pulmonary hypertension (PH) in patients undergoing mitral-tricuspid surgery.
Methods: From January 2009 to December 2012, 541 patients underwent mitro-tricuspid surgery. The entire cohort was divided into 6 subgroups: 63 cases had normal RV and no PH (Group A), 180 normal RV but moderate PH (Group B), 101 normal RV but severe PH (Group C), 15 abnormal RV and no-PH (Group D), 86 abnormal RV and moderate PH (Group E) and 96 abnormal RV and severe PH (Group F).
Results: Forty-two (7.8%) patients died in hospital due to any cause: 1.6% in group A, 3.9% in group B, 8.9% in group C, 13.3% in group D, 9.3% in group E, 15.6% in group E, $p = 0.005$. Among 78 patients with no-PH, mortality was significantly higher in patients with aRV (1.6%vs 13.3%. $p = 0.03$). Among 344 patients with normal RV, mortality was significantly higher in patients with severe PH (1.6% vs 3.9% vs 8.9%. $p = 0.03$).
Comparing the presence of both abnormal RV and severe PH with the remaining patients, mortality was significantly higher in the first group (15.6% 6.1%, $p = 0.004$).
Multivariable analysis confirmed either the independent or the additive role of RV and PH.
Conclusions: In patients undergoing mitral-tricuspid valve surgery, the presence of either RV dysfunction/dilatation or severe pulmonary hypertension, might play an independent prognostic role for mortality. The worst scenario is surely the contemporary presence of both conditions.

1. Introduction

The prognostic role of right ventricle has been clearly demonstrated in patients with myocardial infarction (MI) [1,2], heart failure (HF), either ischemic or not [3,4], or receiving cardiac resynchronization therapy [5]. This finding changed the insight of the cardiologists, resulting in a more careful evaluation of the right ventricle in order to assess the prognosis.

In cardiac surgery, although there are sufficient evidences [6–11] in favor of routine preoperative assessment of the right ventricle, the main surgical risk score systems [12,13] do not take into account neither dysfunction nor dilatation of the right ventricle.

On the contrary, pulmonary hypertension (PH) is considered a strong predictor for mortality after cardiac surgery; but, as already demonstrated in patients with HF, PH does not always mirror RV dysfunction, which has an independent and additive prognostic value [14]. In addition, RV dysfunction seems to be a better predictor of postoperative circulatory failure rather than pulmonary hypertension(PH), in patients undergoing mitral valve surgery (MVS) [8].

Hence, the purpose of this retrospective study is to evaluate the additive and independent prognostic value of abnormal right ventricle and pulmonary hypertension in a cohort of patients undergoing mitro-tricuspid surgery.

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https://doi.org/10.1016/j.ijcard.2017.11.031
0167-5273/

2. Methods

2.1. Study population

From January 2009 to December 2012, 541 patients with mitral valvulopathy and secondary tricuspid regurgitation were consecutively operated on at Prince Sultan Cardiac Center in Riyadh. The study received the approval from local Institutional Review Board. The entire cohort was divided into 6 subgroups: group A (normal RV and no-PH), group B (normal RV and moderate PH), group C (normal RV and severe PH), group D (abnormal RV and no-PH), group E (abnormal RV and moderate PH), group F (abnormal RV and severe PH). Table 1 summarizes difference among groups.

2.2. Echocardiography

All the patients underwent routine preoperative trans-thoracic echocardiography. Right ventricle (RV) dimension and function were assessed according to guidelines [15]. Briefly, right ventricular basal diameter (RVD) was assessed via 4 chamber view; RVD >42 mm was considered dilated. Tricuspid annular plane systolic excursion (TAPSE) was measured in M-mode, evaluating systo-diastolic excursion of lateral tricuspid annulus; Using the same view and tissue pulse Doppler, peak velocity of lateral tricuspid annulus (TDI S′) was measured. Right ventricular dysfunction was defined as the presence of either TAPSE < 16 mm or Pulsed Doppler peak velocity at TDI S′ < 10 cm/s. The presence of RV dilatation and/or dysfunction was labeled as "abnormal RV".

The systolic pulmonary artery pressure (sPAP) was estimated as the sum of the gradient across the tricuspid valve (calculated from the simplified Bernoulli equation) and the right atrial pressure. Right atrial pressure was estimated using the size and respiratory response of the inferior vena cava in the sub-costal view. Pulmonary hypertension was considered moderate with value of sPAP between 31 and 55 mm Hg and severe with sPAP > 55 mm Hg according to their prognostic value in cardiac surgery [13]. Left ventricular ejection fraction was measured with modified Simpson biplane method [16]. Mitral and tricuspid valves were assessed according to the European recommendations [17].

2.3. Surgery

After a median sternotomy, the ascending aorta and both cavae were cannulated, the superior one directly. In all the cases, intermittent antegrade warm blood cardioplegia was used. The MV was approached transeptally via a right atriotomy. MA was always reshaped using the SMB40™ (Sorin, Saluggia, Italy). The band 40 mm long was inserted from A1 (that coincides with the left trigone) to A3 (the fibrous zone that represents the offshoots of the right trigone) with several interrupted sutures, leaving the only A2 insertion-free. In some cases, chordal replacement of chordal cutting was needed. Insertion of a prosthesis inside the mitral valve was performed sparing, where possible, the annular-subvalvular connection. Tricuspid repair was performed using a De Vega suture annuloplasty (38 cases), band annuloplasty with SMB50™ (Sorin Saluggia Italy) in 314 cases, with MC3™ (Edwards Lifescience, Irvin, CA, US) in 109 cases, Cosgrove band (Edwards Lifescience, Irvin, CA, US) in 10 cases and bicuspidalization in 4 cases. In 66 patients, tricuspid valve was replaced with mechanical prosthesis in 19 cases and with bioprosthesis in 47 cases. Average cardiopulmonary bypass and cross-clamping time were 135 ± 46 and 100 ± 34 min, respectively. Surgical details are reported in Table 1.

2.4. Endpoints

The primary end-point of this study is the additive and independent prognostic value of RV and PH on in-hospital mortality of patients undergoing mitral-tricuspid surgery.

2.5. Statistical analysis

Results are expressed as mean (±standard deviation). Categorical variables were reported as counts and percentages. Non-normally distributed variables were reported as median and 25th–75th percentiles. Comparison between groups was performed using chi-square test in case of categorical variables, with ANOVA test with post-hoc analysis in case of continuous variables; when continuous variables were non-normally distributed, Kruskal-Wallis. Finally, a multivariable analysis was used to verify the additive and independent prognostic value of RV and PH. ROC curve was used to assess the AUC of the final model (discrimination power) and the final model was validated in 1000 bootstrap samples, reporting distortion from AUC original AUC. Calibration was assessed by means of Hosmer-Lemeshow test. For all tests, a p-value < 0.05 was significant. The SPSS software (SPSS Inc., Chicago, IL, USA) was used.

3. Results

3.1. Right ventricle

Among 541 enrolled patients, 344 (64%) had normal RV, 102 (18%) had either RV dilatation (72 cases) or dysfunction (30 cases) and 95 (18%) has contemporary RV dilatation and dysfunction. Hence, abnormal RV was recorded in 197 (36%) patients.

3.2. Pulmonary hypertension

Pulmonary hypertension was absent in 78 (14%) cases, moderate in 266 (49%) and severe in 197 (37%).

3.3. Stratification by RV and PH

Sixty-three cases (12%) had normal RV and no PH (Group A), 180 (33%) had normal RV but moderate PH (Group B), 101 (19%) had normal RV but severe PH (Group C),15 (3%) had abnormal RV and no-PH (Group D),86 (16%) had abnormal RV and moderate PH (Group E) and 96 (18%) had abnormal RV and severe PH (Group F).

3.4. Mortality

Forty-two (7.8%) patients died in hospital due to any cause, 27 (5%) within 30-day from surgery and 15 (2.8%) were never discharged from

Table 1
Demographic, clinical and surgical and echocardiographic data.

Variables	Group A (63)	Group B (180)	Group C (101)	Group D (15)	Group E (86)	Group F (96)	p-Value
Age (years)	52 ± 17	55 ± 16	56 ± 15	52 ± 13	53 ± 13	53 ± 16	0.26
Gender M/F	26/37	70/110	51/50	8/7	32/54	51/45	0.16
Logistic ES II	3 (2–6)	4 (2–6)	6 (3−11)	5 (2–9)	6 (3–11)	7 (4–11)	0.00
LVEF (%)	49 ± 11	49 ± 11	47 ± 12	44 ± 14	47 ± 12	45 ± 14	0.12
LVEDD (mm)	54 ± 6	54 ± 8	56 ± 9	56 ± 7	53 ± 9	53 ± 12	0.11
LVESD (mm)	37 ± 8	38 ± 9	39 ± 9	42 ± 9	39 ± 10	39 ± 12	0.21
TAPSE (mm)	22 ± 4	21 ± 2	21 ± 3	14 ± 6	13 ± 3	12 ± 3	0.00
TDI S′ (cm/s)	13 ± 2	12 ± 1	13 ± 1	8 ± 4	9 ± 2	8 ± 3	0.00
RVD (mm)	33 ± 5	36 ± 3	34 ± 4	41 ± 10	43 ± 4	43 ± 3	0.00
sPAP (mm Hg)	28 ± 2	47 ± 6	69 ± 10	28 ± 2	46 ± 2	73 ± 14	0.00
MR grade	3.0 ± 1.2	3.0 ± 1.2	3.2 ± 1.1	2.7 ± 1.5	2.8 ± 1.2	3.1 ± 1.1	0.12
TR grade	2.0 ± 0.9	2.4 ± 1.0	2.7 ± 1.0	3.0 ± 1.3	3.0 ± 1.1	3.3 ± 1.0	0.00
MV surgery							0.45
Repair	23 (36%)	63 (35%)	33 (33%)	5 (33%)	32 (32%)	34 (35%)	
Replacement	40 (64%)	117 (65%)	68 (67%)	10 (67%)	54 (68%)	62 (65%)	
TV surgery							0.00
Repair	62 (98%)	169 (94%)	92 (91%)	9 (60%)	63 (73%)	80 (83%)	
Replacement	1 (2%)	11 (6%)	9 (9%)	6 (40%)	23 (27%)	16 (17%)	

RV = right ventricle; pH = pulmonary hypertension; Group A (normal RV and no-PH); Group B (normal RV and moderate PH); Group C (normal RV and severe PH); Group D (abnormal RV and no-PH); Group E (abnormal RV and moderate PH); Group F (abnormal RV and severe PH), M/F = male/female, ES = Euroscore, LVEF = left ventricular ejection fraction, LVEDD = left ventricular end-diastolic diameter, LVESD = left ventricular end-systolic diameter, TAPSE = tricuspid annular plane systolic excursion, TDI S′ = tissue-Doppler imaging, RVD = right ventricular diameter, sPAP = systolic pulmonary artery pressure, MR = mitral regurgitation, TR = tricuspid regurgitation, MV = mitral valve, TV = tricuspid valve.

Please cite this article as: M. Di Mauro, et al., Additive and independent prognostic role of abnormal right ventricle and pulmonary hypertension in mitral-tricuspid surgery, Int J Cardiol (2017), https://doi.org/10.1016/j.ijcard.2017.11.031