A contemporary analysis of pulmonary hypertension in patients undergoing mitral valve surgery: Is this a risk factor?

Daniel H. Enter, MD,[a] Anthony Zaki, BS,[a] Brett F. Duncan, MD,[a] Jane Kruse, RN, BSN,[a] Adin-Cristian Andrei, PhD,[a] Zhi Li, MS,[a] S. Chris Malaisrie, MD,[a] Sanjiv J. Shah, MD,[b] James D. Thomas, MD,[b] and Patrick M. McCarthy, MD[a]

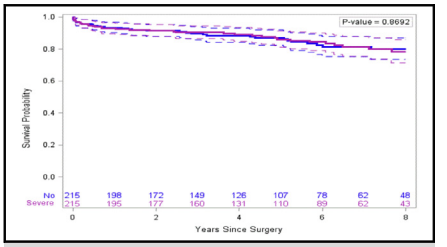
ABSTRACT

Objective: Pulmonary hypertension (PHT) has been considered a risk factor for mortality in cardiac surgery. Among mitral valve surgery (MVS) patients, we sought to determine if severe PHT increases mortality risk and if patients who undergo concomitant tricuspid valve surgery (TVS) incur additional risk.

Methods: Preoperative PHT was assessed in 1571 patients undergoing MVS, from 2004 to 2013. Patients were stratified into PHT groups as follows (mm Hg): none (<35); moderate (35-49); severe (50-79); and extreme (≥80). Propensity-score matching resulted in a total of 430 patients, by PHT groups, and 384 patients, by TVS groups.

Results: Patients with severe PHT had higher mortality, both 30-day (4% PHT vs 1% no PHT, $P < .02$) and late (defined as survival at 5 years): 75.5% severe versus 91.9% no PHT ($P < .001$). In propensity-score–matched groups, severe PHT was not a risk factor for 30-day (3% each, $P = 1.0$) or late mortality (86.2% severe vs 87.1% no PHT; $P = .87$). TVS did not increase 30-day (4.7% TVS vs 4.2% no TVS, $P = .8$) or late mortality (78.7% TVS vs 75.3% no TVS, $P = .90$). Late survival was lower in extreme PHT (75.4% vs no PHT 91.5%, $P = .007$), and a trend was found in 30-day mortality (11% extreme vs 3% no PHT, $P = .16$).

Conclusions: Mortality in MVS is unaffected by severe PHT or the addition of TVS, yet extreme PHT remains a risk factor. Severe PHT (50-79 mm Hg) should not preclude surgery; concomitant TVS does not increase mortality. (J Thorac Cardiovasc Surg 2016;151:1288-99)



Kaplan-Meier estimates in propensity-score matched groups: severe group (*Severe*) versus no PHT (*No*).

Central Message

Mortality in mitral valve surgery is unaffected by severe pulmonary hypertension or the addition of tricuspid valve surgery, but extreme pulmonary hypertension remains a risk factor.

Perspective

Pulmonary hypertension is considered a risk factor for 30-day mortality in MVS patients. Our study found no difference in mortality for MVS patients with severe PHT or with the addition of TVS. Severe PHT should not be a contraindication to MVS, and TVS can be safely added; however, extreme PHT remains a consideration when determining operative risk.

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Pulmonary hypertension (PHT) historically has been considered a mortality risk factor in cardiac surgical patients, and is found in 15% to 60% of patients who have valvular heart disease. PHT is associated with a higher risk of cardiovascular events with medical management, during valve surgery, and even after successful surgical intervention.[1] In patients who have mitral valve disease, PHT is a common finding in the preoperative evaluation,[2] often resulting from elevated left atrial pressures that lead to pulmonary vascular remodeling.[3] Longstanding PHT increases the afterload on the right ventricle, leading to hypertrophy and eventually, cor pulmonale.[3] This right-heart

From the Divisions of [a]Cardiac Surgery and [b]Cardiology, Bluhm Cardiovascular Institute, Northwestern University Feinberg School of Medicine, Chicago, Ill.

Read at the 95th Annual Meeting of The American Association for Thoracic Surgery, Seattle, Washington, April 25-29, 2015.

Received for publication April 29, 2015; revisions received Dec 18, 2015; accepted for publication Dec 30, 2015; available ahead of print Feb 28, 2016.

Address for reprints: Patrick M. McCarthy, MD, Executive Director of the Bluhm Cardiovascular Institute, Chief of the Cardiac Surgery Division, Heller-Sacks Professor of Surgery at the Northwestern University Feinberg School of Medicine, 201 E Huron St, Ste 11-140, Chicago, IL 60611-2908 (E-mail: pmccart@nm.org).

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2015.12.063

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Abbreviations and Acronyms
MVS = mitral valve surgery
PASP = pulmonary artery systolic pressure
PHT = pulmonary hypertension
RHC = right-heart catheterization
STS = Society of Thoracic Surgeons
TVS = tricuspid valve surgery

failure is associated with tricuspid annulus, right ventricular dilation, and tricuspid regurgitation, further exacerbating right ventricular dysfunction.[4,5] Current guidelines suggest that the most effective therapy for severe degenerative mitral regurgitation is surgical intervention,[6] yet in some cases, operative treatment is not pursued, owing to perceived high perioperative risks.

In this study, we aim to elucidate the isolated impact of PHT on short- and long-term outcomes of patients who have PHT. Although conventions vary, we defined PHT as the presence of a pulmonary artery systolic pressure (PASP) >35 mm Hg, which we have further stratified into moderate (35-49 mm Hg), severe (50-79 mm Hg), and extreme (≥80 mm Hg). Preoperatively, PASP is either measured directly via right-heart catheterization (RHC), or estimated via Doppler echocardiography, using the simplified Bernoulli equation.[7,8]

Up to 50% of patients undergoing MVS have tricuspid valve regurgitation,[9,10] which has been shown to negatively affect survival independently.[11] Current guidelines provide a Class I indication for repair of severe tricuspid regurgitation for patients undergoing left-sided valve surgery,[6] consistent with long-term outcomes demonstrating a survival advantage of tricuspid valve repair concomitant with MVS.[10,12-14] We performed a subset analysis on the MVS patients who had PHT, to assess the impact of concomitant tricuspid valve surgery (TVS) on patient outcomes.

METHODS

Patients and Study Design

Data for this project were obtained from the Cardiovascular Research Database in the Clinical Trial Unit of the Bluhm Cardiovascular Institute at Northwestern Memorial Hospital. This database was approved by the Institutional Review Board at Northwestern University. Any subjects who declined to participate in the project were not included in the analysis. Between April 1, 2004, and December 31, 2013, a total of 3755 adult patients underwent first-time valve surgery, excluding patients who had transcatheter aortic valve replacement, ventricular assist devices, transplant, trauma, or endocarditis. Of these, 1714 patients had MVS. Preoperative PASP data were available in 1571 (92%) cases: 1075 (62.7%) patients had PHT (defined as PASP >35 mm Hg); 496 (28.9%) patients had no PHT; and 143 (8.34%) patients had unknown PASP values. PHT patients were further stratified into groups based on PASP (mm Hg): 600 (55.8%) moderate (35-49); 426 (39.6%) severe (50-79); and 49 (4.6%) extreme (≥80).

Our institutional database did not indicate whether the PASP was obtained by echocardiography or RHC. In patients who did not receive an RHC study preoperatively, PASP values were obtained from Doppler echocardiography, using the modified Bernoulli equation ($4 \times [\text{tricuspid regurgitation}]^2 + \text{right atrial pressure}$).[15] The absence of pulmonary stenosis and right ventricular outflow obstruction allowed for the estimation of PASP from the right ventricular systolic pressures obtained from echocardiography. When both RHC and echocardiography were obtained preoperatively, results obtained from RHC were used preferentially. No intraoperative echocardiogram measurements were used. Baseline PASP data were not available on 143 patients, who were excluded from this study.

Mortality Data Collection

Mortality data were aggregated continuously and in an equally thorough manner by a dedicated team of research personnel upon consulting various sources, including the following: (1) the local cardiovascular research database registry, which captures extensive information via postal surveys mailed (to patients alive at discharge) at 6 and 12 months after surgery, and annually thereafter or until notice of death; (2) copies of records for medical procedures and hospitalizations, to verify patient self-reported events captured via survey questionnaires; (3) reviews of external medical records and written or electronic correspondence with the referring or treating physician; (4) direct interviews with the patient during follow-up visits and clinical evaluation; (5) online death indexes, including the Social Security Death Index and genealogy resources (eg, ancestry.com) that provide copies of the death information, for this index, that is supplied directly by family members (at least once a year, our dedicated team reviews the entire cohort of patients known to be alive at last follow-up); and (6) local newspaper death notices, because a substantial segment of our patient population resides in the metropolitan Chicago area or in a state neighboring Illinois. Utilizing these sources, follow-up information was available on 100% of the cohort. The Society of Thoracic Surgeons (STS) database definitions were used for 30-day mortality.

Statistical Analysis

Given the risk for confounding due to baseline imbalances, we employed propensity-score matching methods. Groups compared were matched 1-to-1, based on this score, using a greedy algorithm with a caliper of size 0.2 logit propensity-score standard deviation units. The adequacy of between-groups balance in each baseline characteristic used to create the propensity-score model was assessed using standardized differences[16] (orange color for the prematching groups; violet color for the matched groups). Variables used in the matching process were as follows: age; gender; body surface area; preoperative creatinine level; Ambler score; angina; coronary artery disease; family history of coronary artery disease; diabetes; hypercholesterolemia; hypertension; chronic obstructive pulmonary disease; cerebrovascular accident; prior coronary artery bypass graft; prior valve surgery; repeat sternotomy; prior myocardial infarction; New York Heart Association functional class III or IV; history of atrial fibrillation; elective status; and mitral valve functional class and TVS (except for the subgroup analysis comparing concomitant TVS vs no TVS among MVS patients).

Additional propensity-score matched analyses have compared the incidence of receiving a predischarge permanent pacemaker by concomitant tricuspid valve repair or replacement status, among the subgroup of patients with preoperative PHT, and separately in the entire cohort (PHT classification was included as a variable in the respective propensity-score models). Propensity-score matching was implemented using the SAS macro %GMATCH (SAS Institute, Inc, Cary, NC).

Kaplan-Meier curves with corresponding 95% pointwise confidence intervals were used to summarize postoperative overall survival; group comparisons were based on the log-rank test. The association between long-term mortality and PASP as a continuous variable was assessed using