UPDATES IN PERIOPERATIVE MANAGEMENT OF SECONDARY PULMONARY HYPERTENSION DURING MITRAL VALVE SURGERIES

An essay submitted for fulfillment

Of master degree MSc in ANESTHESIOLOGY

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Abstract

Patients with long standing mitral valve disease are at risk of developing pulmonary hypertension, which may present a formidable challenge for the cardiac anesthetist (perioperatively) during cardiac surgery. Pulmonary hypertension is an important risk factor for the development of acute right sided heart failure during cardiac surgery . Even with early and adequate therapy, right ventricular (RV) failure is associated with increased morbidity and mortality . Adequate treatment of RV failure consists of different strategies. The main goal is to decrease RV afterload by using vasodilating agents .

Key Word

Rv

Mitral Valve Surgeries

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Contents

List of abbreviations

ASE	American Society Of Echocardiography
cAMP	Cyclic Adenine Mono Phosphate
cGMP	Cyclic Guanine Mono Phosphate
CI	Cardiac Index
CO	Cardiac Output
COPD	Chronic Obstructive Pulmonary disease
CPB	Cardio Pulmonary Bypass
CVP	Central Venous Pressure
EF	Ejection Fraction
EtA	Endothelin-1 receptor type A
EtB	Endothelin-1 receptor type B
GTN	Glyceryl Tri-Nitrate
HPV	Hypoxic Pulmonary Vasoconstriction Reflex
HR	Heart Rate
IOTEE	Intra Operative Trans Esophageal Echo
Kg	Kilogram
L	Liter
LV	Left Ventricle
LA	Left Atrium
LVOT	Left Ventricle Outflow Tract
MAP	Mean Arterial Pressure
ml	Milliliter

mmHg	Millimeter Mercury
MPAP	Mean Pulmonary Artery Pressure
MR	Mitral Regurge
MS	Mitral Stenosis
MS/MR	Double Mitral
NO	Nitric Oxide
NYHA	New York Heart Association
PA	Pulmonary Artery
PAH	Pulmonary Artery Hypertension
PaO2	Arterial O2 tension
PAP	Pulmonary Artery Pressure
PASP	Pulmonary Artery Systolic Pressure
PCWP	Pulmonary Capillary Wedge Pressure
PDEI III	Phospho Di-esterase Enzyme Inhibitor III
PDEI V	Phospho Di-esterase Enzyme Inhibitor V
PH	Pulmonary Hypertension
PPH	Primary Pulmonary Hypertension
PVOD	Pulmonary Veno-Occlusive Disease
PVR	Pulmonary Vascular resistance
RAP	Right Atrial Pressure
RV	Right Ventricle
SaO2	Arterial Oxygen Saturation
SPAH	Secondary Pulmonary Hypertension

SV	Stroke Volume
SVR	Systemic Vascular Resistance
TEE	Trans Esophageal Echocardiography
TTE	Trans Thoracic Echocardiography
WHO	World Health Organization

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Introduction

Patients with long standing mitral valve disease are at risk of developing pulmonary hypertension, which may present a formidable challenge for the cardiac anesthetist (perioperatively) during cardiac surgery[1]. Pulmonary hypertension is an important risk factor for the development of acute right sided heart failure during cardiac surgery[2].

Even with early and adequate therapy, right ventricular (RV) failure is associated with increased morbidity and mortality[3]. Adequate treatment of RV failure consists of different strategies. The main goal is to decrease RV afterload by using vasodilating agents [4].

Strategies to reduce pulmonary vascular tone aim to enrich vascular smooth muscle cyclic adenosine monophosphate (cAMP) levels through beta agonists (e.g. isoproterenol) or with phosphodiesterase type III inhibitors (e.g. milrinone). Oral Sildenafil is a selective vasodilator that prolongs the action of cyclic guanosine monophosphate (cGMP) by selective inhibition of phosphodiesterase (PDE) type 5, of which the lung has a rich supply. It has been shown to be very effective in lowering pulmonary artery pressure. Furthermore, its effects have been noted to last for at least three hours without affecting systemic arterial pressure[5,6].

Alternatively, increasing cyclic guanine monophosphate (cGMP) with nitroso vasodilators (sodium nitroprusside, nitroglycerin, inhaled nitric oxide [NO]) also reduces pulmonary vascular tone [7].

Functional Anatomy

The Right ventricle:

"Two souls with but a single thought, two hearts that beat as one"[8], Although the right and left ventricles develop from the same primitive heart tube during morphogenesis, they evolve into two relatively independent structures with so many different characteristics that with some justification they may be regarded as two different organs. Despite that, they are closely linked physically, mechanically, and electrically and appear to "beat as one" [9].

The shape of each ventricle is genetically determined to suit its exact function. Thus, the left ventricle is "flask" shaped with the inlet and outlet sharing one orifice. This enables the ventricle to deliver a bolus of blood against high resistance [10].

In contrast the right ventricle consists of a flattened tube wrapped around the left ventricle with separate inlet and outlet orificies and a presumed contraction pattern simulating peristalsis. Such an arrangement is suited for pumping blood against low resistance [11].

The right ventricle occupies a large triangular part of the anterior surface of the heart and extends from the right atrium almost to the apex. Superiorly the part of the right ventricle called the conus arteriosus or infundibulum joins the pulmonary trunk. Inferiorly its wall forms the acute margin of the heart and extends for some distance around the diaphragmatic surface [12].

The right ventricular chamber can be divided to a main chamber (the inflow tract) and the infundibular portion (the outflow tract).

The main chamber has a triangular shape on the longitudinal axis and a crescentic shape in the horizontal axis. This peculiar shape results in a large surface area relative to the intercavitary volume, rendering the right ventricle well suited to eject a large volume of blood with little fiber shortening, Pumping action of the right ventricle has been compared to that of a bellows working in series with a low pressure circuit [(13)].

The main chamber is limited by two walls: a lateral, thin, concave, free ventricular wall and a medial, thick, convex, interventricular septal wall.

The right ventricular wall is about one third the thickness of that forming the left ventricle, but their capacities are the same, about 85ml.

The tricuspid valve encircles the right atrioventricular orifice and is notched into 3 triangular cusps named anterior, posterior and septal. It measures about 4 cm in diameter and is large enough to admit the tips of four fingers. The free border of each cusp presents a ragged edge for the attachment of chordae tendineae. In addition to their attachment to the cusps the chordae are secured to the papillary muscles in the ventricle[(12)].

The right ventricular outflow tract includes the infundibulum, the pulmonary valve, and the main pulmonary artery.

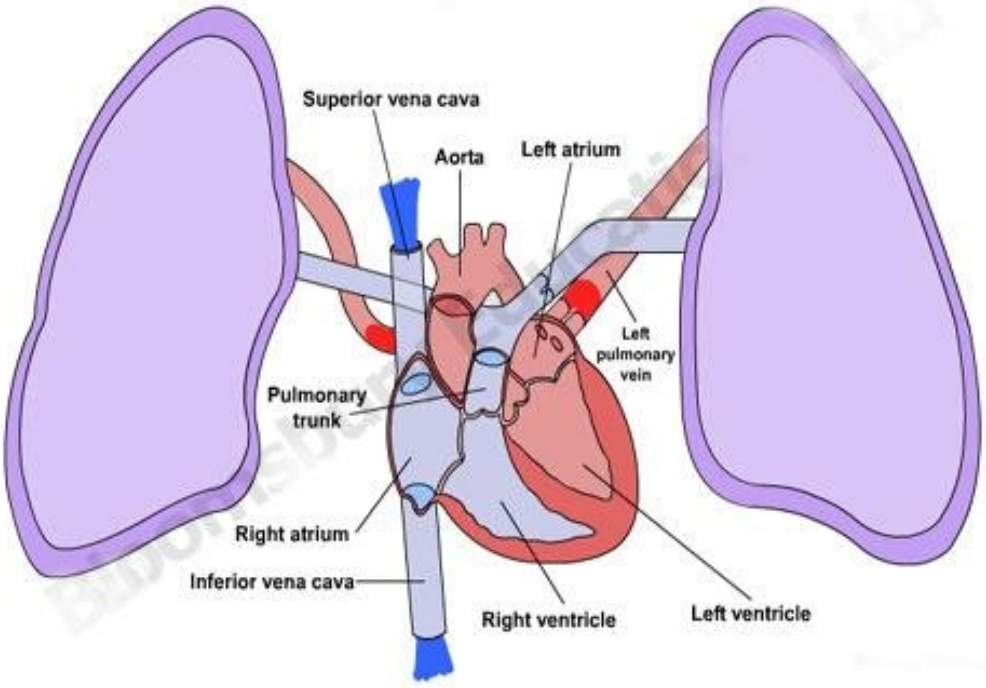

Figure 1: The Pulmonary circulation [12].

The pulmonary artery

Arises from the infundibulum of the right ventricle at the pulmonary orifice. Its 5 cm in length and 3 cm wide in diameter, at about the level of fibro-cartliage between fifth and sixth thoracic vertebrae, the pulmonary trunk divides into right and left pulmonary arteries which are of nearly equal size[12].

The right pulmonary artery passes under the arch of the aorta more or less horizontally and before entering the hilum divides into a superior division (which supplies the upper lobe) and the continuation of the main

trunk. The superior division which is quite prominent and is some times referred to as the truncus anterior, lies in front of the right upper lobe bronchi and its branches follow those of the airways. The lower division proceeds downwards, lying in front of the intermediate and lower lobe bronchi passing outside the middle lobe bronchus [(14)].

The left pulmonary artery takes a backward and upward course. It lies about 1cm higher than the right pulmonary artery. The remains of the ductus arteriosus of the neonate connect the left pulmonary artery to the arch of the aorta above. The artery divides into a short superior division, which promptly divides into branches supplying the upper lobe. The inferior division hooks backwards over the top of the upper lobe bronchus and continues downwards and backwards lateral to and a little behind the lower lobe bronchus. In doing so it forms a vascular arch, which is seen on a lateral radiograph as a smaller curved shadow lying below that of the aorta [(14)].

The distribution of the pulmonary arteries within the lobes of the lungs, although broadly following the branching pattern of the bronchi, shows considerable variation.

The pulmonary arterial vessels convey deoxygenated blood from the right ventricle of the heart to the lungs, consistent with the relatively thin wall of the right ventricle in comparison to that of the left ventricle; the pulmonary arterial vessels also have walls only one-third the thickness of vessels of comparable size in the systemic arterial circulation [(12)].