Early outcome of minimally invasive aortic valve replacement through mini sternotomy and mini thoracotomy versus conventional approach

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Abbreviations & Acronyms

ACC: American college of cardiology.
AF: Atrial fibrillation.
AHA: American heart association.
ALT: Alanine transferase.
A-M: Aortic- mitral.
AS: Aortic stenosis.
AST: Aspartate transferase.
AR: Aortic regurgitation.
AVA: Aortic valve area.
AVR: Aortic valve replacement.
CA: California.
CABG: Coronary artery bypass grafting.
CBC: Complete blood count.
CF: Colored flow.
CO_2: Carbon dioxide.
CPB: Cardiopulmonary bypass.
CPR: Cardiopulmonary resuscitation.
CT: Computed tomography.
DC: Direct current.
DM: Diabetes mellitus.
ECC: Extracorporeal circulation.
ECG: Electrocardiogram.
EF: Ejection fraction.
ERO: Effective regurgitant area.
ETT: Exercise treadmill test.
HDL: High density lipoprotein.
HF: Heart failure.
HTN: Hypertension.
Hz: Hertz.
IABP: Intraaortic balloon pump.
ICS: Intercostal space.
ICU: Intensive care unit.
IE: Infective endocarditis.
IMA: Internal mammary artery.

Inc.: Incorporated.
INR: International normalized ratio.
IV: Intravenous.
K: Potassium.
LAA: Left atrial appendage.
LDL: Light density lipoprotein.
LV: Left ventricle.
LVEDD: Left ventricular end diastolic diameter.
LVEF: Left ventricular ejection fraction.
LVESD: Left ventricular end systolic diameter.
LVOT: Left ventricular outflow tract.
MIAVR: Minimally invasive aortic valve replacement.
mmHg: Millimeter mercury.
MV: Mitral valve.
Na: Sodium.
PA: Postero-anterior.
PW: Pulsed wave.
RF: Regurgitant fraction.
RIMA: Right internal mammary artery.
RSPV: Right superior pulmonary vein.
R Vol: Regurgitant volume.
TAVI: Transcutaneous aortic valve implantation.
TEAVR: Total endoscopic aortic valve replacement.
TEE: Transesophageal echocardiography.
TV: Tricuspid valve.
VA: Ventriculo-arterial.
Vmax: Maximum velocity.
2D: Two dimensional.
ΔP: Pressure gradient.
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Introduction and Aim of the work

Introduction

Since the first aortic valve replacement in 1960s, hundreds of thousands of lives have been saved and improved by this procedure using the conventional full median sternotomy approach.

Minimally invasive approaches for aortic valve surgery were introduced in the late 1990s. In 1996**, *Konertz, Gundry*** and colleagues described partial J shaped ministernotomy, while in 1997 ***Bennetti*** and colleagues described the right thoracotomy approach

Minimal access aortic valve surgery theoretically has many potential advantages compared to valve surgery performed through conventional median sternotomy. These advantages include less surgical trauma, less bleeding, decreased pain, reduced risk of wound infection, shorter hospital stay, and faster rehabilitation. The small incisions are also cosmetically better. However, there are also many disadvantages with limited access.

Aim of the Work

Aim of this study is to compare early morbidity and mortality during the in-hospital stay after aortic valve surgeries using minimally invasive approaches through mini sternotomy and right anterior thoracotomy, and conventional full median sternotomy approach, in order to identify advantages and disadvantages of these techniques.

Review of literature

Anatomy of aortic valve and root

Background history:

The earliest documented interest in the anatomy of the aortic valvular complex stems from the Renaissance, with the description and drawings by Leonardo da Vinci**.**(Nicoló Piazza et al. 2008)

He had an almost perfect understanding of the physiology of the human heart. But he had no inkling of the circulation of the blood, and the existence of one-way valves was incompatible with the ancient belief that the heart simply churned blood in and out of the ventricles, thus generating heat and 'vital spirit'. Leonardo described the ventricles and atria with great accuracy, and analysed the structure and functioning of the valves in minute detail. In a brilliant experiment, he made a glass model of the aortic valve, through which he pumped water mixed with grass seeds to study the vortices in the widening of the aortic root. He deduced that these vortices were crucial in closing of the valve — a finding that was confirmed only in the twentieth century.***(Clayton 2012)***

The next anatomist to study the aortic valve was Andreas Vesalius. Then, for almost 400 years the study of the human heart was very sporadic and limited. ***(Tilea et al., 2013)***

According to Walmsley (1929), Henle was the first to introduce the term “arterial root”. During the first half of the 20th century the rise in autopsy rates in Europe and North America facilitated the study of cardiac anatomy. ***(Tilea et al., 2013)***

Aortic Root

There is still no consensus on the best way to describe the anatomy of the aortic root.***(Anderson 2007)***

The term "aortic root" refers to the direct continuation of the left ventricular outflow tract to its junction with the ascending portion of the aorta. To appreciate the anatomy of the aortic valve, it is necessary to examine its component parts and how they relate to each other so as to function as a unit. The valve comprises of the semilunar leaflets with attachments (or hingelines) to ventricular and aortic walls and the 'anterior' mitral leaflet, interleaflet triangles, aortic sinuses (of Valsalva), and the sinutubular junction, ***(Ho 2009)***

Anatomic versus hemodynamic junctions:

As shown in ***Figure 1***, there is a marked discrepancy between the circular anatomic junction and the semilunar hemodynamic junction.(Anderson 2000a)The root surrounding and supporting the leaflets, has length in that it extends from the basal attachments of the leaflets within the left ventricle to the sinutubular junction. These lines, semilunar in structure, extend throughout the root, running from their basal attachments within the left ventricle to their distal attachments at the sinutubular junction. The root as thus defined, therefore, is a cylinder, its walls being made up of the aortic valvar sinuses along with the interdigitating intersinusal fibrous triangles, and with two small crescents of ventricular muscle incorporated at its proximal end.

It is the semilunar attachments of the leaflets within the valvar sinuses that form the haemodynamic junction between the left ventricle and the aorta. All structures on the distal side of these attachments are subject to arterial pressures, whereas all parts proximal to the attachments are subjected to ventricular pressures. ***(Anderson 2007)***

The discrete anatomic ventriculo-aortic junction is a circular locus within this root, formed where the supporting ventricular structures give way to the fibro-elastic walls of the aortic valvar sinuses. This discrete ring, however, is markedly discordant with the morphology of the attachment of the leaflets of the aortic valve. Indeed, it is crossed at several points by the hingelines of the valvar leaflets. (Nicoló Piazza et al. 2008)