Minimally Invasive Mitral Valve Surgery

Essay

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Content

Appreviations

3-D	**Three dimensional**
ABC	**Argon beam coagulation .**
ABG	**Arterial blood gas**
AESOP	**The automated endoscopic system for optimal positioning**
BMI	**Body mass index**
C °	**Celsius**
CBC	**Complete blood count**
CCD	**Charging coupling device**
CO2	**Carbon dioxide**
Cm	**Centimeter**
COPD	**Chronic obstructive pulmonary disease.**
CPB	**Cardiopulmonary bypass**
CT	**Computed tomography**
CVP	**Central venous pressure**
DLT	**Double lumen endotracheal tube**
ECG	**Electrocardiogaraphy**
Fr	**French**
FEV1	**Forced expiratory volume in one second.**
FVC	**Forced vital capacity**
HZ	**Hertz**
ICU	**Intensive care unit.**
Kg/m2	**Kilogram/ meter square**
LA	**Left atrium**
LASER	**Light amplification by stimulated emission of radiation.**
LV	**Left ventricle**
LVESVI	**Left ventricular end systolic volume index**
Ml	**Milliliter.**
mm	**Millimeter.**
MmHg	**Millimeter mercury.**
MRI	**Magnetic resonant imaging**
M V	**Mitral valve**
MVR	**Mitral valve repair /replacement**
NYHA	**New York Heart Association**
PA	**Pulmonary artery**
PEEP	**Positive end expiratory pressure**

Appreviations

P Ms	**Papillary muscles**
RA	**Right atrium**
RV	**Right ventricle**
SVC	**Superior vena cava**
TEE	**Trans esophageal echocardiography**
VATS	**Video assisted thoracic surgery**
VHS	**Video home system**
VMIMS	**Video assisted minimally invasive mitral surgery**
YAG	**Yttrium aluminium garnet**

List of figures

Introduction

Introduction

The significant technological advances over the last decade have allowed for the development of minimally invasive endoscopic operative technique in a variety of operative disciplines (1).

The endoscopic technique are currently used in a wide range of general , gynecological , thoracic and orthopedic procedures(2)

The proposed benefits of a minimally invasive approach include decreased postoperative pain, improved cosmoses and patient satisfaction, improved postoperative recovery, decreased hospital length of stay , decreased resource utilization, and ultimately faster return to normal activities (3-4).

Recently there has been increasing interest in the use of minimally invasive cardiac surgery .More recently , cardiac surgeons applied endoscopic techniques.

Beginning in the early 1990s, a variety of minimally invasive incision types have been developed for mitral valve surgery, including partial sternotomy, parasternal incisions, minithoracotomy, and totally endoscopic approaches(5-6). While the technical aspects of each approach differ, the overall goals are similar—development of a safe and effective mitral valve repair or replacement with minimal surgical trauma.

The port access approach is an individual option to avoid cracking of ribs and cartilages. Endocardiopulmonary bypass and endo-aortic clamp allows installation of the extracorporeal circulation and cardiac arrest from the groin . Video assistance and shafted instrument help the surgeon to perform the surgery through a (5×2) cm port and fulfill the main goal of minimally invasive cardiac surgery , comfort , cosmoses , and fast rehabilitation(7) .Using 3-D video and robotic assistance ;it was possible to optimally visualize the whole mitral valve apparatus to perform true port access mitral valve surgery including complex repair techniques(8-9).The robotic devices enhances dexterity , precision , and reduces surgeon's fatigue while preserving the quality of hand suturing (10).

Minimally invasive mitral valve surgery (MIMVS) has been proven as a feasible alternative to conventional full sternotomy approach with low perioperative morbidity and short-term mortality (11, 12). As a result, MIMVS is being employed increasingly as routine approach in many centers worldwide with excellent short-term and long-term results (13, 14).

Historical background

HISTORICAL BACKGROUND

The first successful cardiac operation was performed on September 7, 1896, in Frankfurt, Germany by Rehn (15), followed by the first successful cardiac valve operation in 1912 by Tuffier (16) and the first successful mitral valve (MV) operation in 1923 (17).

In 1956, Lillehei repaired multiple valvular lesions through a right thoracotomy using cardiopulmonary bypass (CPB) (18). The ensuing years witnessed the rapid development of various valvular prostheses placed via a conventional approach—a full sternotomy with CPB.

In the 1990s, the success of laparoscopic operations in general surgery renewed an interest in minimally-invasive approaches for cardiac surgery.

The first minimally-invasive valve operations were performed (via the right parasternal and trans-sternal approaches). Remarkably excellent exposure was achieved through smaller incisions, thereby making complex valve repair possible and safe. These were done by Navia, Cosgrove (19) and Cohn et al. (20).

In 1996, the first video-assisted mitral valve repair (MVR) through a mini-thoracotomy using ventricular fibrillation performed by Carpentier et al. (17). With more experience, video-assistance, 2-dimensional endoscopes and robotics were introduced by Carpentier et al. (21) and Chitwood et al. (22-23). Soon thereafter in 1998, a 3-dimensional videoscope with voice-activated robot assistance (Aesop

3000, Computer Motion, Goleta, California), enabled solo surgery (24) done by the Leipzig group (Germany). Also in that same year, the first completely robotic MVR using the Da Vinci Surgical System performed by Carpentier et al. (25) (Intuitive Surgical, Inc., Sunnyvale, California).

An important adjunct in the evolution of minimally invasive mitral valve surgery is the parallel progress in perfusion technology. First, smaller, nonkinking arterial and venous cannulae have been combined with vacuum-assisted venous drainage to allow maximal space use provided by the smaller incisions. Second, the implantation of transjugular coronary sinus catheters provides cardiac protection via retrograde cardioplegia. Third, the application of carbon dioxide (CO_2) into the operating field limits intracardiac air (to reduce air embolism). Finally, intraoperative transesophageal echocardiography allows for real-time monitoring of cardiac distention, de-airing, and cannula placement (26).

Thus, minimally invasive valve surgery has evolved into a routinely performed operation with excellent results in many specialized centers (19,27-28).

Anatomy

SURFACE ANATOMY OF THE HEART

The heart fills the central part of the thorax (the middle mediastinum) and is cover by a loose fibrous coat (the fibrous pericardium) , which has a lubricating lining (the serous pericardium) to cut friction as the heart beats . from its central position the apex extends to the left .The heart shape and position vary , not only due to its own beating but also with repiration.As the diaphragm is lowered during inspiration the heart lies more vertically (appearing narrow in the radiograph) , becoming more transverse in expiration (29) .

The apex and apex beat therefore vary with the phase of respiration .In broad chested individual and with a naturally higher diaphragm , the heart lies more transversely , whereas a narrow chested individual will have a more vertical heart .These changes affect the position of the apex and apex beat ,which is described normally by being just inside the midclavicular line in the fifth intercostal space (29).

Borders of the heart :

From the front , the right border of the heart is made up entirely of the right atrium the superior venacava runsdown the right side of the manubrium and sternum , to enter the atrium level with the third right costal cartilage.The atrium curves a little outside the right border of the sternum to the sixth costal cartilage or the xiphisternal joint . The inferior vena cava enters from below (29).

On the left side the arch of the aorta lies behind the lower half of the manubrium sterni with the pulmonary artery just below forming a bulge with its branch evident on an anteroposterior radiograph .The two arteries form the aortic and the pulmonary knuckles in the radiograph(29).

Below this and extending 2.5 cm to the left of the sternum and behind the second inter-costal space and the third costal cartilage there is a small portion of the left auricle .The rest of the left border of the heart is made up of the left ventricle (29).

The lower border of the heart has the inferior vena cava opening to the right , with the reminder made up of $\frac{2}{3}$right ventricle and the apical $\frac{1}{3}$ left ventricle though the latter increases a little in systole owing to the twist of the heart(29).

As the left ventricle runs behind the right , it forms the posterior aspect towards the apex , with the left atrium forming the major upper part of the heart . this lies immediately infront of the oesophagus , so that left atrial dilatation tends to compress the oesophagus , producing difficulty on swallowing , a common feature of left sided problems in the heart(29) .

The valves of the heart all lie surrounded by a fibrous ring , on which both atrial and ventricular muscles are mounted . Because of the obliquity of the heart in the chest the valves lie on a line from the medial end of the third left costal cartilage downwords and to the right , towards the right border of the sternum , level with the fourth intercostal space. they lie , from left to right , pulmonary valve , aortic valve (a little behind the pulmonary) , then mitral , a little behind the tricuspid valve.

The transverse pericardial sinus runs above the heart , between the two great arteries and the veins , at the level with the sternal angle . The oblique sinus lies behind the ventricles (29).

Mitral valve :

The mitral valve comprises two leaflets, annular attachment at the atrioventricular junction, tendinous chords and the papillary muscles (PMs). The two leaflets of the MV are noticeably different in structure and are referred to as the anterior and posterior leaflets. Although neither description is anatomically correct, the terms aortic and mural leaflets are preferred(30).

The mural (posterior) leaflet is narrow and extends two-thirds around the left atrioventricular junction within the inlet portion of the ventricle. In adults, the mural leaflet has indentations (sometimes called ‘clefts’) that generally form three scallops (segments) along the elongated free edge. These indentations do not usually extend all the way through the leaflet to the annulus; if this is seen, then this is usually associated with pathological valve regurgitation. Carpentier'snomenclature describes the most lateral segment as P1, which lies adjacent to the anterolateral commisure, P2 is central and can significantly vary in size, and most medial is P3 segment, which lies adjacent to the posteromedial commissure(31).