Principle of Reconstructive Surgery in Degenerative Mitral Valve Disease

- The most cause of MR in developed countries
- The most common etiology
  - Barlow’s Disease
  - Prolapse of multiple segment or bileaflet prolapse
  - Fibroelastic Deficiency
  - Isolated posterior leaflet prolapse (P2 segment)
- Degenerative mitral valve disease with severe MR, reconstruction surgery should be performed before Af, pulmonary HTN, LV dysfunction

Degenerative Mitral Valve Disease

- The goal of reconstruction of MR
  - Preservation or restoration of normal leaflet motion
  - Creation of a large surface of coaptation
  - Stabilization of entire annulus with a remodeling of annuloplasty

Pathophysiology and Functional Classification

- Carpentier functional classification: based on the opening and closing motions of the mitral leaflet
  - Type I dysfunction
    - Normal leaflet motion
    - MR is due to annular dilation or leaflet perforation
  - Type II dysfunction
    - Increased leaflet motion
    - Free edge of leaflet overriding the plane of annulus during systole
    - Chordae elongation or rupture and papillary muscle elongation or rupture
  - Type IIIa dysfunction
    - Restricted leaflet motion during systole or diastole
    - Common lesion
    - Leaflet thickening and retraction
    - Chordae thickening and shortening or fusion
    - Commissural fusion
  - Type IIIa dysfunction
    - Restricted leaflet motion during systole
    - LV enlargement with apical papillary muscle displacement
Pathophysiology and Functional Classification

- Mitral valve is separated into 8 segments:
  - Anterolateral and posteromedial commissure
  - Posterior leaflet: 3 scallops
    - P1 (anterior), P2 (middle), P3 (posterior)
  - Anterior leaflet: 3 segments
    - A1 (anterior), A2 (middle), A3 (posterior)

Application of Pathophysiologic Triad in Patient with Degenerative Mitral Valve Disease

- Etiology of degenerative mitral valve disease
  - Barlow’s disease
    - Most common condition, 3% of population
  - Marfan’s disease
  - Fibroelastic deficient
    - Increasing frequency as the age of population increases

- Barlow’s disease
  - Appear in early life with long history of systolic murmur
  - Require surgery for MR in 4th or 5th decades
  - Valve
    - Thick leaflet and with marked excess tissue
    - Chordae are thickened, elongated, or ruptured
    - Papillary muscle is occasionally elongated
    - Annulus is dilated and sometimes calcified
    - Prolapse of multiple segments of the valve
  - 30% bileaflet prolapse

- Fibroelastic deficient
  - Common in elderly people; > 65 y/o with relatively short history of MR
  - Valve
    - Transparent leaflet with no excess tissue
    - Elongated, thin, flail, and often ruptured chordae
    - Annulus is often dilated and may be calcified
    - Isolated P2 prolapse

Principle of Mitral Valve Surgery

- Peri-O P management
  - Swan-Ganz catheter should be placed
  - Complex mitral valve reconstructive surgery
  - Multi-valve surgery
  - Combined mitral and coronary artery bypass grafting surgery
  - TEE should be performed in all patients
    - Determine the mechanism and severity of MR
    - Assess LV function, quality of reconstruction, and de-airing of the cardiac cavities at the completion of the procedure
Principle of Mitral Valve Surgery
- Peri-OP management
  - An external defibrillator is placed in reoperation and in minimally invasive approaches
  - An epi-aortic scanning of the ascending aorta before arterial cannulation
  - Elderly patients with associated atherosclerotic risk factors
  - Combined mitral valve and coronary artery bypass grafting surgery

Surgical Incisions and Cardiopulmonary Bypass
- Mini-invasive direct vision
  - A 6-cm skin incision
  - Upper hemisternotomy: from the sternal notch to the left fourth intercostal space
  - Lower hemisternotomy: from the xiphoid to the second right intercostal space
  - Right minithoracotomy
  - At the fourth intercostal space
  - Video-directed and robotic mitral valve surgeries

Surgical Incisions and Cardiopulmonary Bypass
- Myocardial protection
  - Intermittent antegrade or a combined antegrade and retrograde infusion of high-potassium, cold-blood cardioplegia
  - Moderate systemic hypothermia between 28°C and 30°C

Mitral Valve Exposure and Intraoperative Valve Analysis
- Interatrial approach through the Sondergaard’s groove
  - 2 atria are dissected and divided up to the fossa ovalis
  - Exposes the roof of the left atrium, which is opened close to the mitral valve

Mitral Valve Exposure and Intraoperative Valve Analysis
- Entire mitral valve apparatus must be carefully examined
  - Mechanism of mitral regurgitation, to assess the feasibility of reconstruction, and to plan the exact operative strategy
  - The anterior paracommissural scallop of the posterior leaflet (P1) is often intact and rarely prolapsing in patients with degenerative disease

Fundamentals of Mitral Valve Reconstructive Surgery
- Posterior leaflet prolapse
  - Treated by a quadrangular resection of the prolapsed area
  - Stay sutures are placed around the normal chordae to determine the prolapsed area
  - Removed by performing a perpendicular incision from the free edge toward the annulus, resecting a quadrangular portion of the leaflet
  - Plication sutures are placed along the posterior annulus in the resected area
  - Direct sutures of the leaflet remnants restore valve continuity without tension
Fundamentals of Mitral Valve Reconstructive Surgery

- Posterior leaflet prolapse
  - If excessive posterior leaflet tissue is present, important to reduce the height of the posterior leaflet to less than 15 mm to prevent postoperative systolic anterior motion
  - A sliding leaflet technique is performed after quadrangular resection
  - P1 and P3 segments are detached from the annulus and the gap between the 2 scallops is closed with interrupted sutures

- Anterior leaflet prolapse
  - Triangular Resection
    - Limited prolapse of the anterior leaflet with excess tissue
    - Small, triangular resection of the prolapsed area followed by direct closure with interrupted monofilament sutures
    - Not extended to the body of the anterior leaflet and should not involve more than 10% of the anterior leaflet surface area

- Anterior leaflet prolapse
  - Chordae Transposition
    - Absence of normal secondary chordae, chordae transposition from the posterior leaflet to the anterior leaflet should be considered
    - Marginal chordae of the posterior segment opposite to the prolapsed area of the anterior leaflet is normal
Fundamentals of Mitral Valve Reconstructive Surgery

- Anterior leaflet prolapse
  - Papillary Muscle Sliding Plasty
    - Convenient for anterior leaflet prolapse due to elongation (<5 mm) of multiple chordae arising from a papillary muscle
  - Papillary Muscle Shortening
    - Papillary muscle elongation or chordae elongation involving a group of chordae
      - A triangular wedge at the base of the papillary muscle is resected
      - Closed by direct suture resulting in a reduced height of the papillary muscle and correction of chordae length
      - Typically indicated in Barlow’s disease with bileaflet prolapse

Fundamentals of Mitral Valve Reconstructive Surgery

- Commissural Prolapse
  - Limited prolapse ➔ annular plication
  - Extensive prolapse ➔ sliding plasty of the paracommissural area
  - Additional inverting sutures should be placed in the newly created commissure to avoid residual minimal regurgitation
  - The rupture of 1 head can lead to commissural prolapse, which can be corrected by reattachment of the latter to the remnant papillary muscle

Fundamentals of Mitral Valve Reconstructive Surgery

- Remodeling Ring Annuloplasty
  - Normal mitral valve
  - Ratio between anteroposterior (septolateral) and transverse diameter of the mitral annulus is 3:4 during systole
  - The remodeling ring annuloplasty restores the physiologic ratio with maximal orifice area during systole
  - Remodeling annuloplasty provides increased leaflet coaptation area without causing any valvular stenosis

Fundamentals of Mitral Valve Reconstructive Surgery

- Saline Test and Postbypass TEE
  - Saline solution is injected into the ventricular cavity through the mitral valve with a syringe, while the aortic root is vented to prevent air emboli into the coronary arteries
  - If the posterior leaflet occupies half or more of the orifice area, its height should be reduced (less than 15 mm) to minimize the risk of systolic anterior motion

Fundamentals of Mitral Valve Reconstructive Surgery

- Remodeling Ring Annuloplasty
  - If the surgeon hesitates between 2 sizes, in patients with degenerative valve disease, the selection of the greater size is recommended in most instances
  - In Barlow’s valve, the typical size of the prosthetic ring is between 36 and 40 mm

Fundamentals of Mitral Valve Reconstructive Surgery

- Saline Test and Postbypass TEE
  - At the completion of cardiopulmonary bypass, the quality of reconstruction is assessed by TEE
  - No patient should leave the operating room with more than 1+ residual MR.
  - In patients with 2+MR, a second bypass run is necessary to reanalyze the valve and correct a residual valvular dysfunction
Results

- The operative mortality rate in this group of patients is less than 0.5% in experienced centers

Results

- 162 patients operated between 1970~1984 (90% degenerative disease)
- Posterior, anterior, and bileaflet prolapse were present in 93 (61%), 28 (15%), and 31 (20%)
- All underwent annuloplasty, valve resection 126 patients, and shortening or transposition of the chordae in 46 patients
- Reoperation was 0.4% per patient year
- Freedom from reoperation was 97%, 86%, and 83% for posterior, anterior, and bileaflet prolapse, respectively, at 20 years