

# *Techniques of Valve Repair*



Kiick Sung, MD, PhD

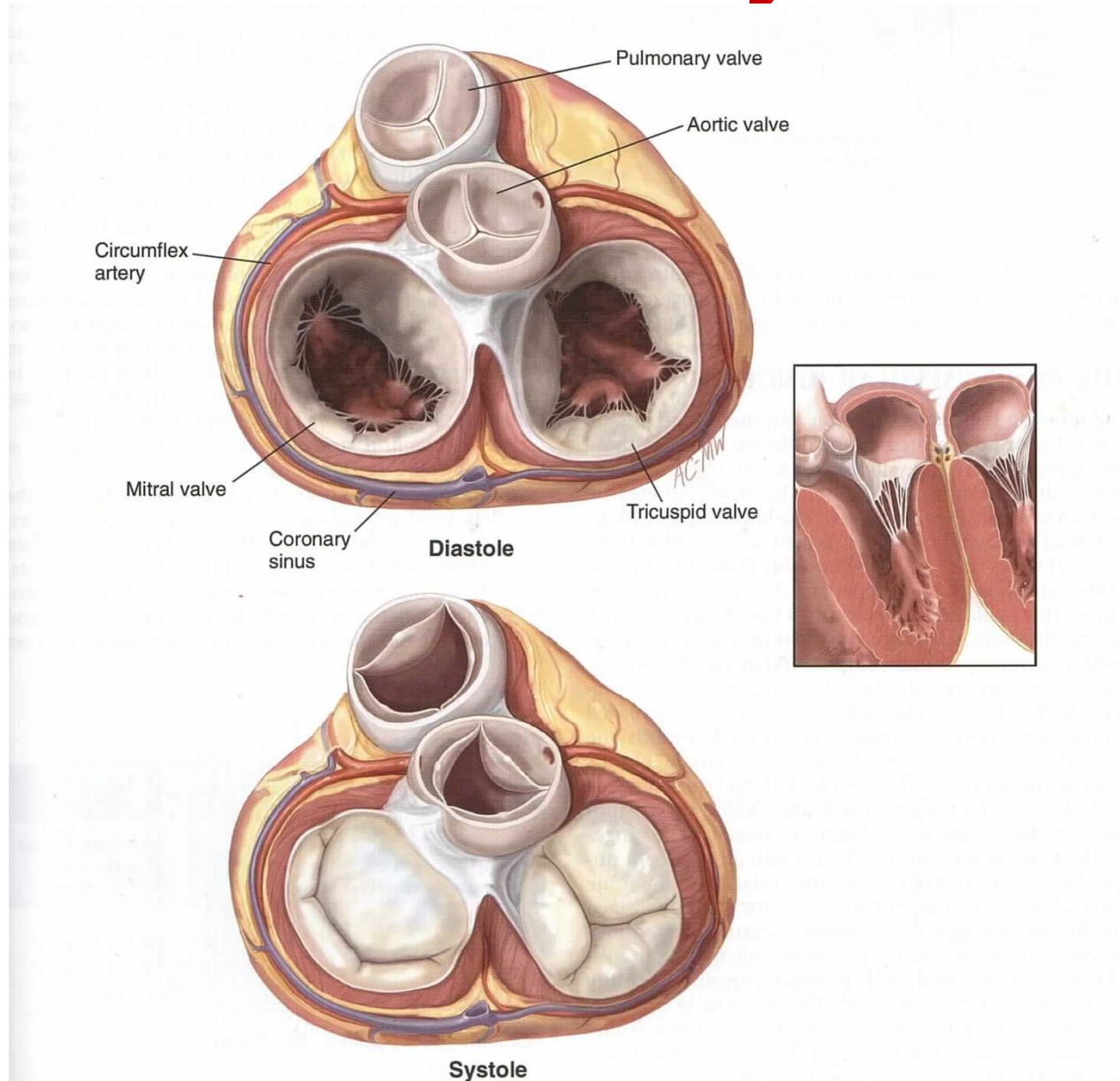
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**S-MCTS**

## ***Why Repair ?***

- Lower operative mortality and morbidity
- Lower cardiac complication rates (eg, TE)
- Higher survival rates
- Potential improvement in LV function  
(preserving subvalvular apparatus)
- Reduced need for anticoagulation
- Lower cost
- Infection resistant

# Anatomy

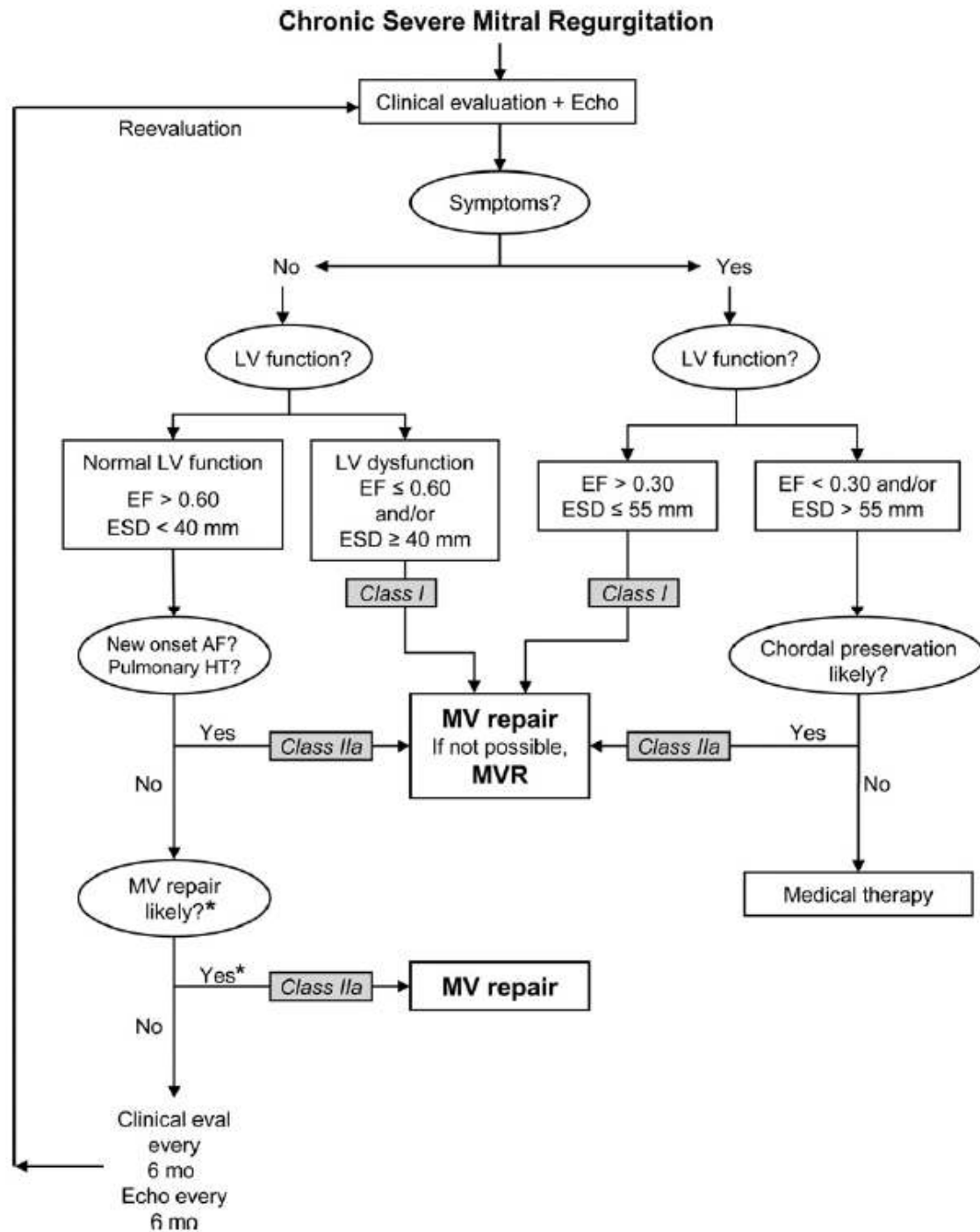


# *Mitral Valve Repair*



**SMCTS**

# 2013 Techniques



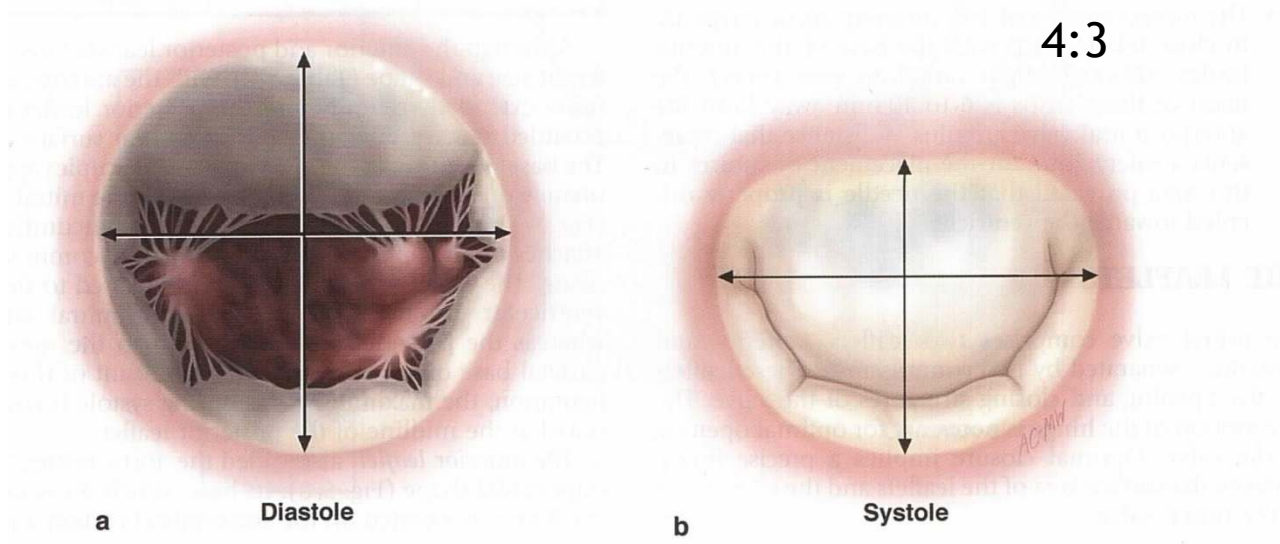
# History

- 1902 Brunton TL suggest op. for MS
- 1925 Soutar finger dilatation
- 1938 Glover, Davila MR repair w pedicled graft
- 1957 Lillehei 1<sup>st</sup> successful repair of MR
- 1960s Kay, Reed, Wooler annuloplasty for MR
  - Sauvage, Wood post. leaflet augmentation
  - Rumel rheumatic MS (mobility)
  - McGoon ruptured chordae repair
  - Merendino triangular resection
  - Kay flail segment suture to PM
- 1971 Carpentier classification of MR,  
rigid ring annuloplasty
- 1980 Duran flexible ring annuloplasty

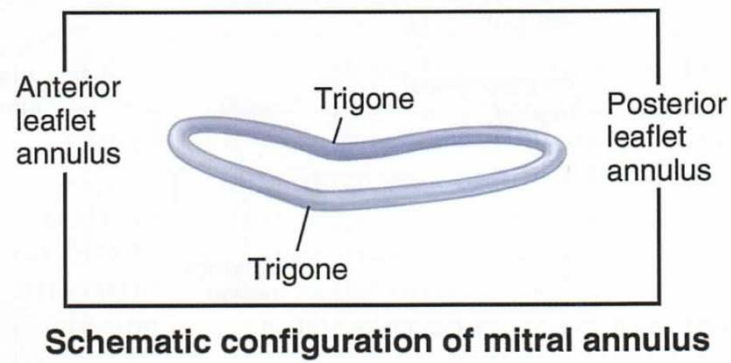
# ***Mitral Valve Anatomy-Annulus***

- Nonexistent structure (virtual space at the transition)
- Orifice area: 6.5cm<sup>2</sup> ~ 8.0cm<sup>2</sup>
- 30% larger than EOA of the leaflet
- Circumference: 9 ~ 10cm
- Size difference during cardiac cycle: 23 ~ 40%
- Saddle shape, circular during diastole
- Fibrous trigones
- Aortomitral (aortoventricular) membrane: 3 ~ 8mm
- Surrounding structures:
  - AV node, aortic valve (LCC, NCC), circumflex artery

# Mitral Valve Anatomy-Annulus



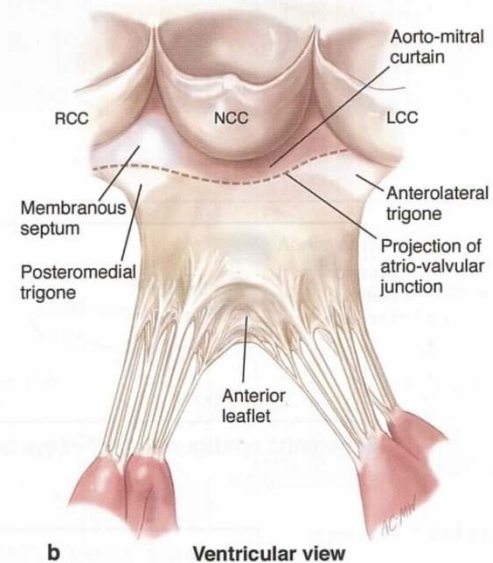
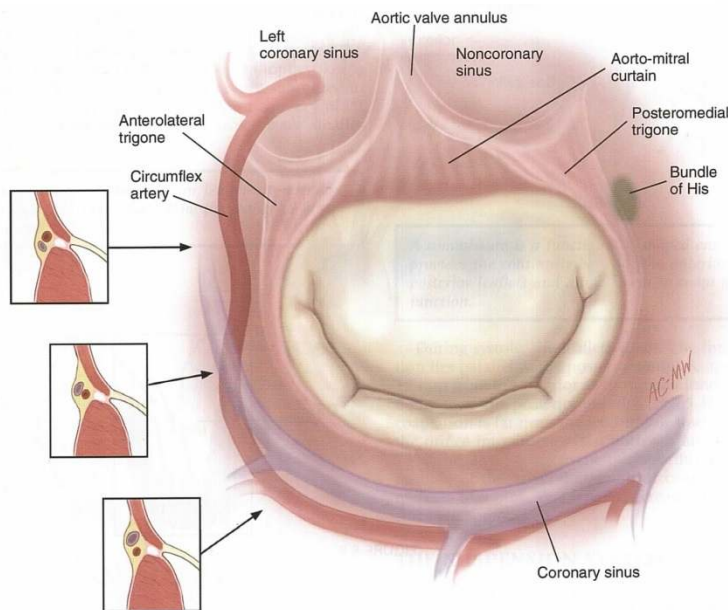
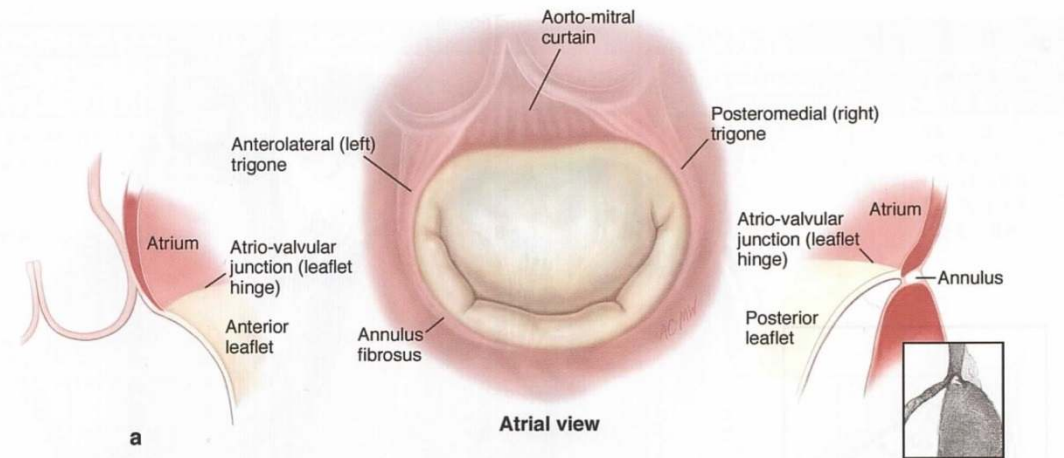
## Saddle shape





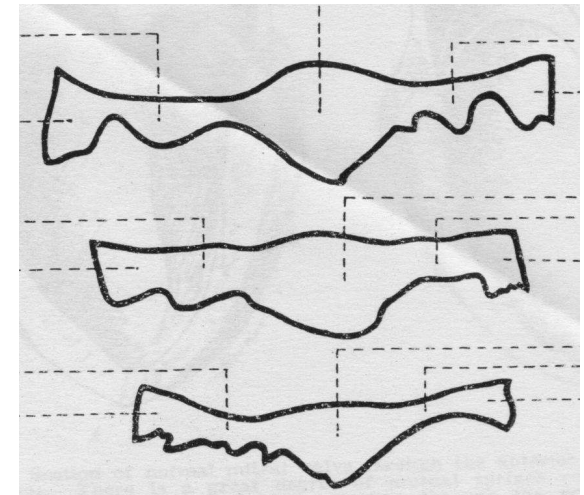
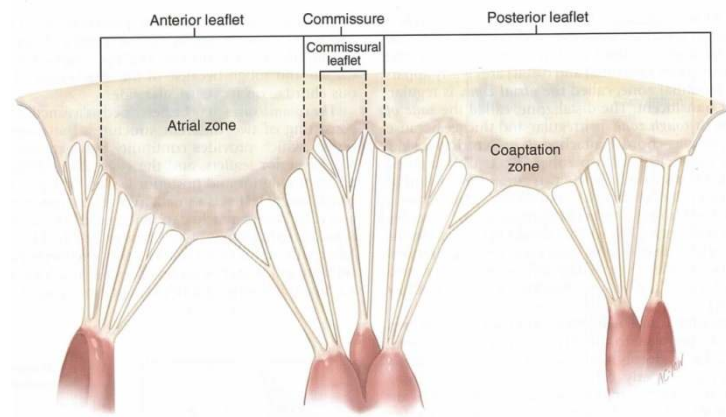
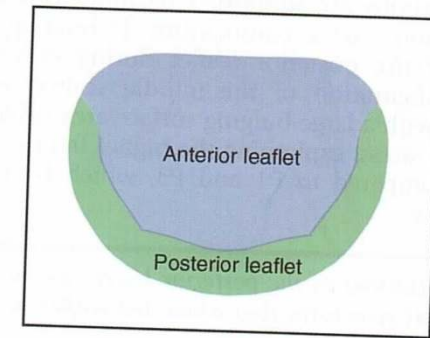
# Annulus-Surrounding Structure

- Aortic valve
- Aortomitral memb.
- Trigons
- LCx
- His bundle



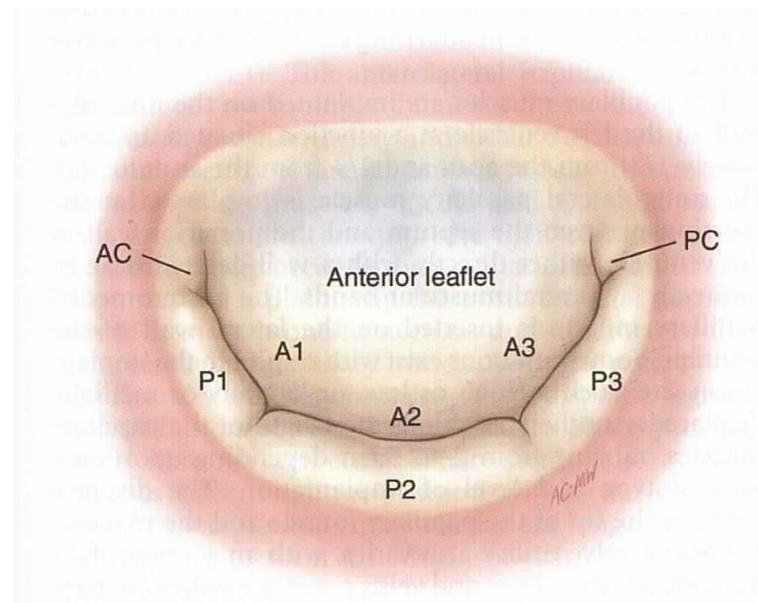
# Mitral Valve Anatomy-Leaflets

- 3 layers
- Two major + accessory tissue
- Anterior: triangular, smooth
- Posterior: rectangular, 0.5cm longer, indentation (cleft)
- Rough zone + smooth zone
- Redundancy → annular dilatation?



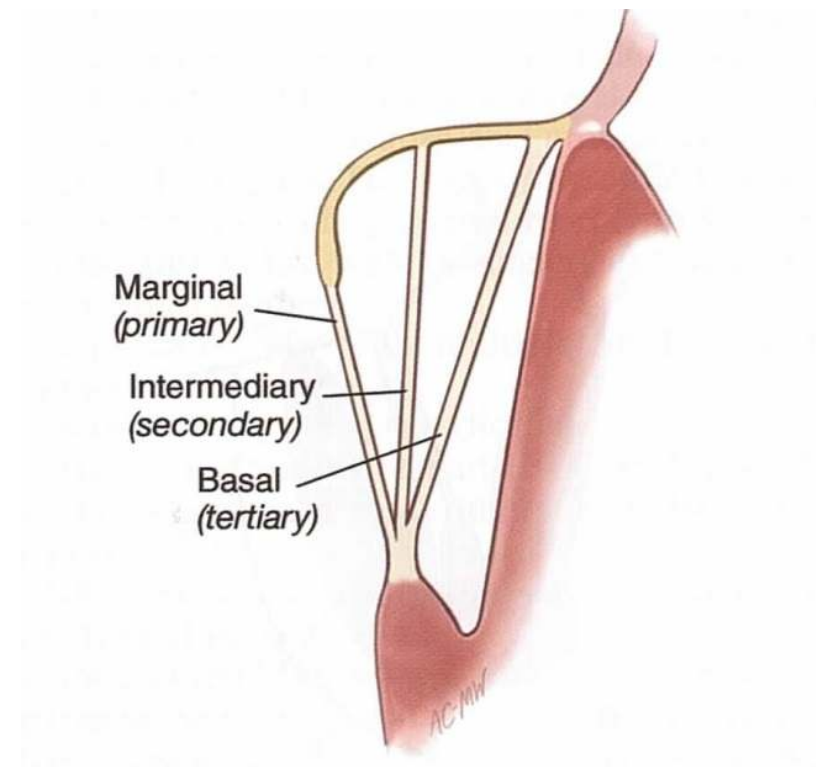
# Mitral Valve Anatomy-Leaflets

- Carpentier classification
  - Anterior leaflet: triangular
  - Posterior leaflet (indentation) - P1, P2, P3
  - AL commissure
  - PM commissure



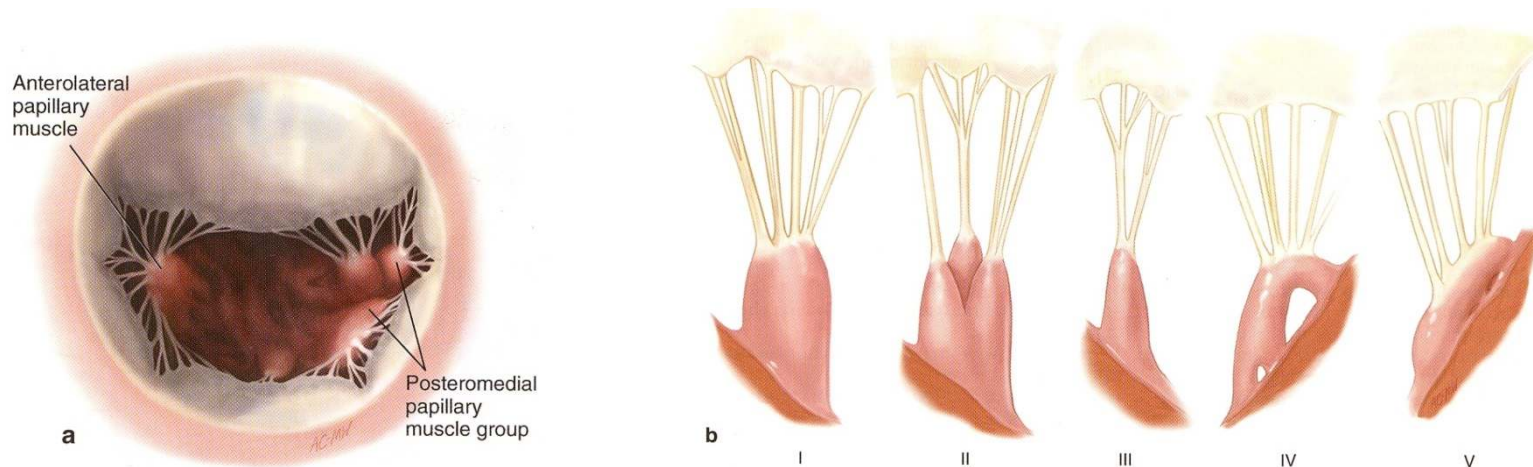
# Mitral Valve Anatomy-Chorda

- Chordae
  - Marginal(primary)
    - : prevent eversion
  - Intermediary(secondary)
    - : prevent doming
  - Basal(tertiary)
    - : maintaining geometry

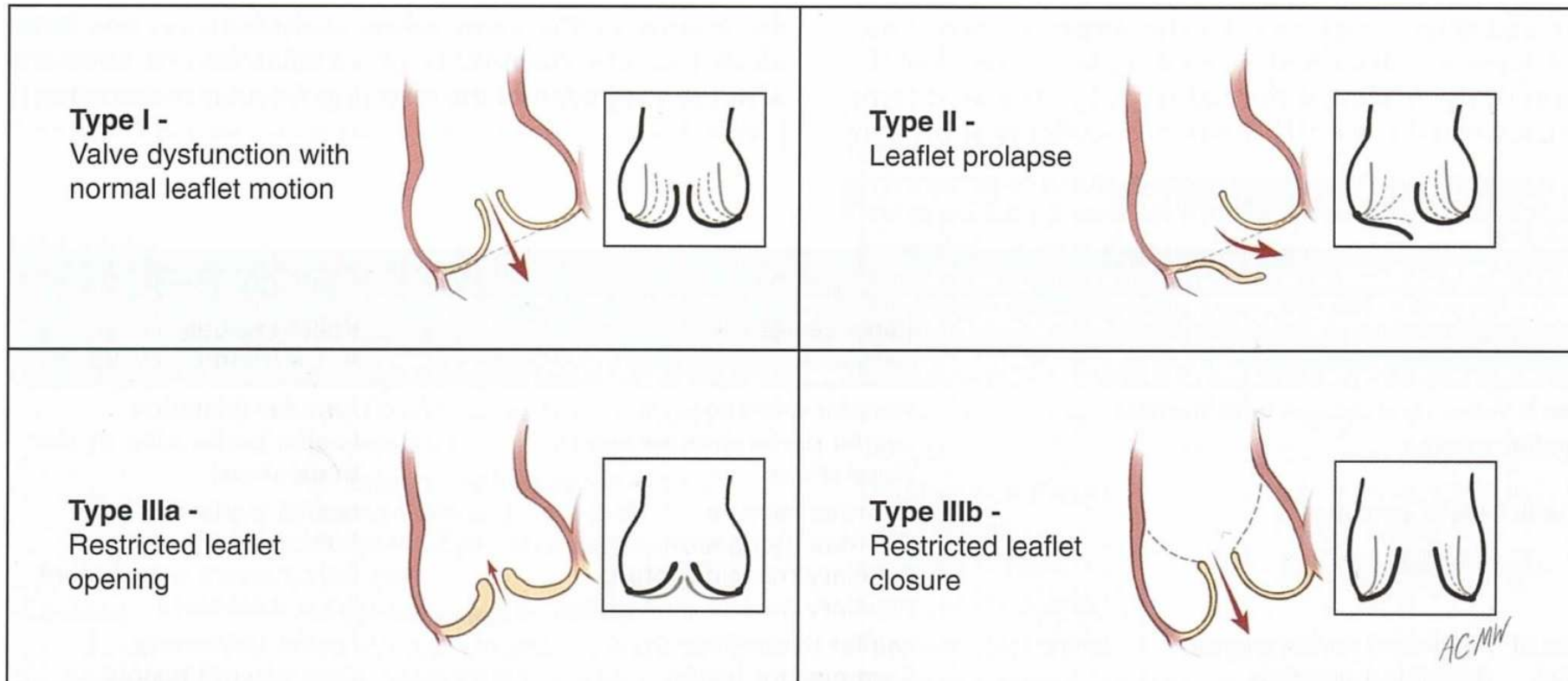


# Mitral Valve Anatomy-PM

- Posterior free wall of LV
- Anterolateral: large, usually single, LCx (or D)  
Posteromedian: U shaped, two or three columns, RCA or LCx, small blood supply
- Function: contract before LV wall contraction  
→ keeping the chords under tension

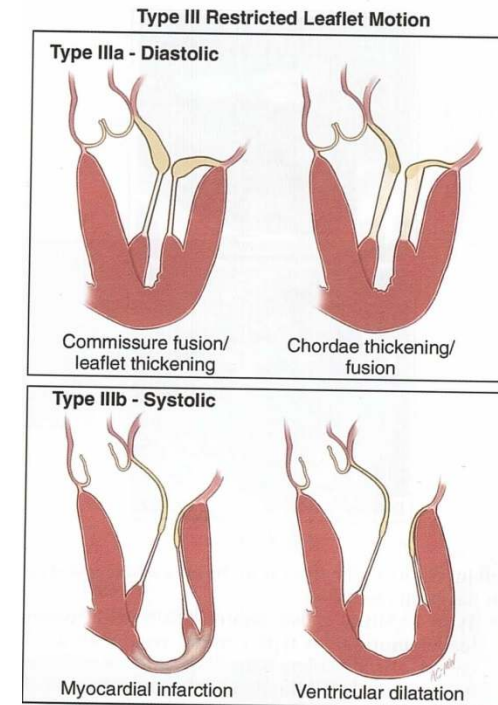
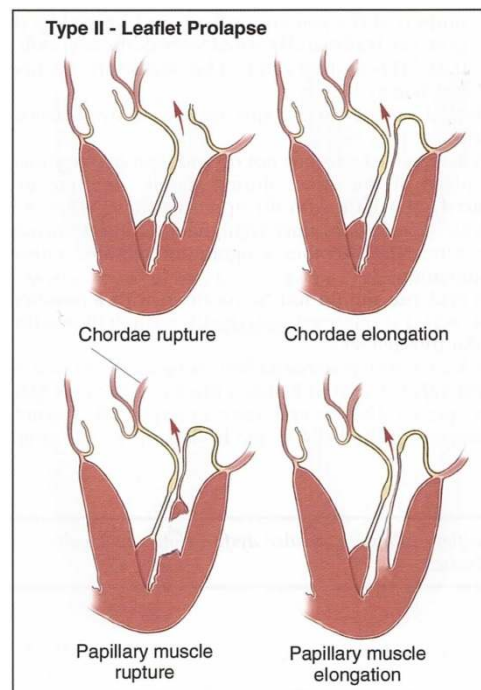
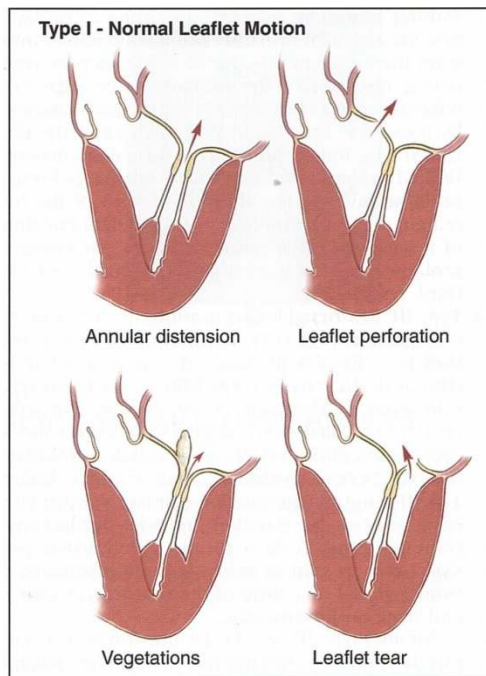


# Functional Classification



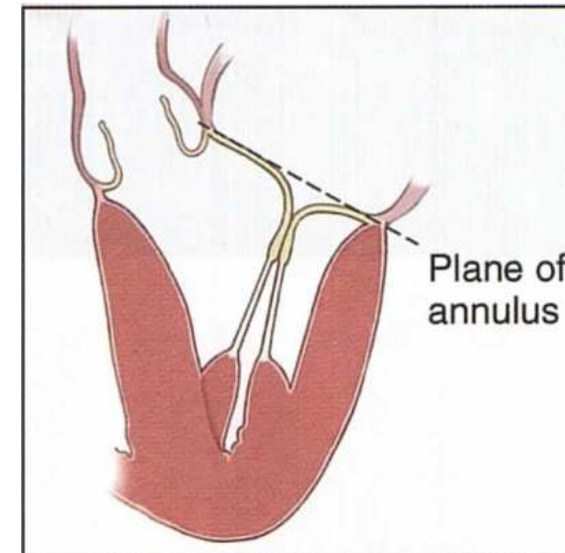
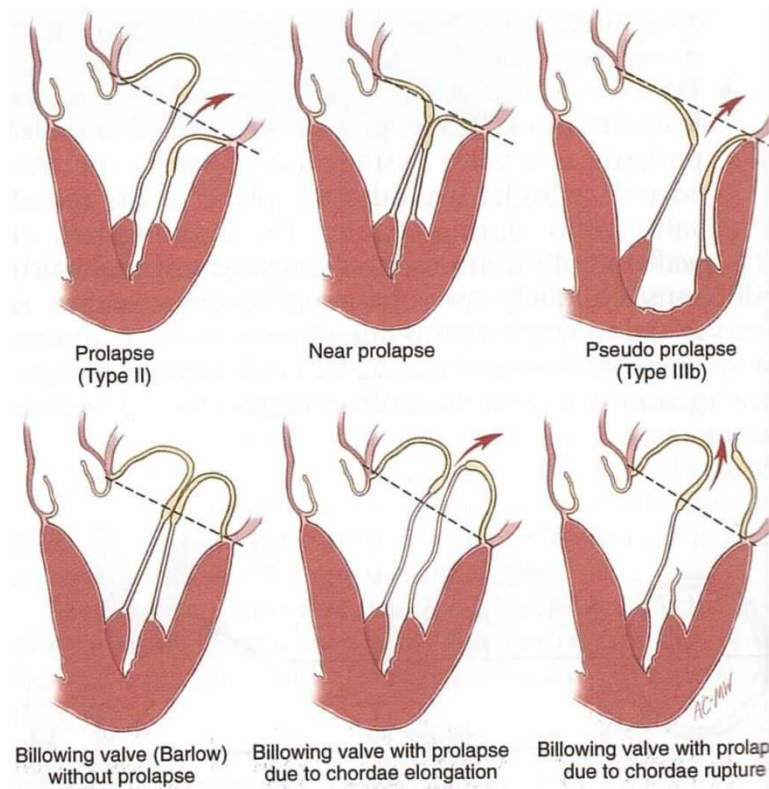
# Functional Classification

- Type I:
- Type II:
- Type III:



# Prolapse ?

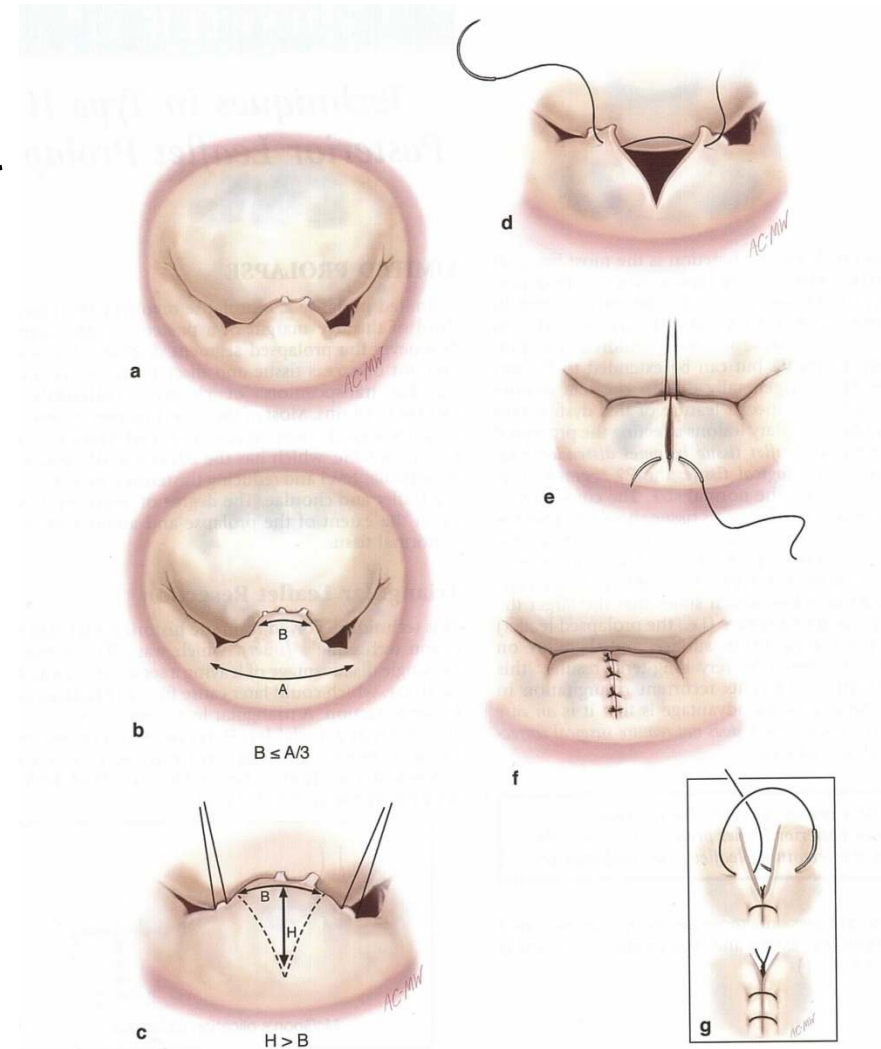
- Plane of annulus
  - coaptation below the plane of orifice





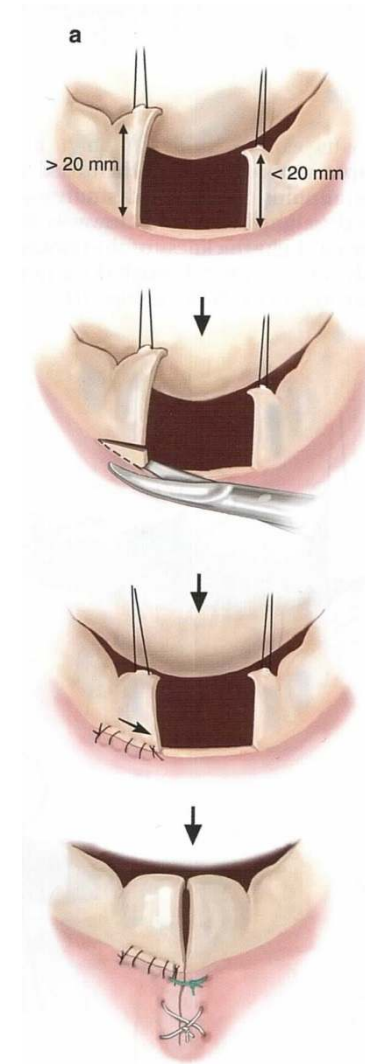
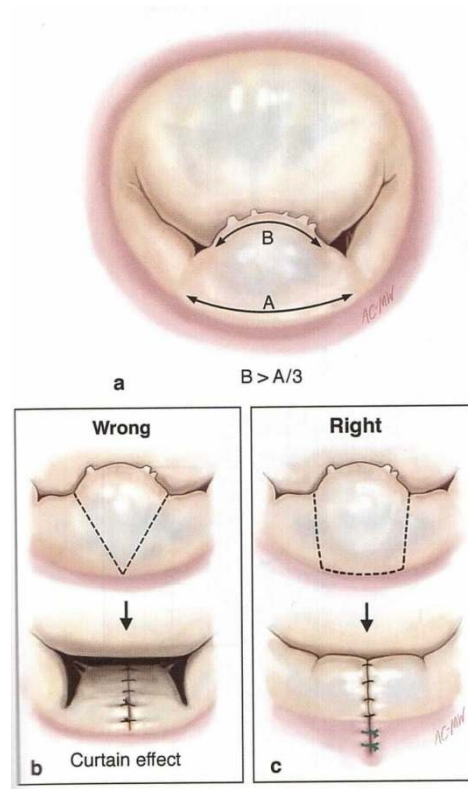
# Posterior Prolapse

- Triangular resection:
  - $< 1/3$  of posterior leaflet



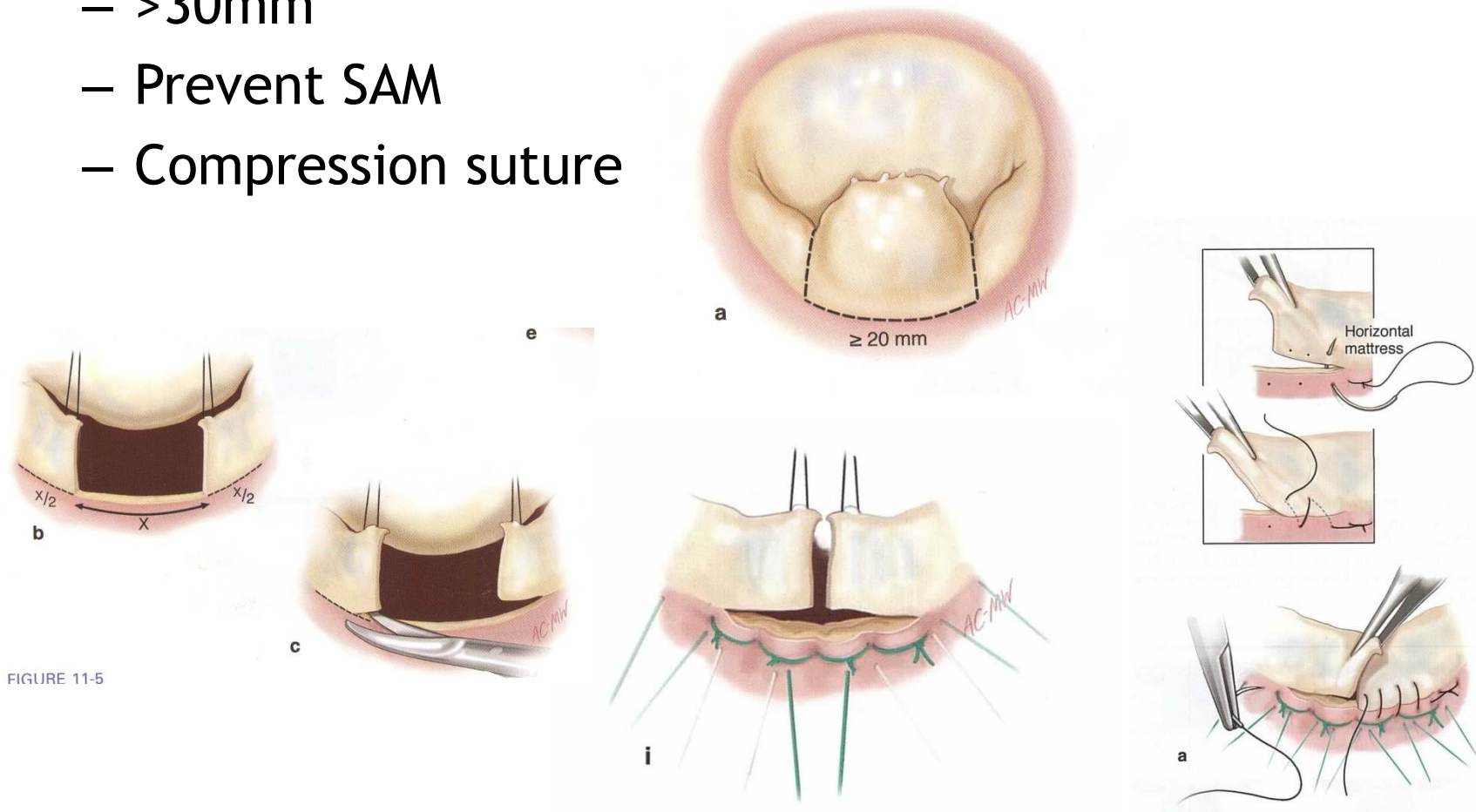
# Posterior Prolapse

- Quadrangular resection:
  - $> 1/3$  of posterior leaflet
  - Annular plication



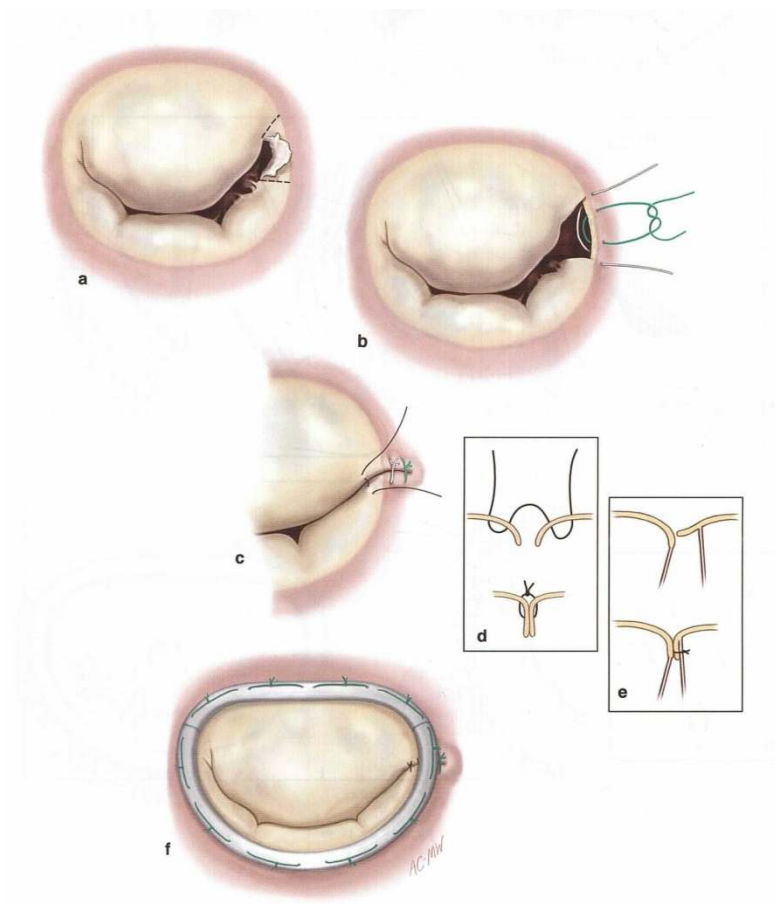
# Posterior Prolapse

- Quadrangular resection + sliding annuloplasty
  - >30mm
  - Prevent SAM
  - Compression suture



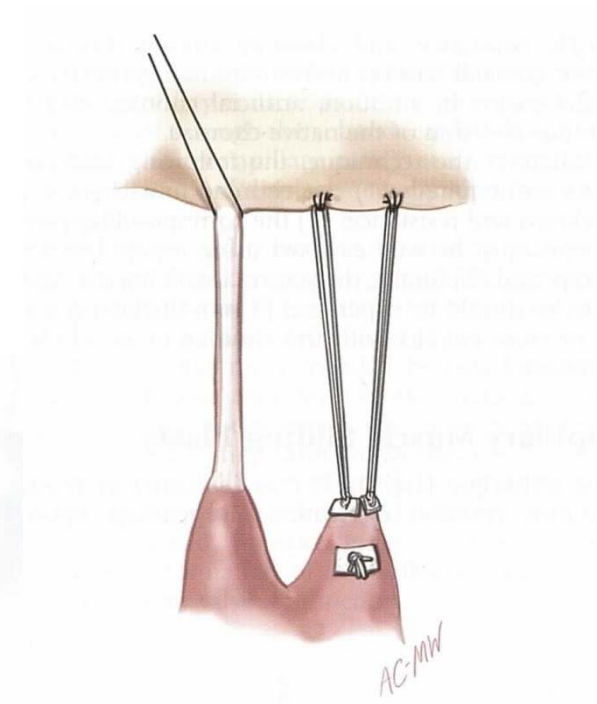
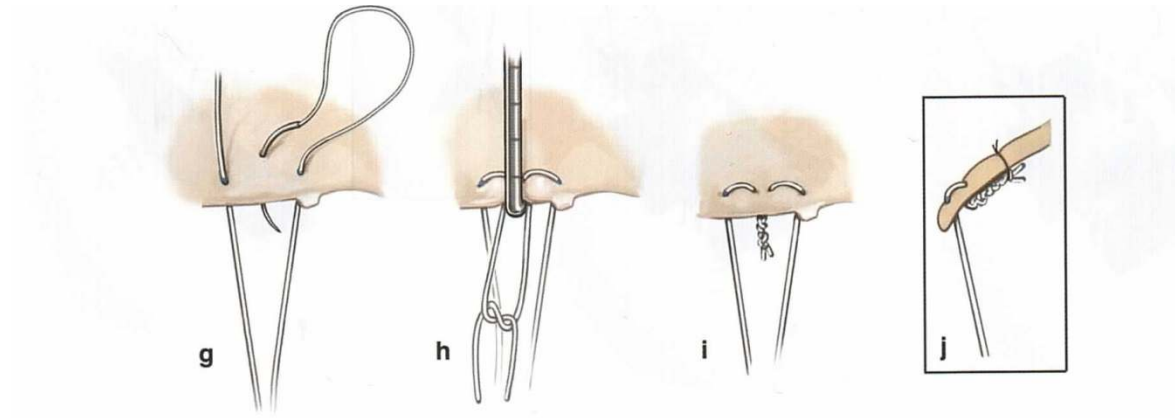
# Commissural Prolapse

- Commissural plication
- Triangular resection



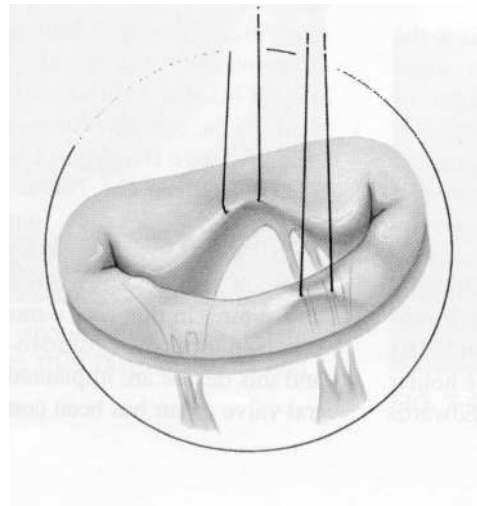
# Anterior Prolapse

- Long-term results: posterior >> anterior
- Artificial chorda implantation



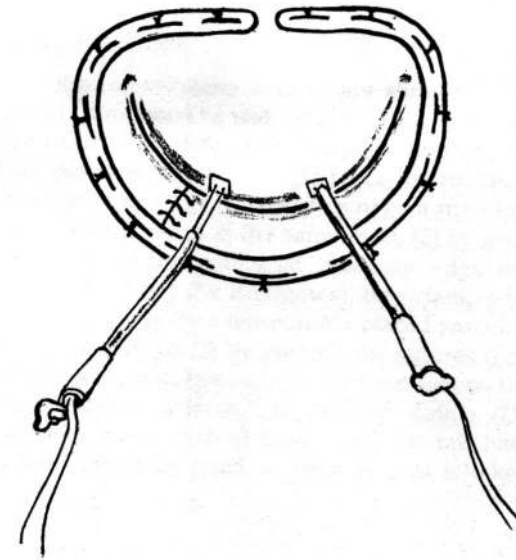
## ***Determination of Chorda Length***

- Echo: distance b/w free edge of the PL and tip of the anterior part of a papillary muscle
- Intraop fluid testing
- Direct measurement using nerve hook



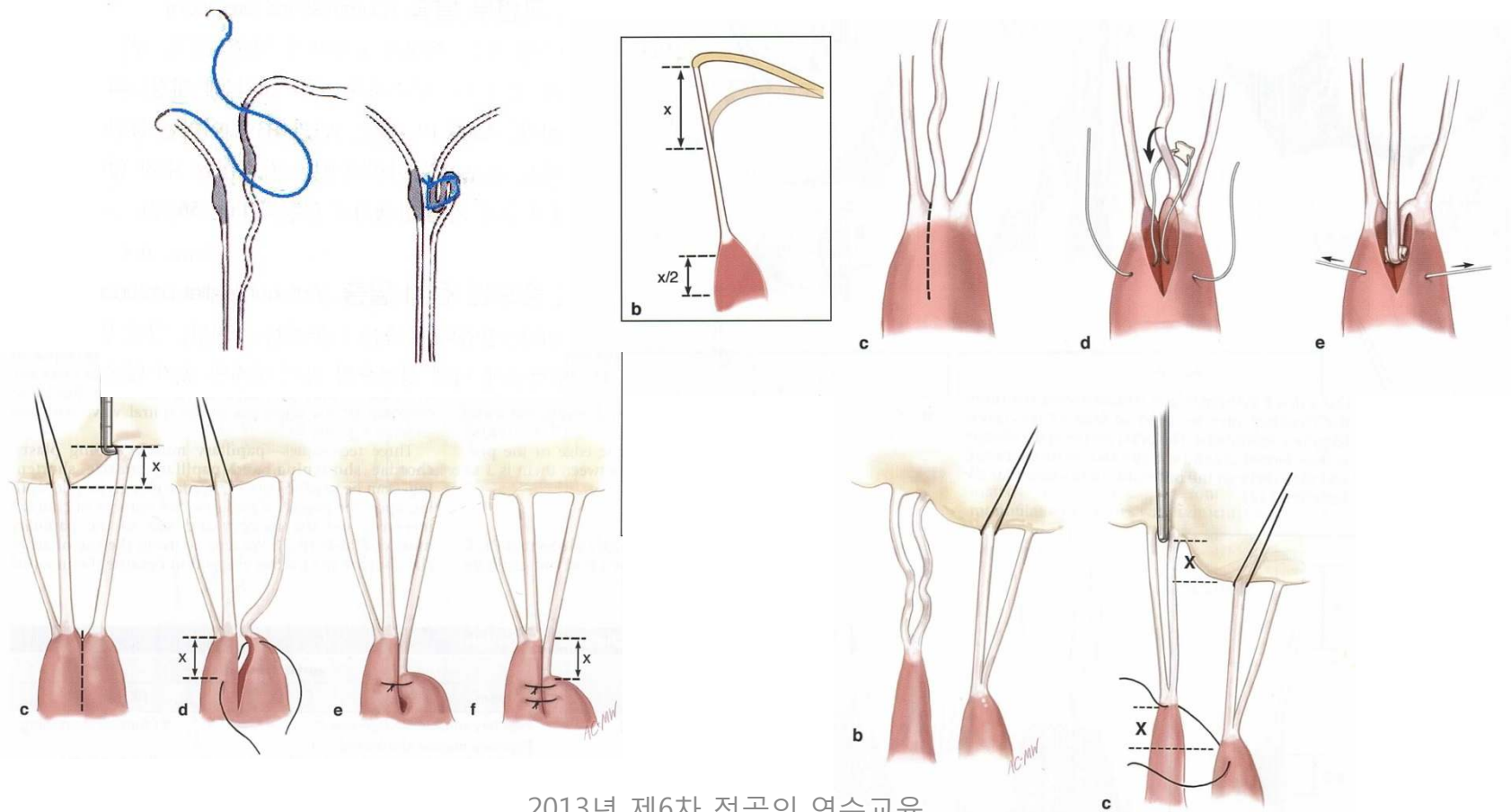
# Determination of Chorda Length

- Before or after ring suture ?
  - Ant cusp fall down
  - Posterior annulus bent
    - edge of ant leaflet disappear
- Tying the knot
  - Countertraction
  - Gripping (hemostat, rubbered jaws, clip)
  - Several sutures



# Anterior Prolapse

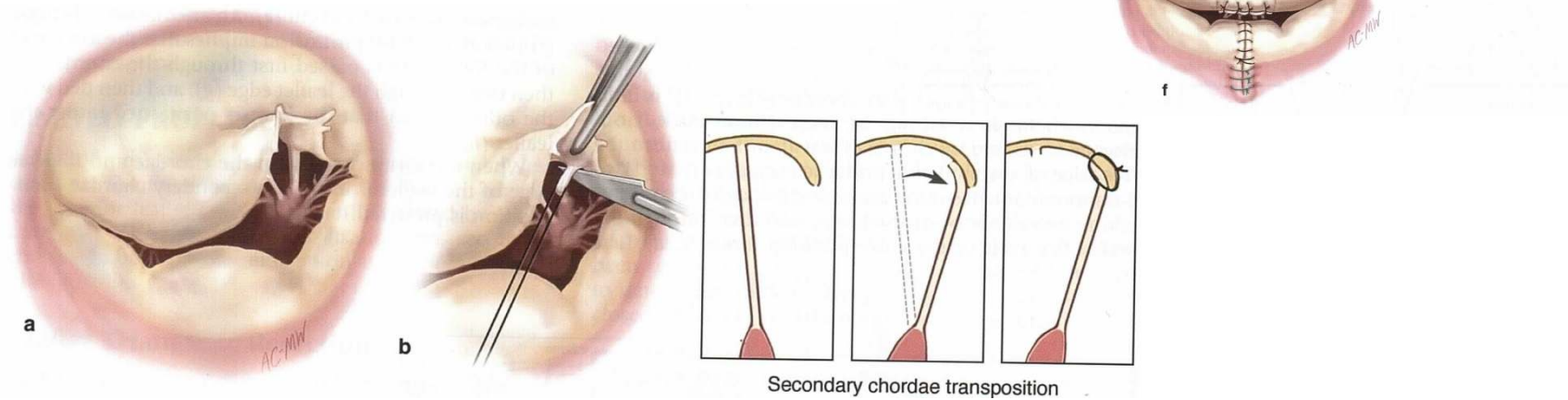
- Chordae shortening
- Papillary m. sliding plasty





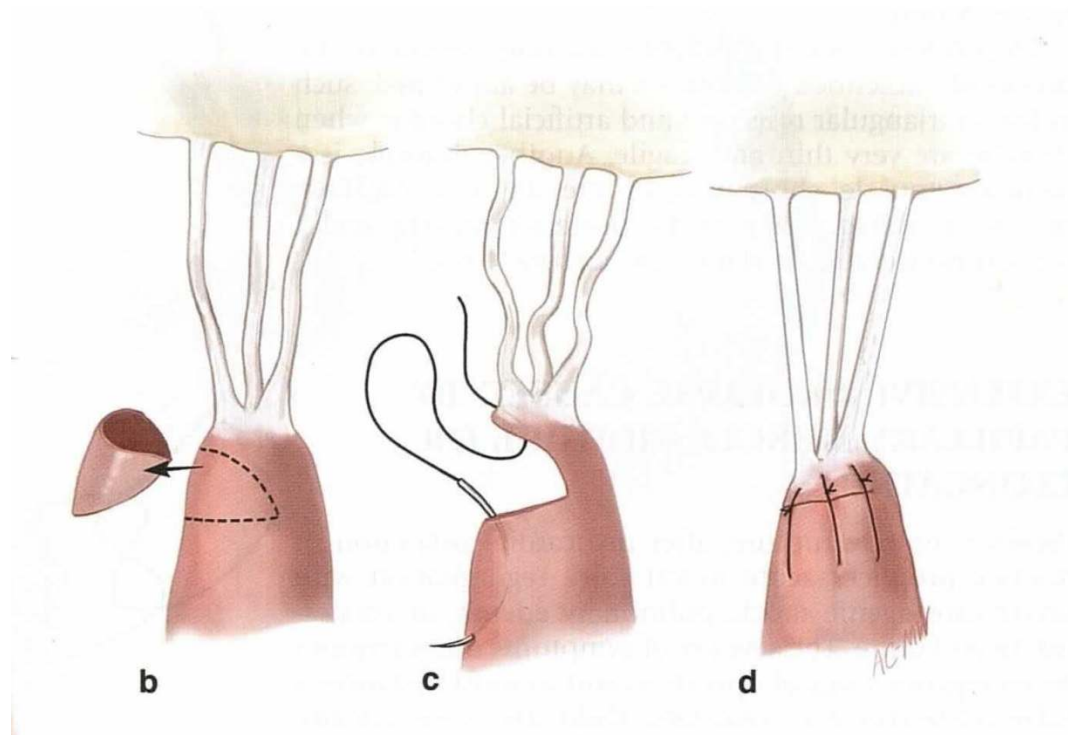
# Anterior Prolapse

- Chordae transfer
  - 2ndary chordae
  - Posterior chordae



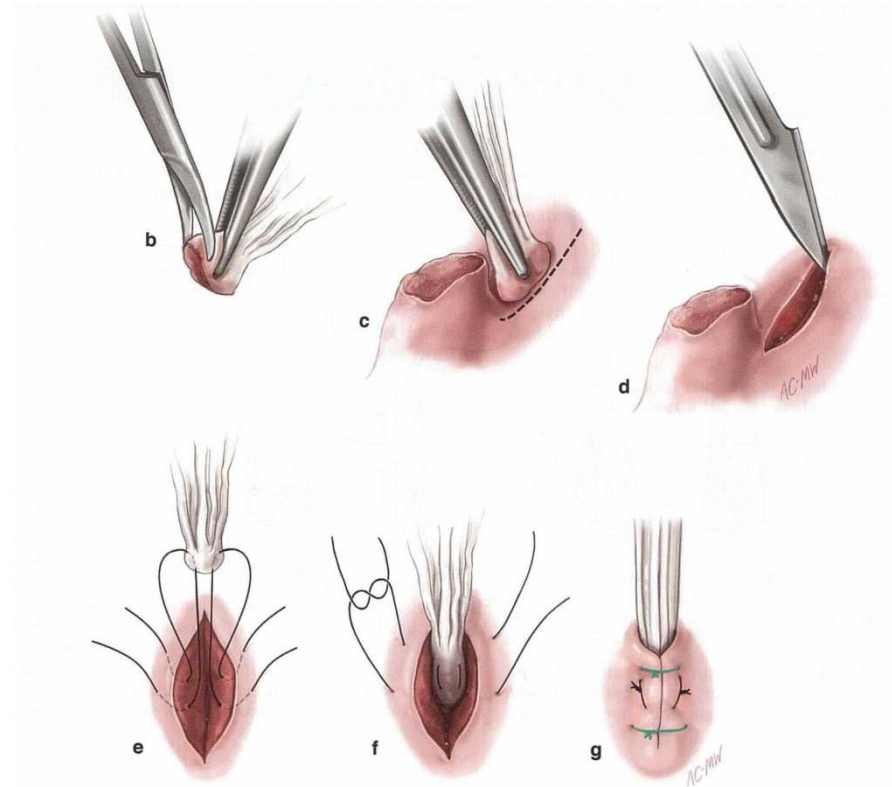
# ***Anterior Prolapse***

- Papillary m. shortening



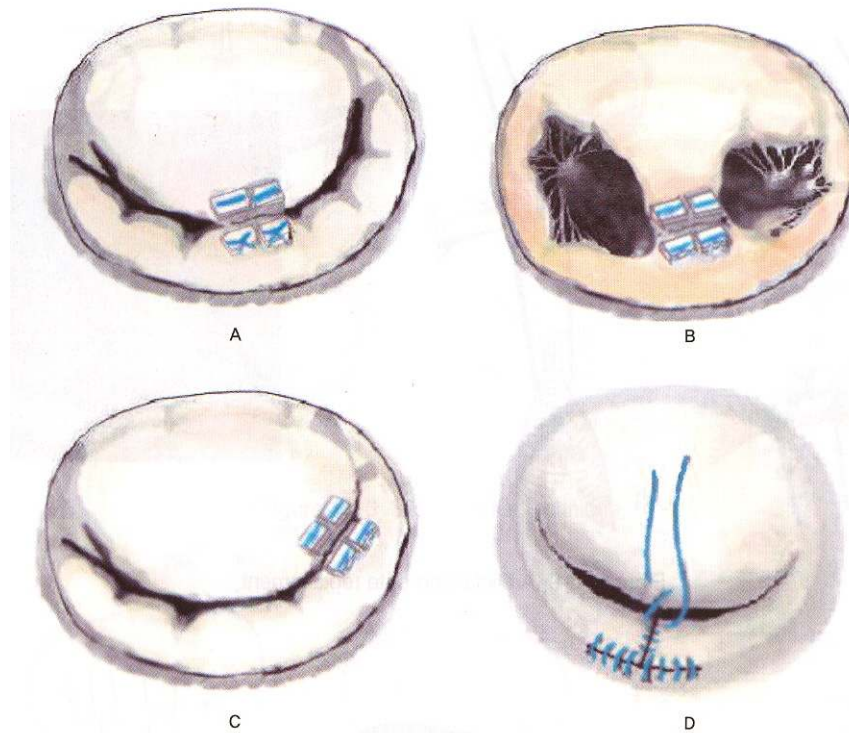
# Anterior Prolapse

- Papillary m. rupture
  - Papillary m. reimplantation



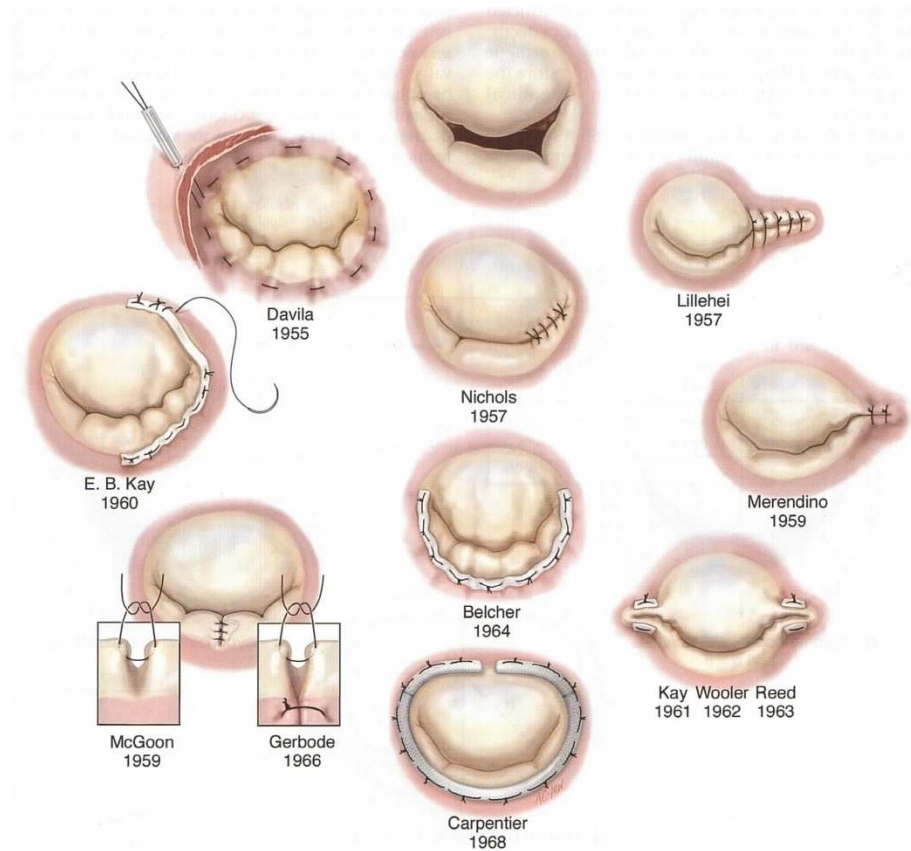
# Anterior Prolapse

- Alfieri (double orifice) technique
  - Not to make stenosis

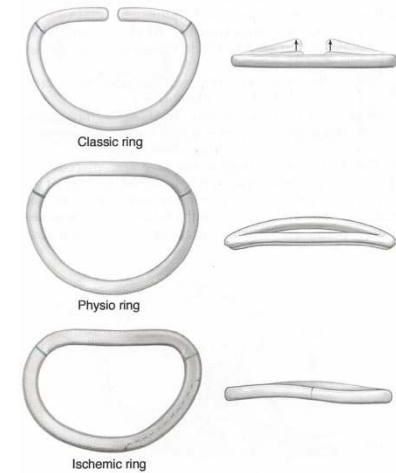


# Annuloplasty

- Suture annuloplasty → mechanical prosthesis



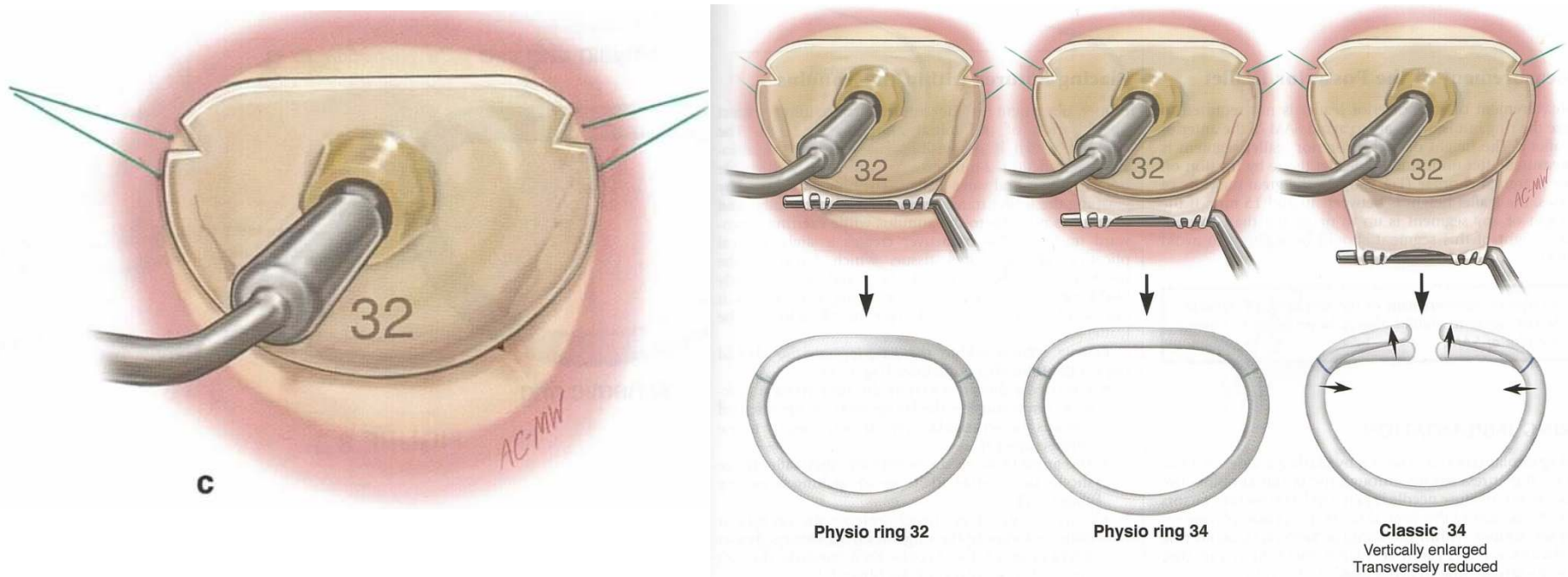
# Annuloplasty Ring



- Complete vs incomplete
  - Incomplete:
    - Usually posterior annular dilatation
    - Leaflet repair itself reduce annular circumference
    - Difficult visualization of anterior annulus
  - Complete
    - Functional MR (to reduce annular circumference)
- Rigid, semi-rigid, flexible
  - Flexible ring
    - physiologic movement of MV annulus
    - Valve distortion or orifice narrowing
  - Rigid ring: more prone to produce SAM
- Adjustable vs fixed

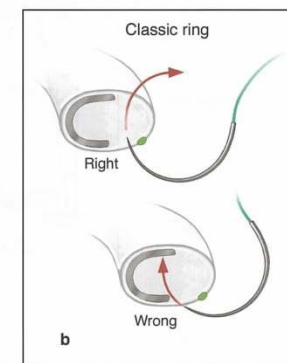
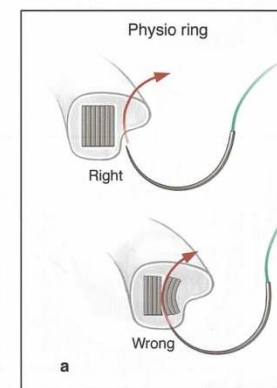
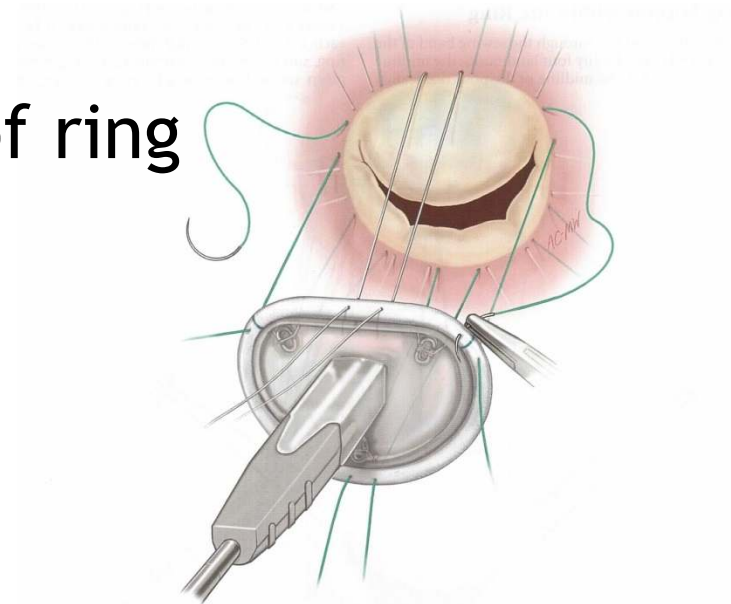
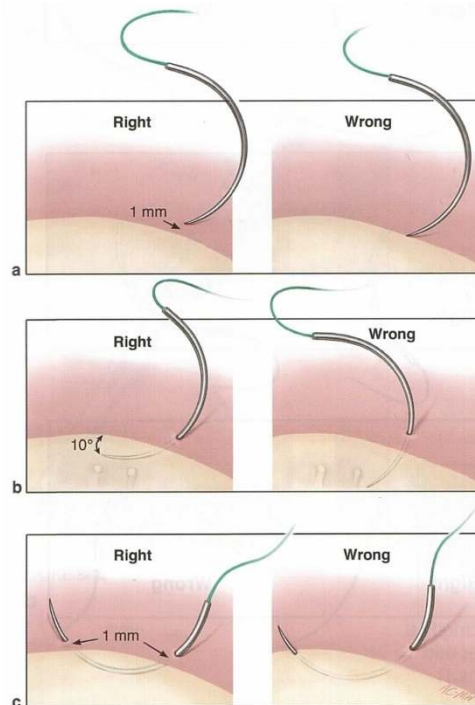
# Ring Sizing

- Measurement of anterior leaflet
  - Commissure to commissure
  - Height of anterior leaflet: partial ring ?



# Annuloplasty Suture

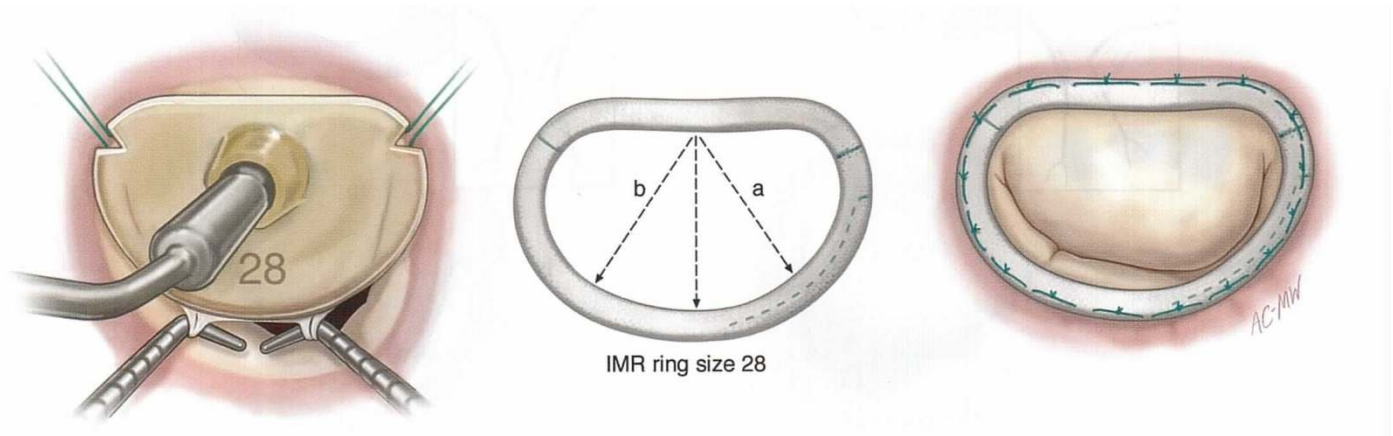
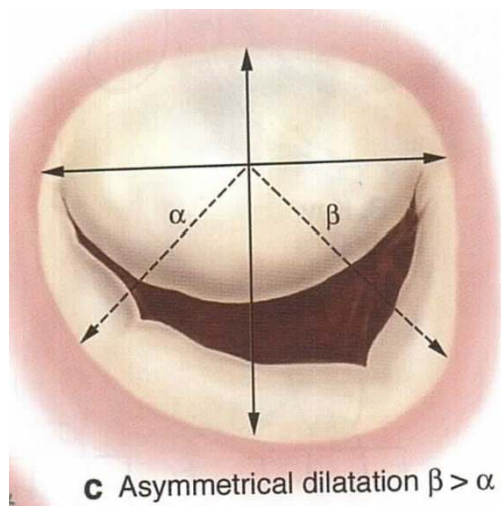
- Suture within the annulus fibrosus
  - To avoid ring dehiscence
- Not to suture metallic core of ring
  - To avoid annular distortion





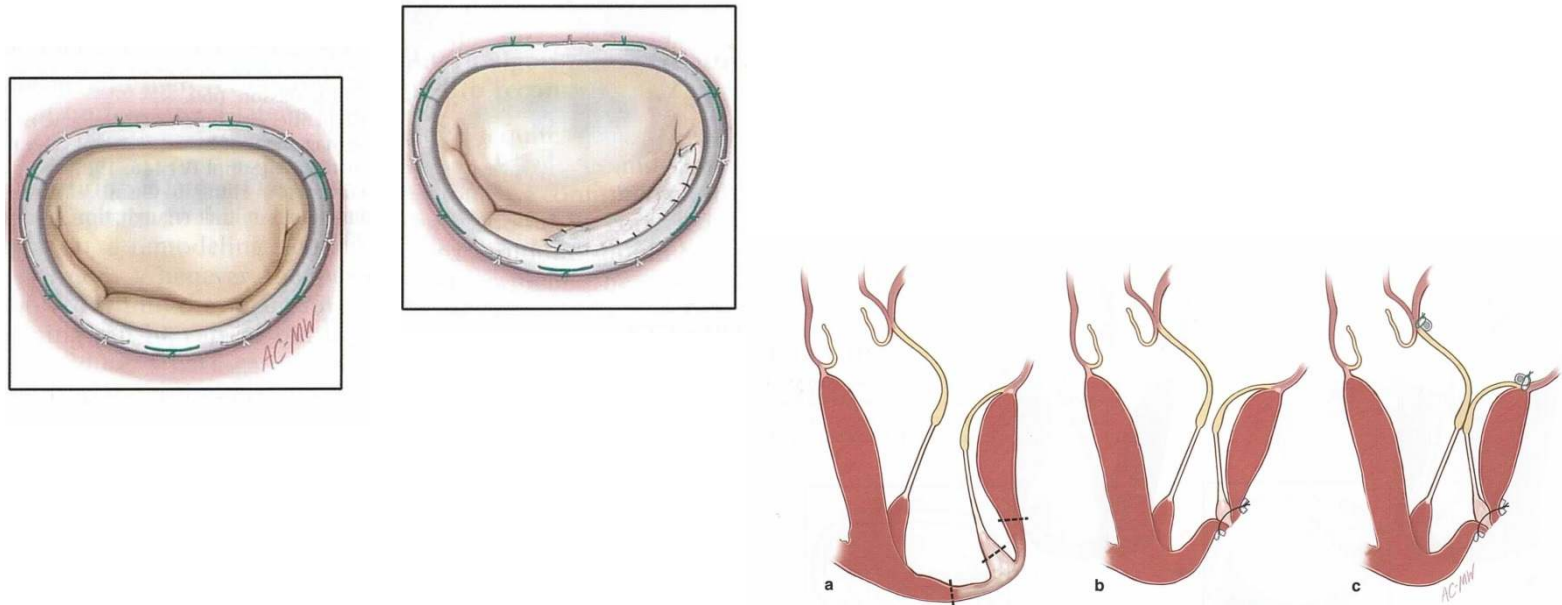
# Asymmetric Annuloplasty

- Functional MR (eg, ischemic MR)
  - Spacing or IMR ring



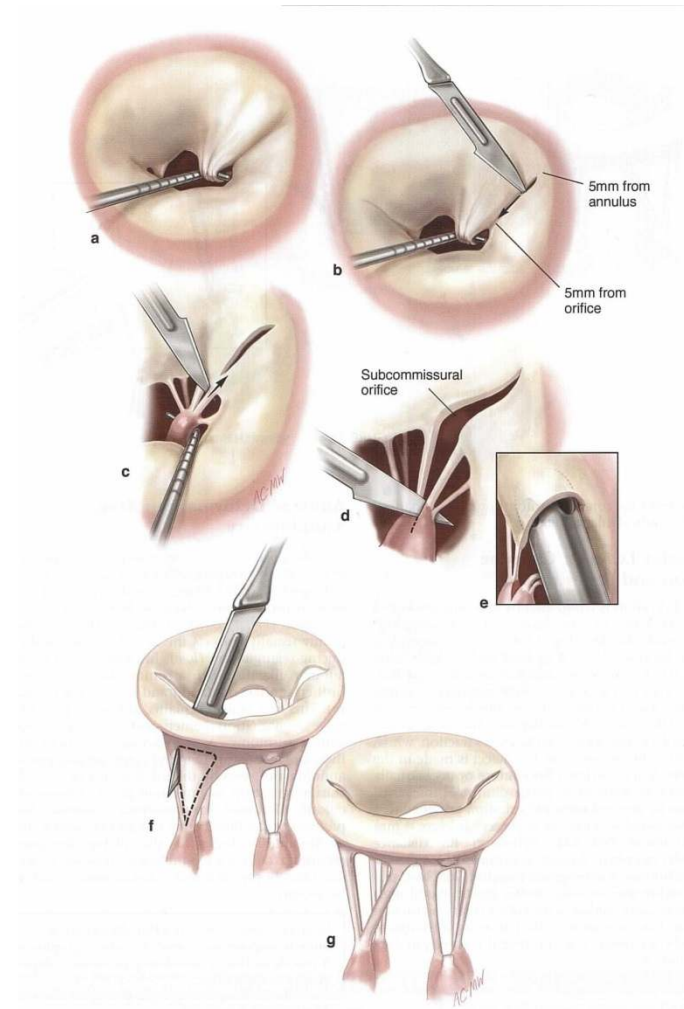
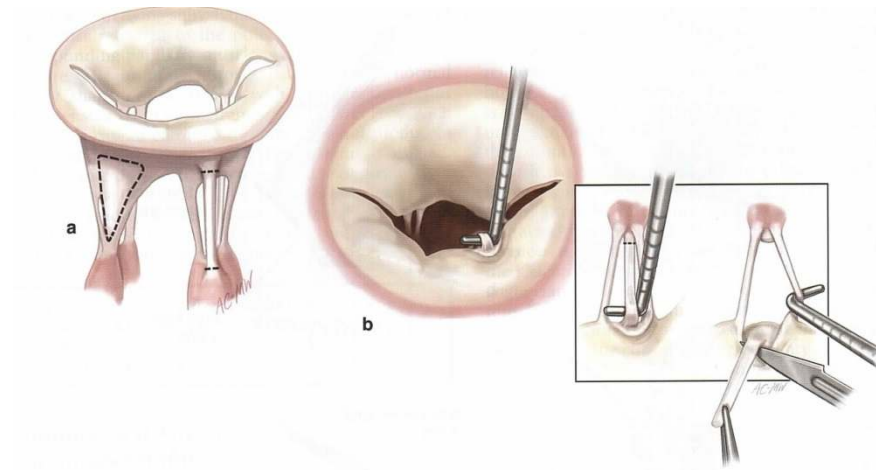
# ***Symmetric Annuloplasty***

- Functional MR: complete > partial
  - Without valvular & subvalvular deformity
    - : secondary chorda cutting, leaflet extension, ventricular resection & papillary m. reimplantation



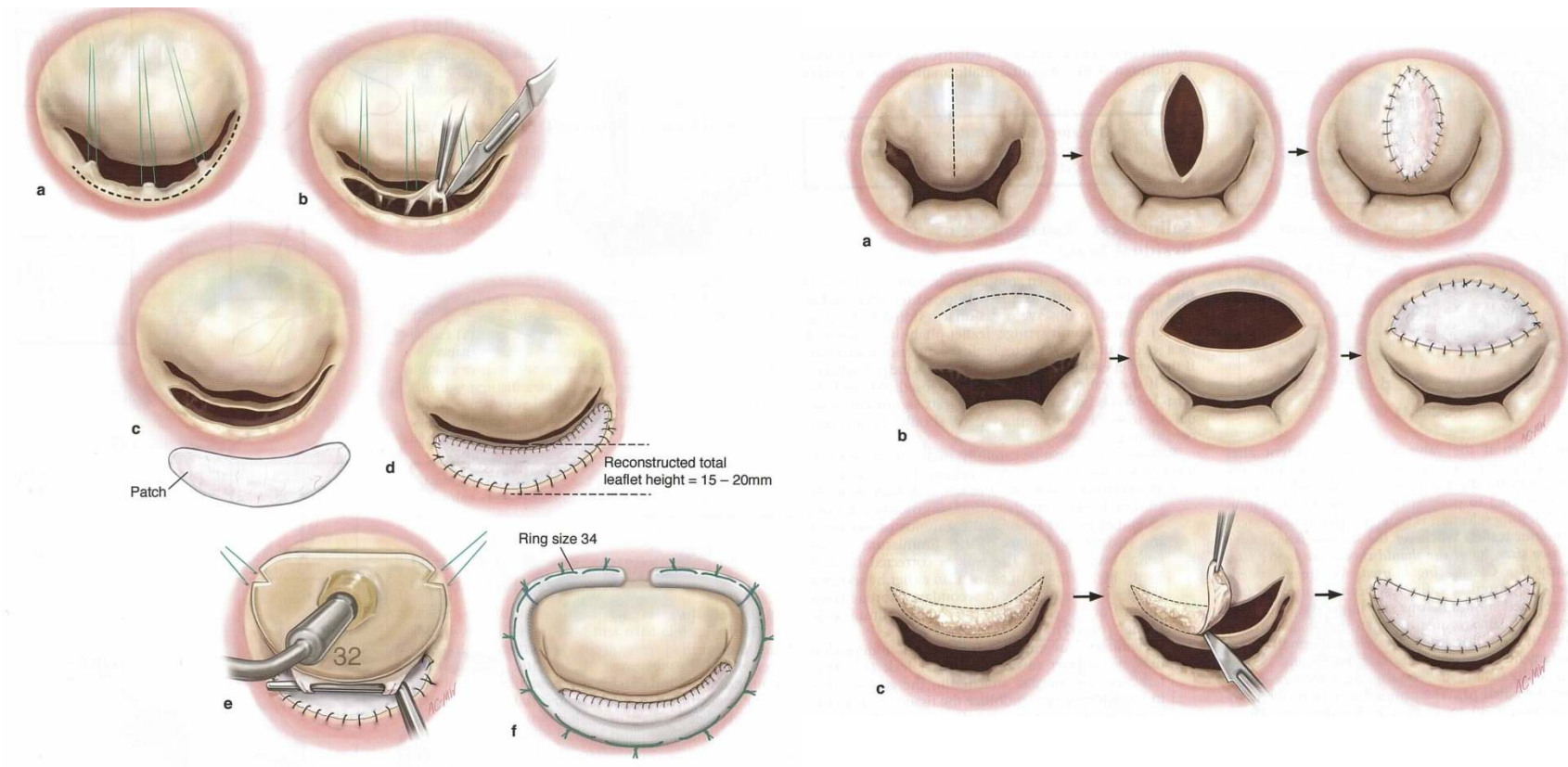
# Rheumatic MV Disease

- Commissurotomy
- 2ndary chordae resection
- Not good result  
in severe deformity valve



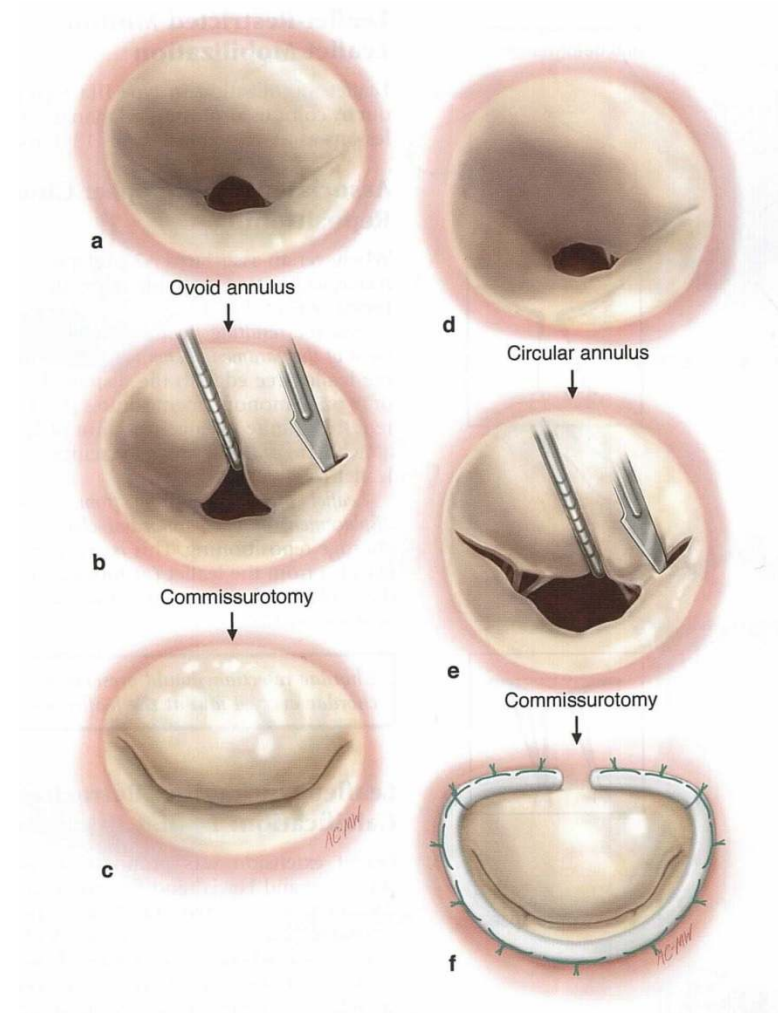
# Rheumatic MV Disease

- Leaflet extension: pericardium



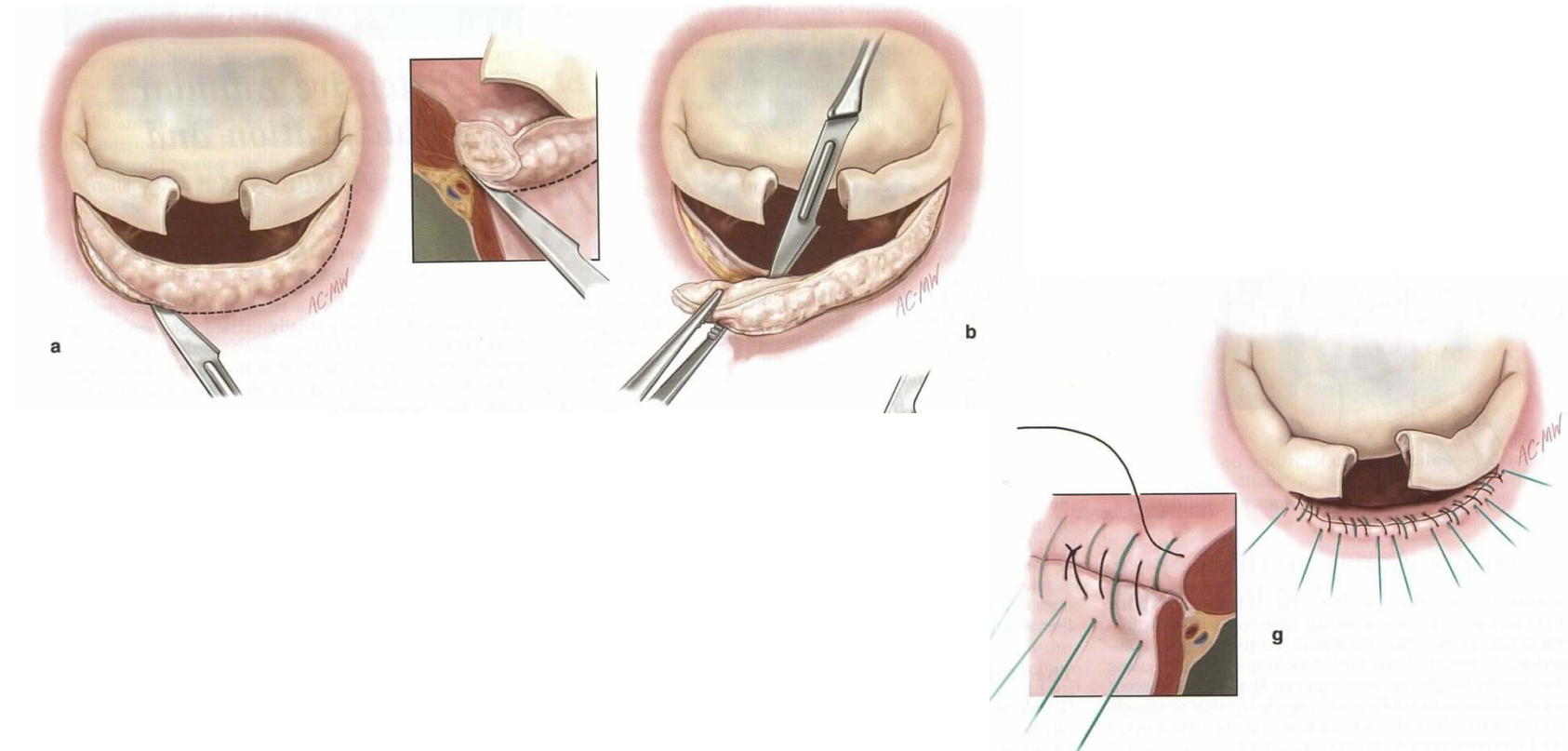
# Rheumatic MV Disease

- Ring annuloplasty
  - Not to make stenosis



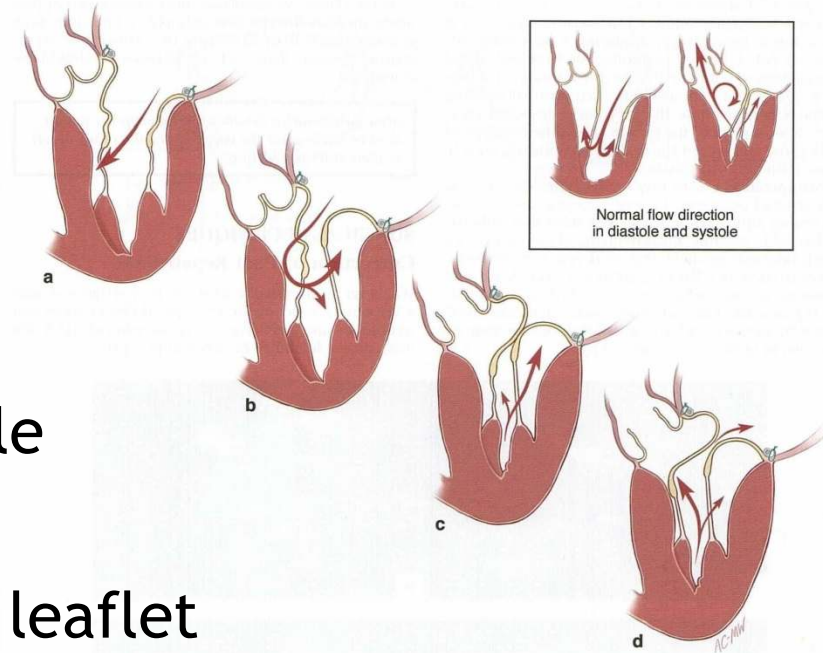
# Annular Calcification or Abscess

- Decalcification or debridement
- Reconstruction of annulus



# SAM

- Systolic anterior motion of MV
- Incidence: 2 ~ 5(10)% in annuloplasty
- Largely depend on hemodynamic status -OR
- Risk factors
  - Excess valvular tissue
  - Undersized annuloplasty
  - Narrow aorto-mitral angle
  - Hyperkinetic small ventricle
  - Septum bulging
  - Abn. Configuration of Ant. leaflet



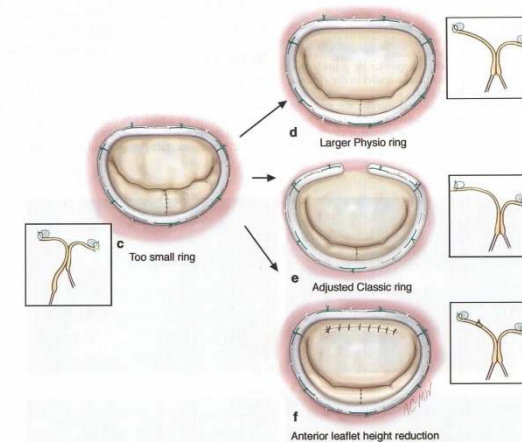
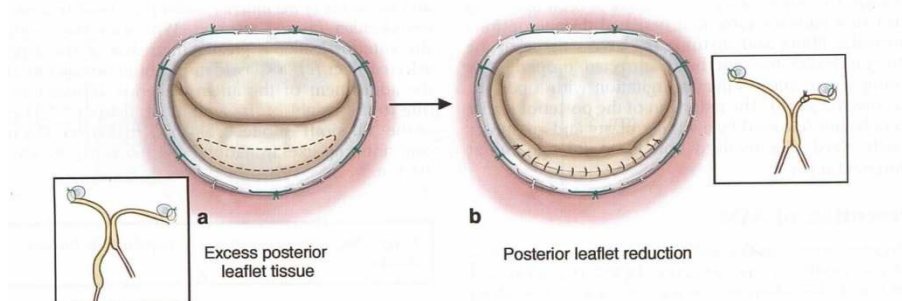
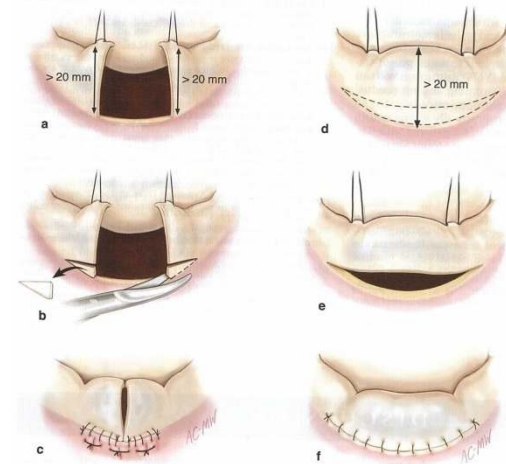
# ***SAM-Medical Therapy***

- Usually associated with
  - Hypotension
  - Hypovolemia
  - Small ventricular cavity
  - Ventricular hypertrophy
  - Hyperdynamic state(eg, catecholamine)
- Correction
  - Withdrawal of inotrops
  - Volume loading
  - Slowing heart rate
  - Increased afterload



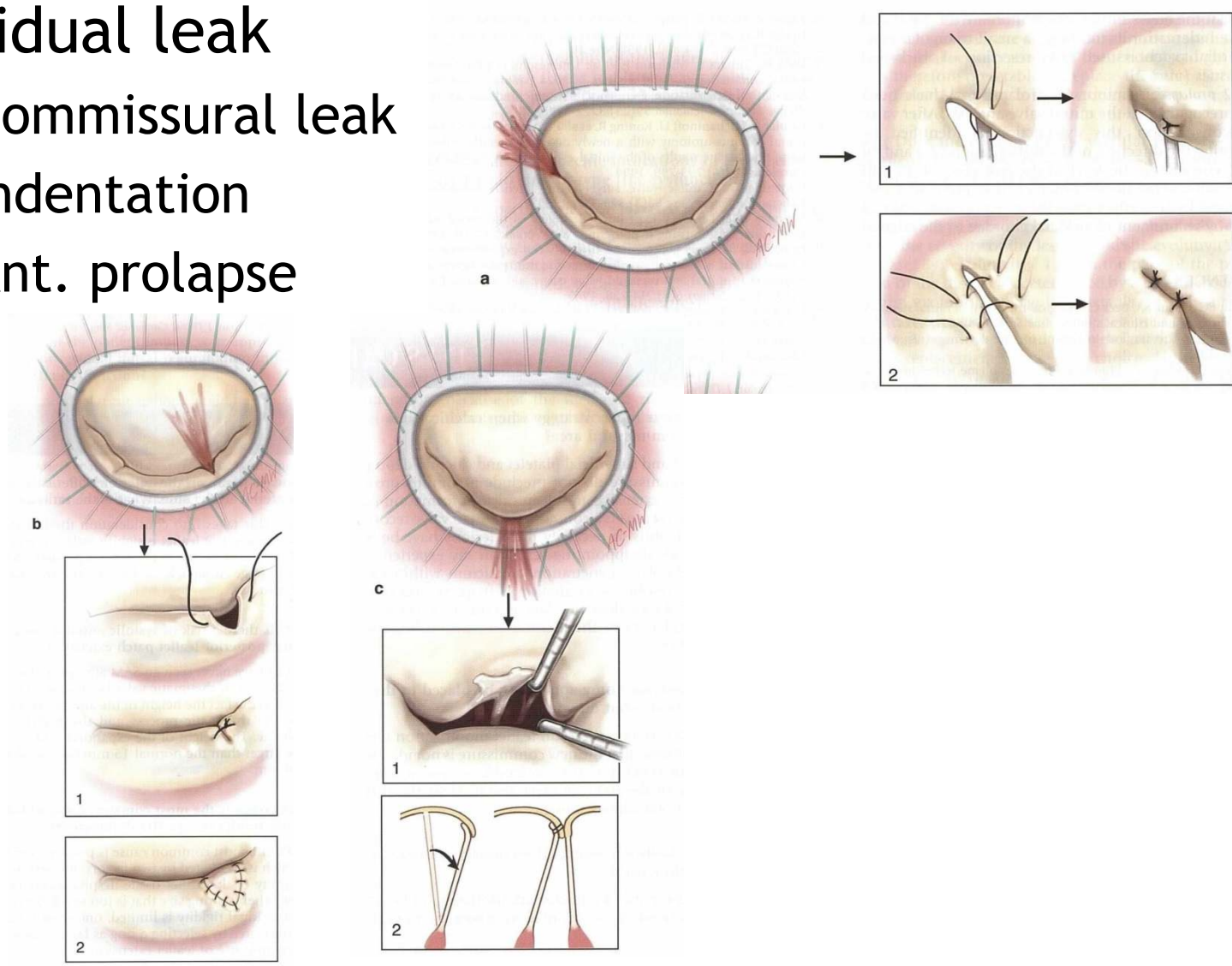
# SAM-Repair Technique

- Larger annuloplasty ring
  - Band >> complete ring
  - Flexible >> rigid ring
- Sliding annuloplasty:  
posterior leaflet height ↓
- Pomeroy procedure: ant. leaflet resection
- Transaortic septal myectomy







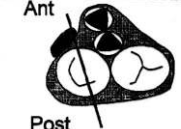

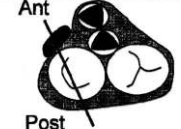
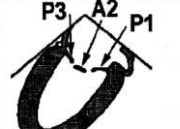
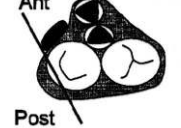
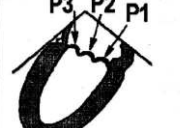


# Saline Test

- Residual leak
  - Commissural leak
  - Indentation
  - Ant. prolapse

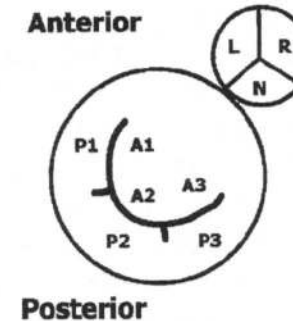


# Intraop. TEE

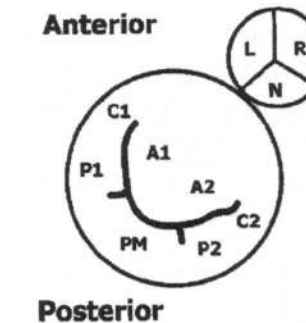
- Essential for good long-term results

<p><b>5-Chamber</b> Allows localization of pathology to the anterior or posterior leaflet. Specific scallops difficult to identify based only on this view, but generally shows anterior elements of the valve.</p>		
<p><b>4-Chamber</b> Allows localization of pathology to the anterior or posterior leaflet. Specific scallops difficult to identify based only on this view, but generally shows posterior elements of the valve.</p>		
<p><b>2-Chamber Anterior</b> Shows a long anterior leaflet (A2/A3) and a short segment of the posterior leaflet (P3). Note that the part of the anterior leaflet that coapts with the P3 scallop is the A3 segment.</p>		
<p><b>2-Chamber Mid</b> Three scallops and two coaptation points are seen: P3, P1, and a variable amount of A2, which disappears during diastole.</p>		
<p><b>2-Chamber Posterior</b> No coaptation point seen. The plane cuts through the posterior leaflet only. Usually demonstrates mostly P2, with some P1 and P3.</p>		
<p><b>Short Axis</b> This view is most useful with color Doppler to localize the site of regurgitation. However it rarely demonstrates the nature of the pathology.</p>		

Carpentier



Duran



# *Tricuspid Valve Repair*



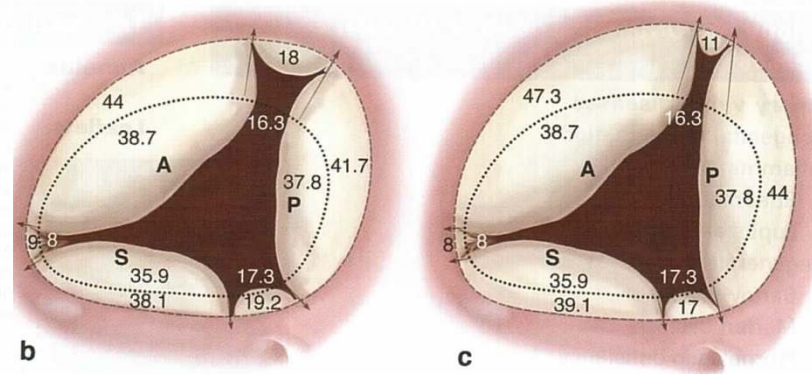
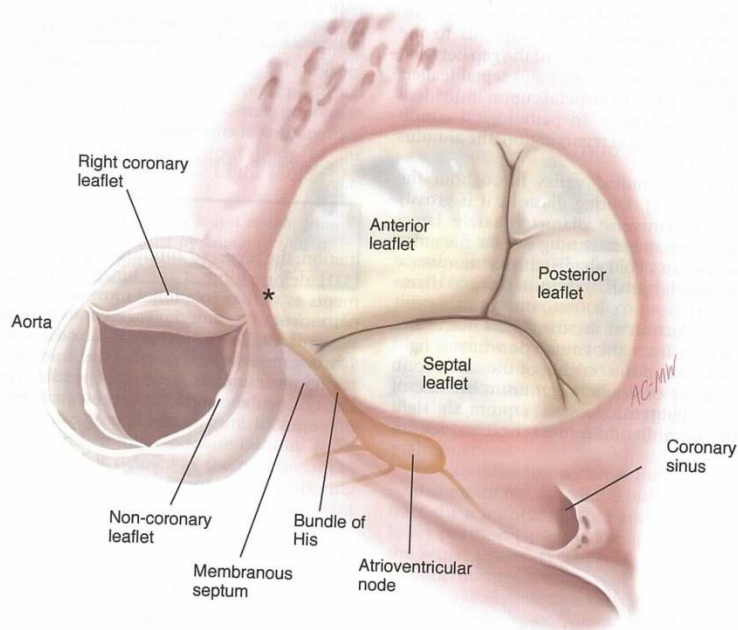
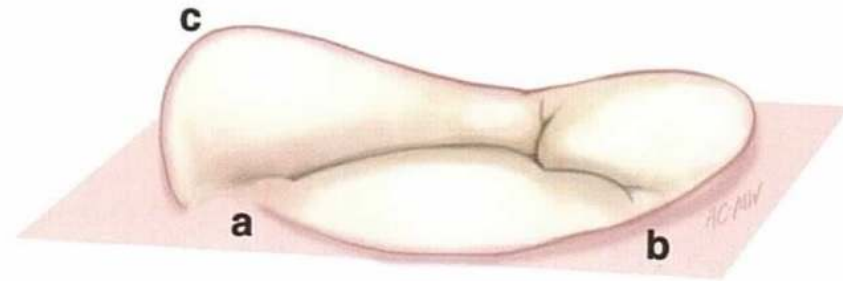
**SMCTS**

# ***TV Surgery-Indications***

- Class I
  - TV repair for severe TR during MV surgery (B)
- Class IIa
  - TV replacement or annuloplasty for severe symptomatic TR (C)
  - TV replacement for severe secondary TR not amenable to annuloplasty or repair (C)
- Class IIb
  - TV annuloplasty for less than severe TR during MV surgery (+ pul. HT, TV annular dilatation) (C)

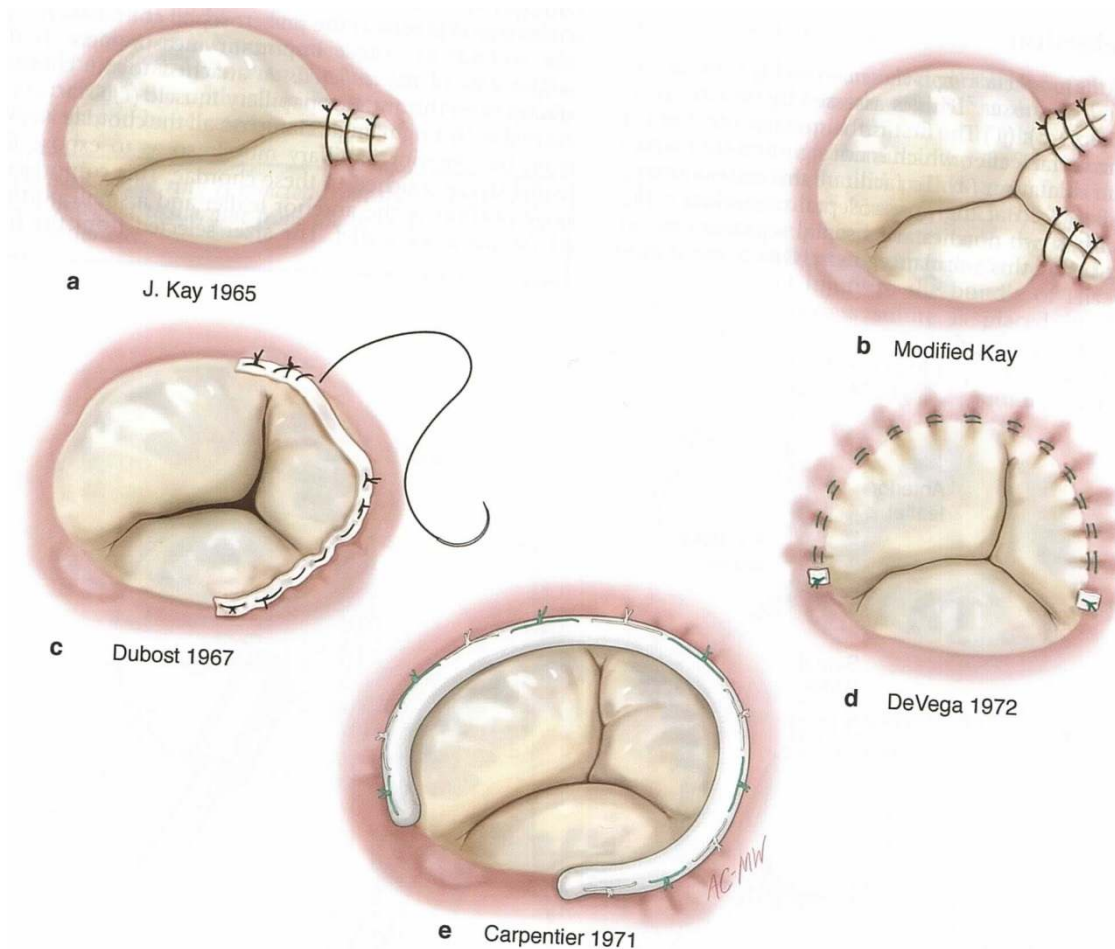
# Anatomy

- Three leaflets
- Mainly functional TR
  - Ant. & post. >> septal



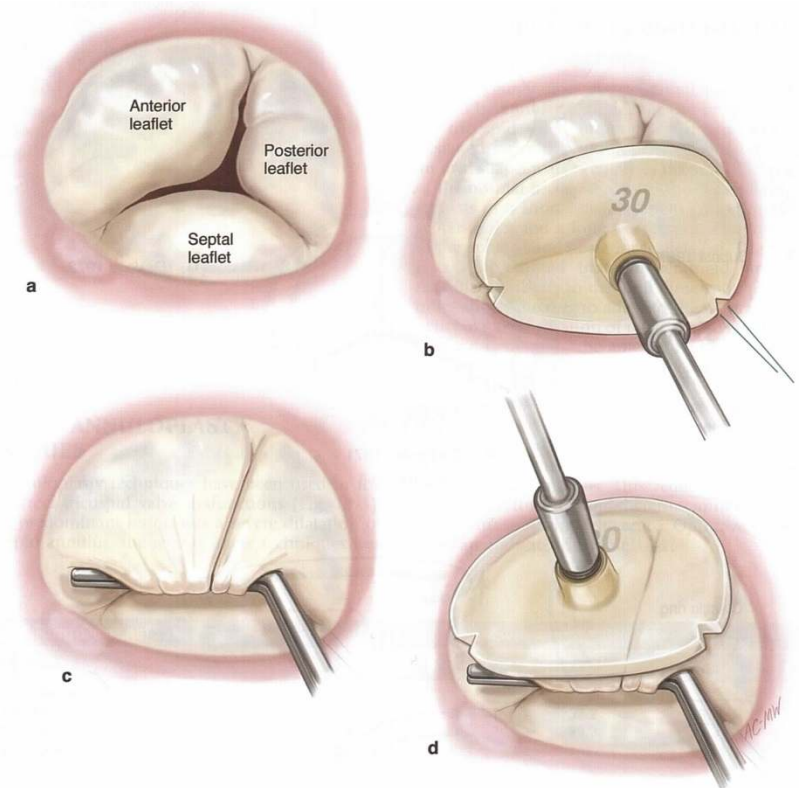
# Annuloplasty

- Ring annuloplasty >> suture annuloplasty



# Ring Annuloplasty

- Sizing
  - Base of septal leaflet
  - Surface area of the leaflet tissue attached to ant. papillary m.



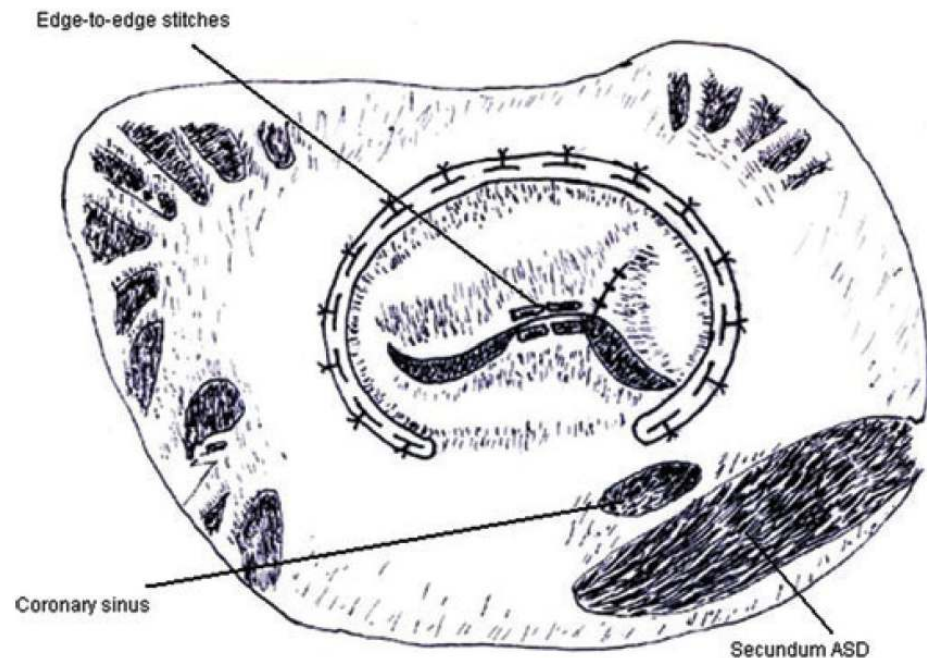
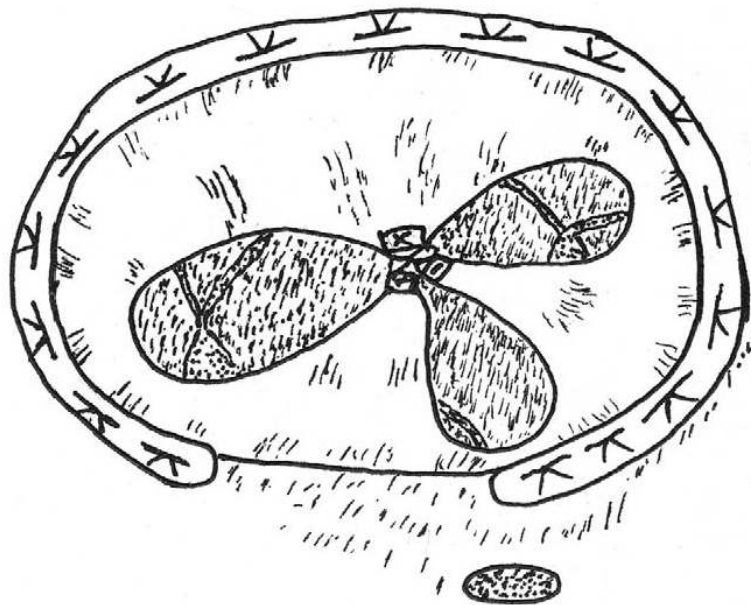


# ***Repair Technique***

- Not frequently used (functional >> primary)
- Classic MV repair (Carpentier's) technique can be used
  - Leaflet perforation: patch or suture
  - Chordae rupture or elongation: triangular resection, chorda transposition or artificial chorda, papillary m. sliding plasty, etc
  - Stenosis: commissurotomy, leaflet augmentation
- Long-term results ?

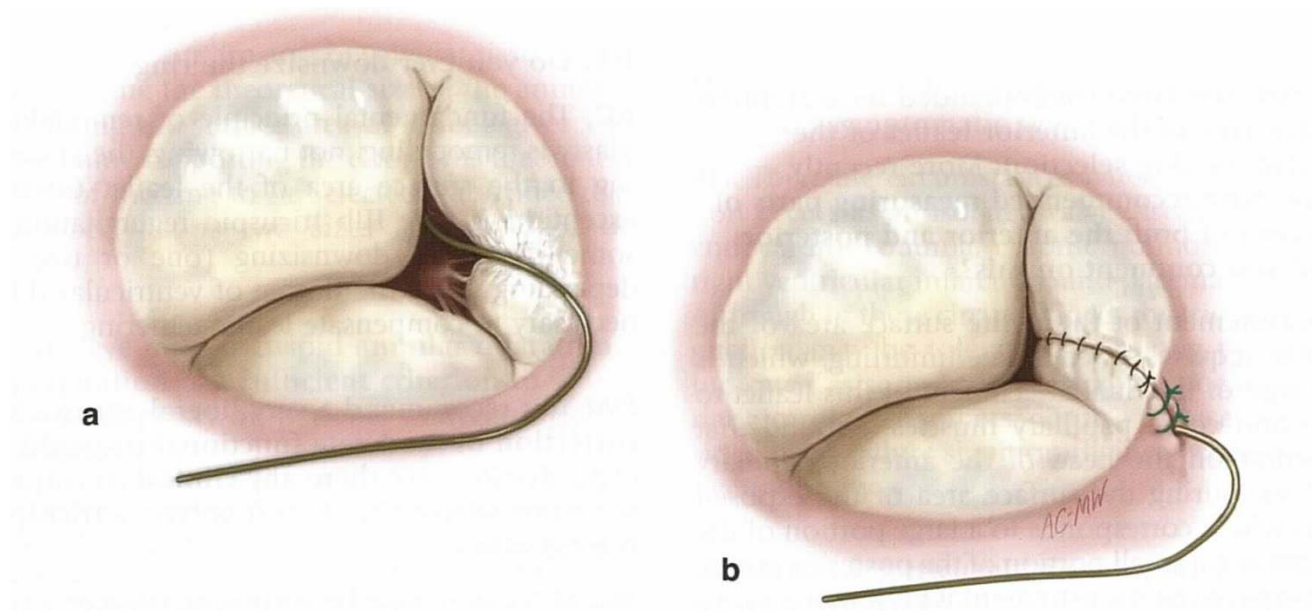
# Edge to Edge Technique

- Alfieri technique of MV
- Clover vs double orifice technique



# **Pacemaker or Defibrillator Lead Damage**

- Scar, perforation, tear
  - leaflet incision → lead repositioning & repair



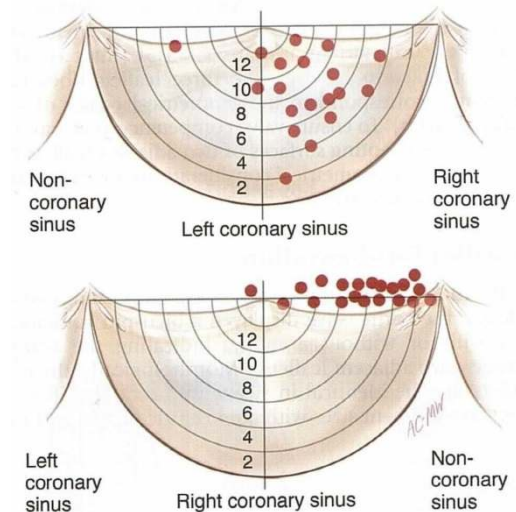
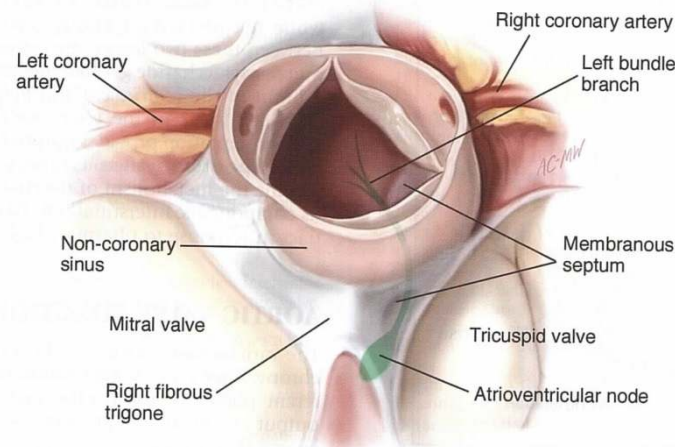
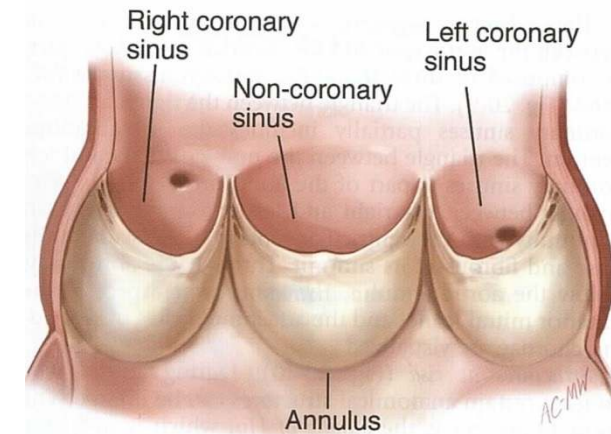
# *Aortic Valve Repair*



**SIMCTS**

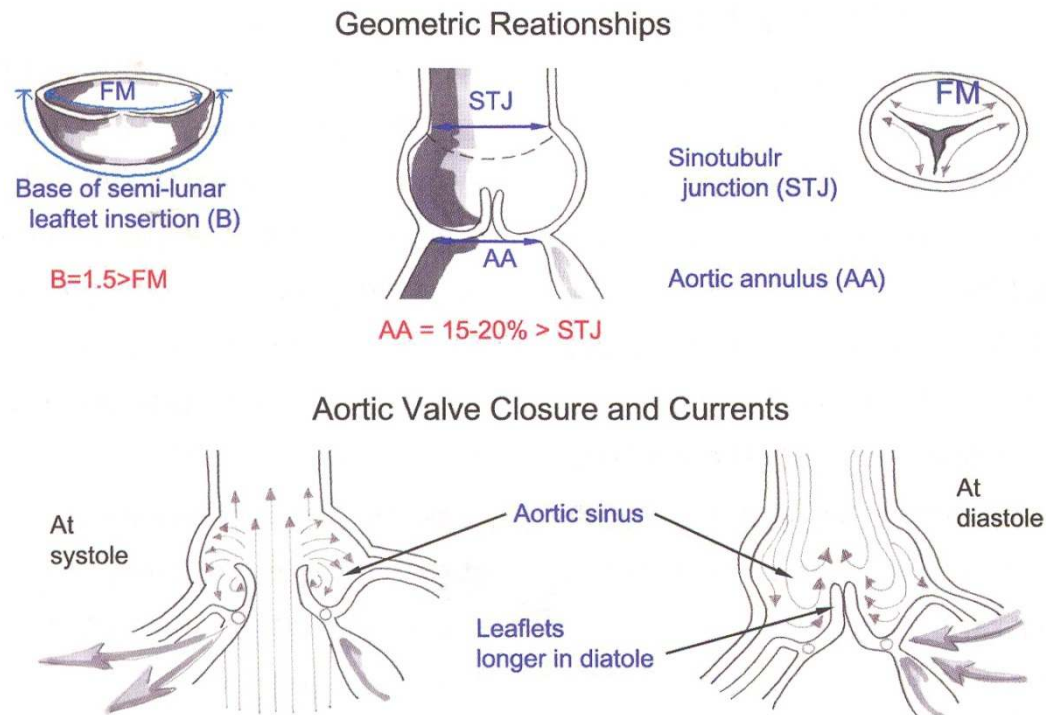
# Anatomy

- Root
  - Annulus
  - ST junction
  - Sinus of Valsalva
- Three sinuses: not symmetrical
- Coronary ostium: different level
- Adjacent structures



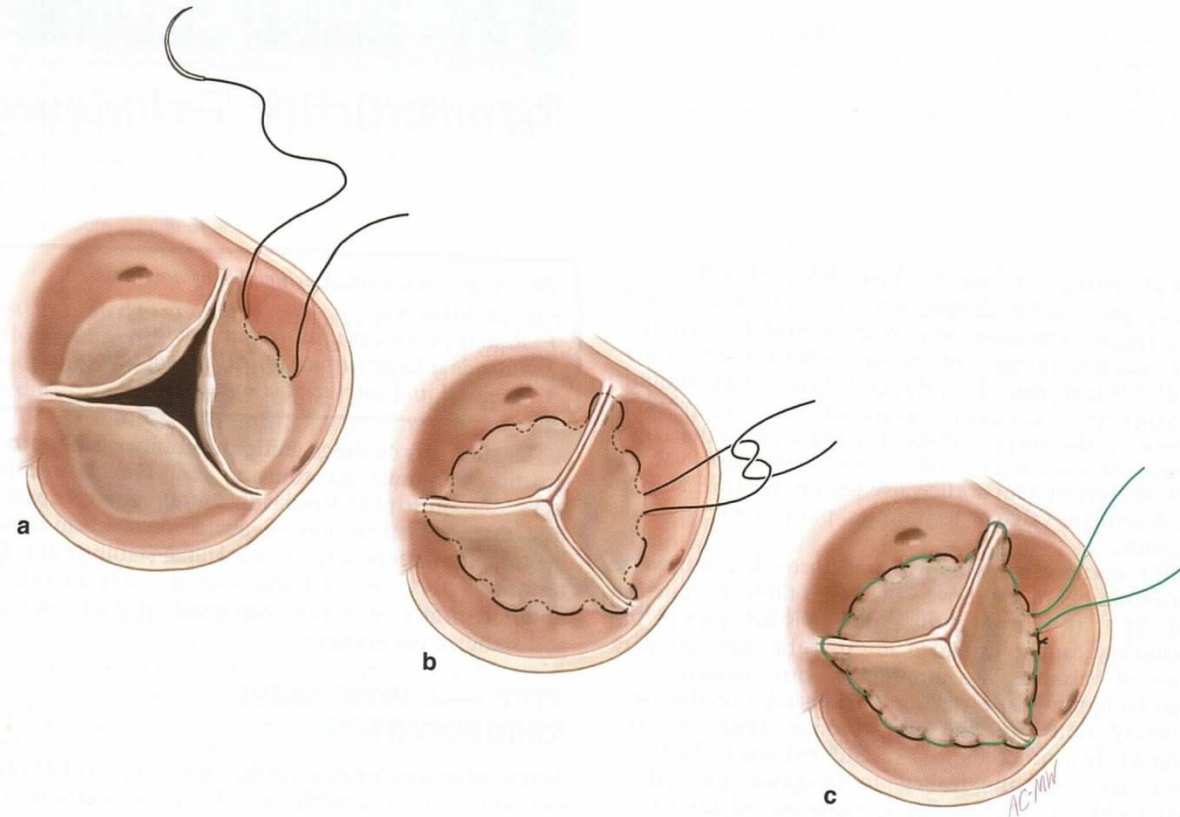
# Physiology

- Base of leaflet: 15% larger than free margin
- STJ: 15% less than AA
- Sinus Valsalva function



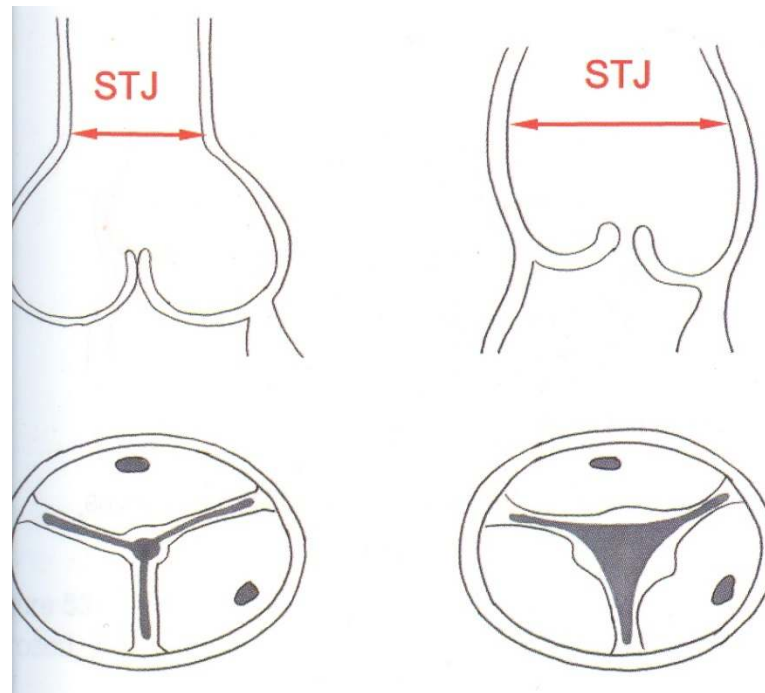
# ***Annular Dilatation***

- Isolated annular dilatation is rare
- Two rows of suture



# ***ST Junction Dilatation***

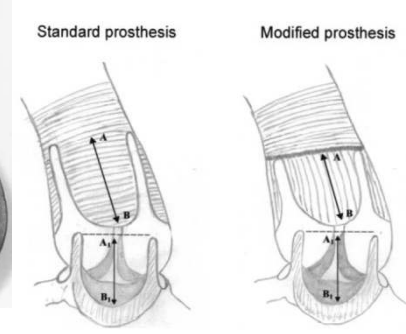
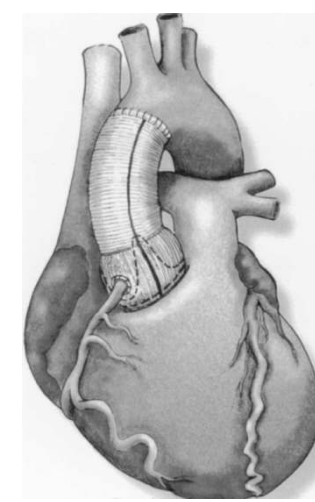
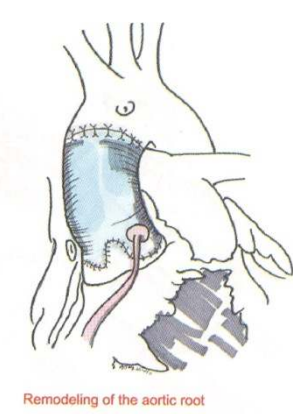
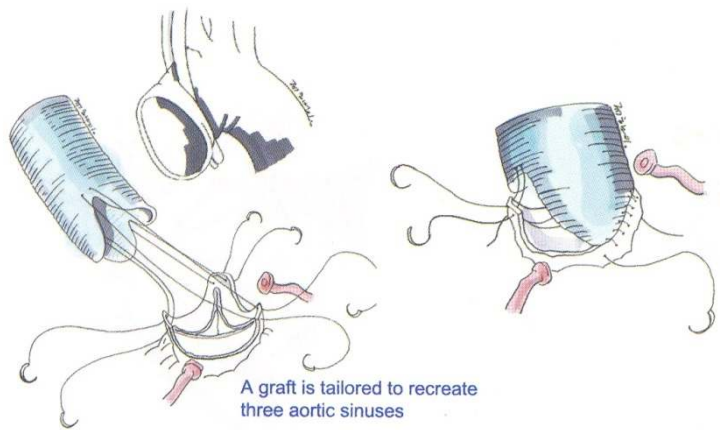
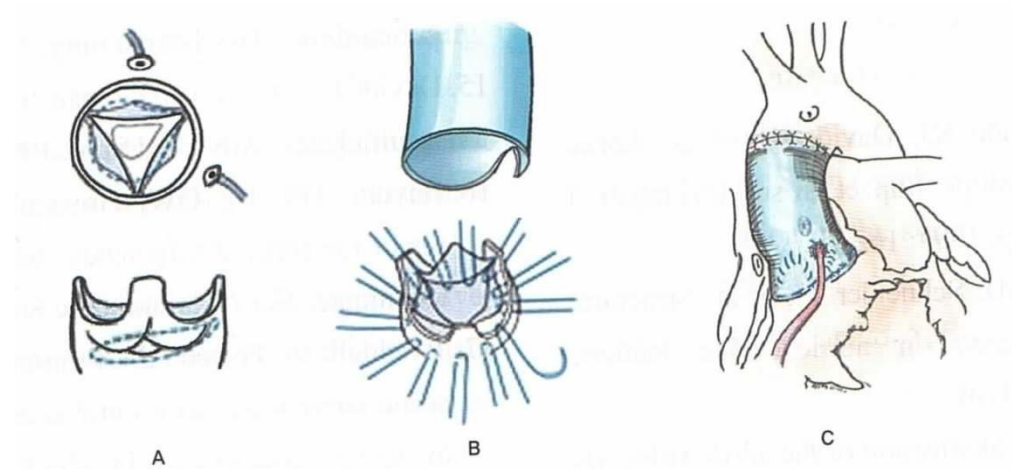
- Coaptation failure





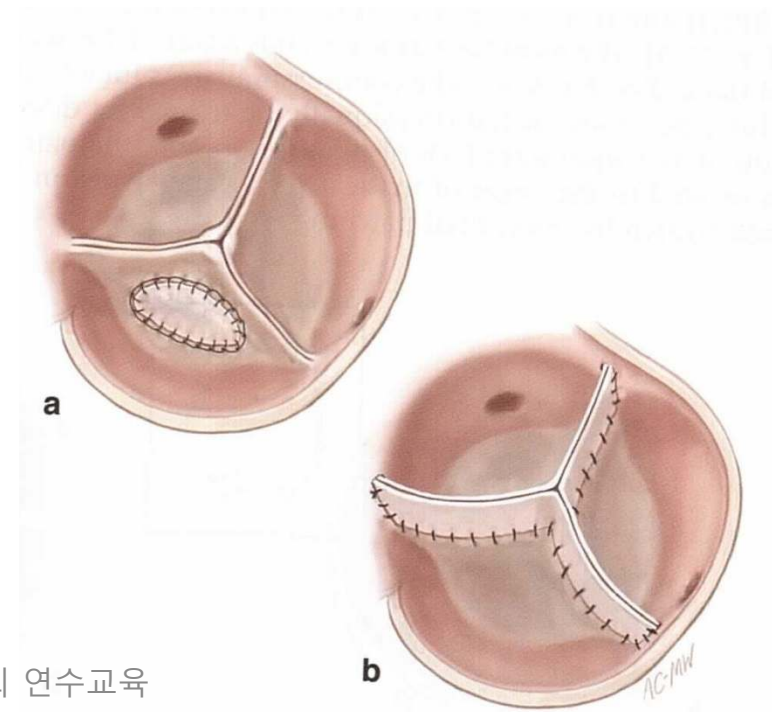
# Root Dilatation

- Valve sparing operation
  - Valve remodeling
  - Valve reimplantation
  - Using valsalva graft



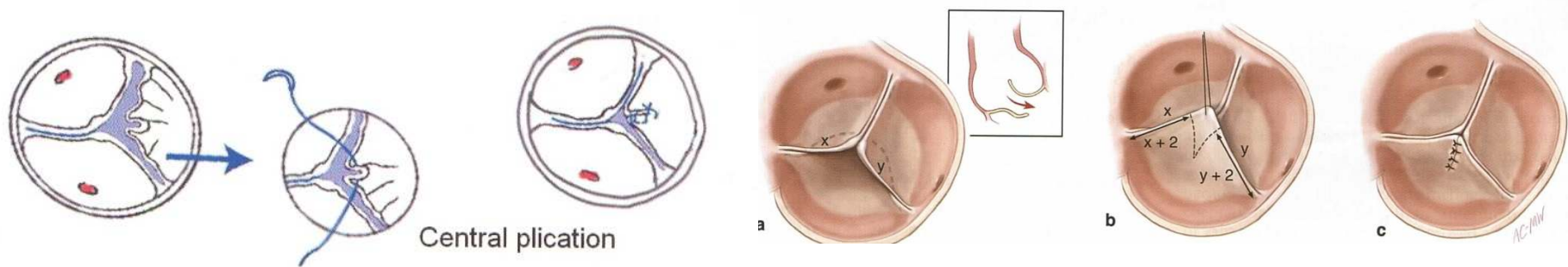
# Leaflet Perforation

- Free-margin preserved
- Fibrotic ridge
- GA-fixed autopericardium
- Not to make purse-string effect

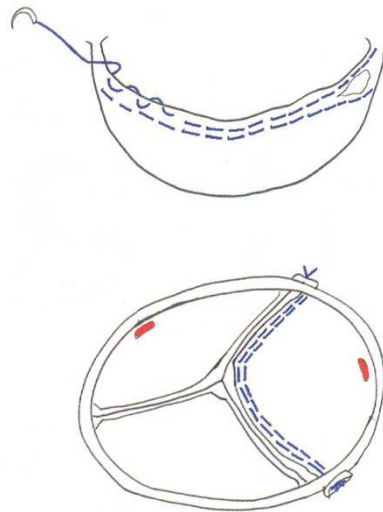


# Leaflet Prolapse

- Plication or triangular resection

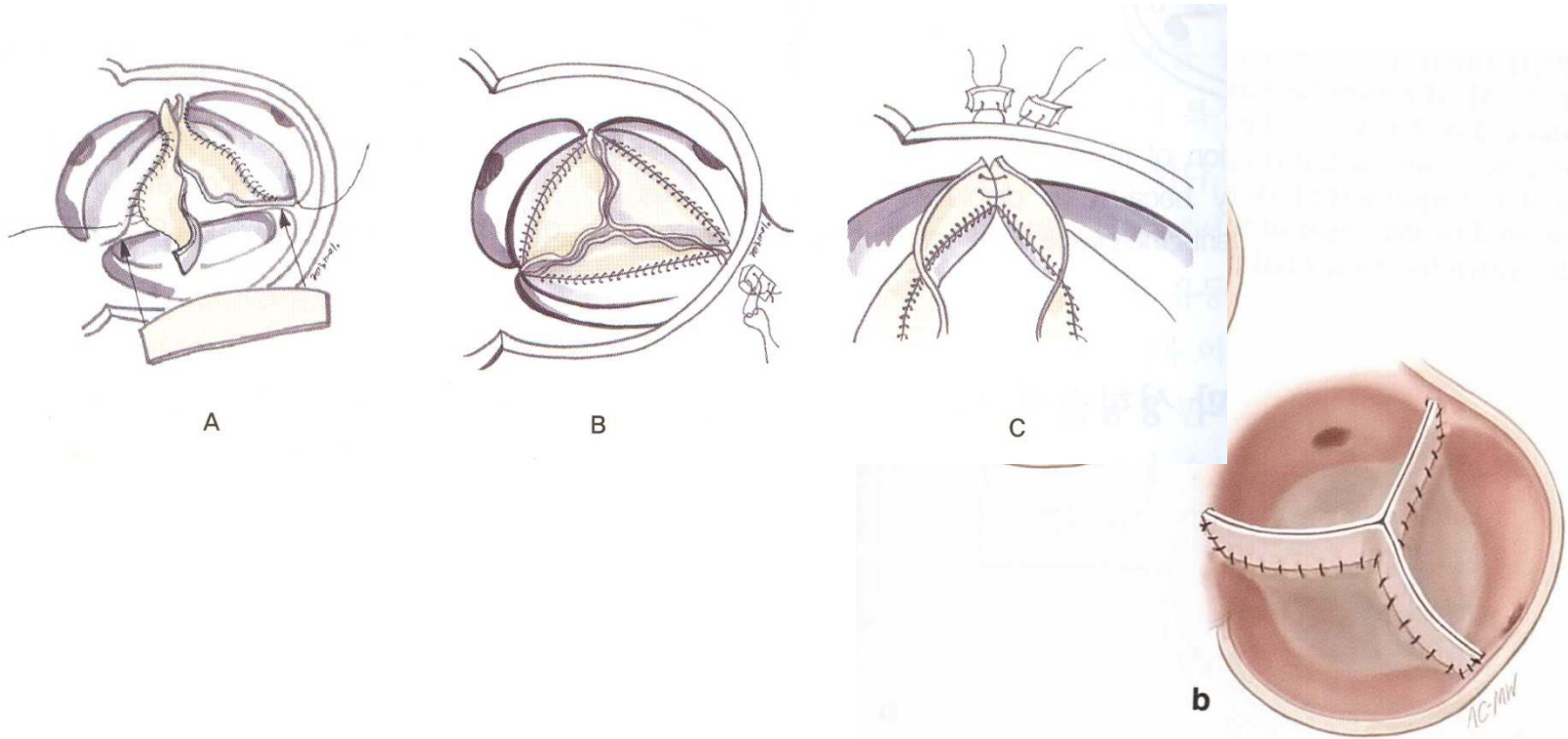


- Free margin reinforcement suture



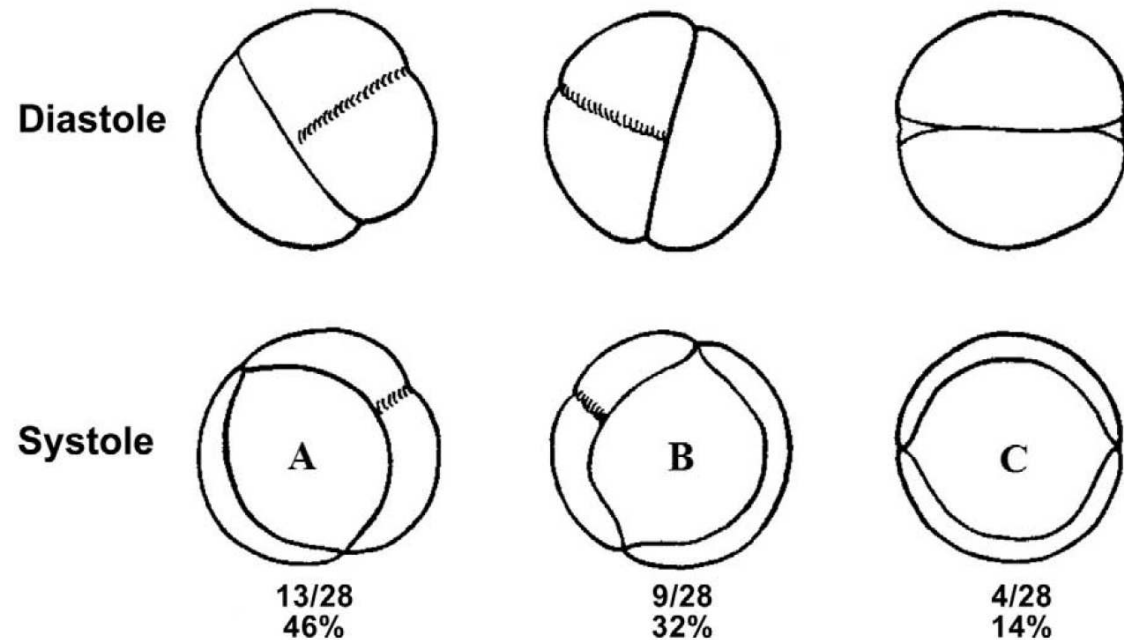
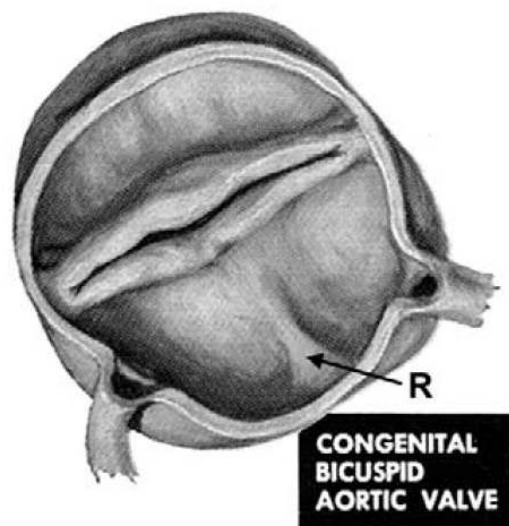
# Leaflet Extension

- Pericardial strip



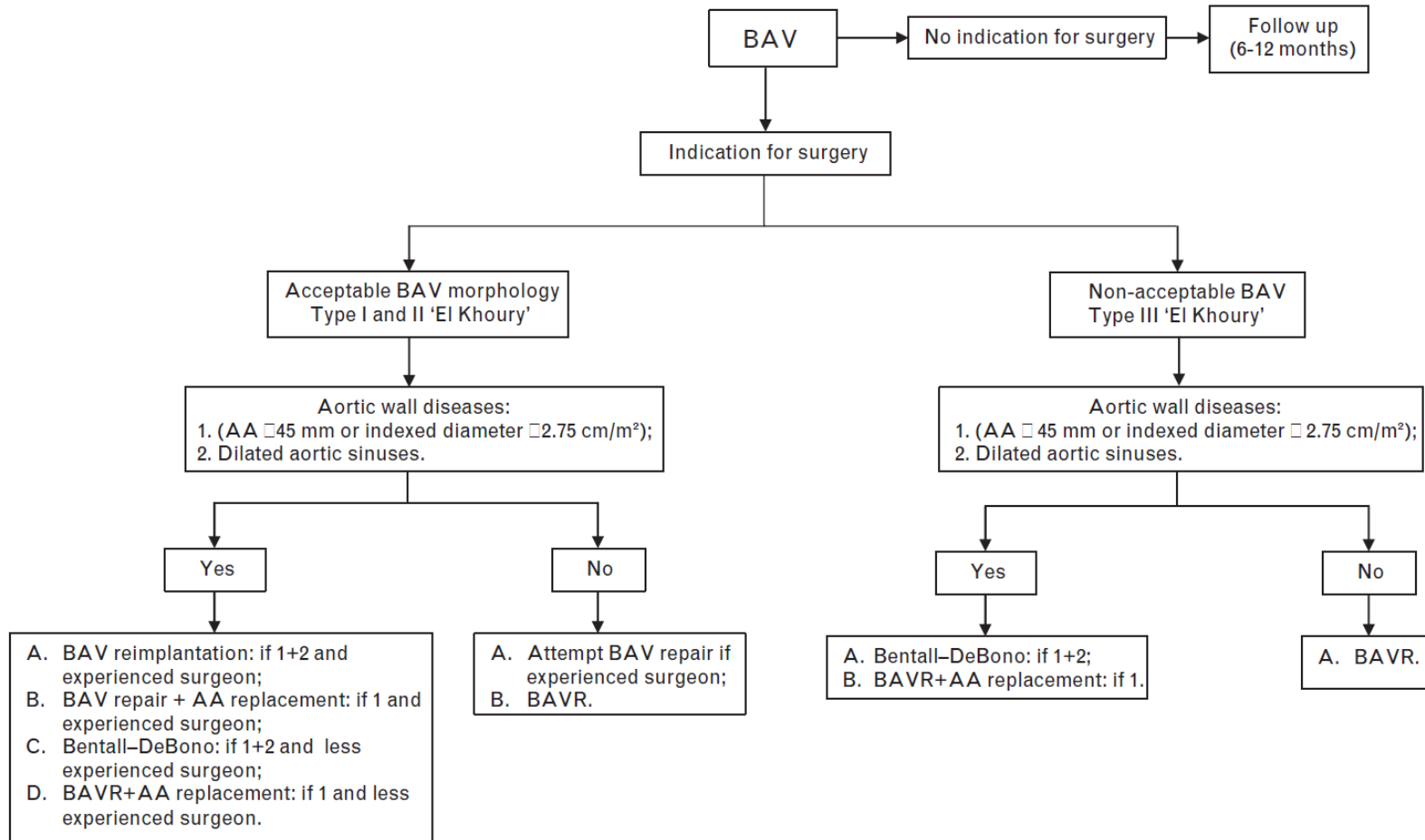
# Bicuspid AV

- 1~2% of general population
- Associated with aortic wall abnormality



# Bicuspid AV

- Custom-made for each patient

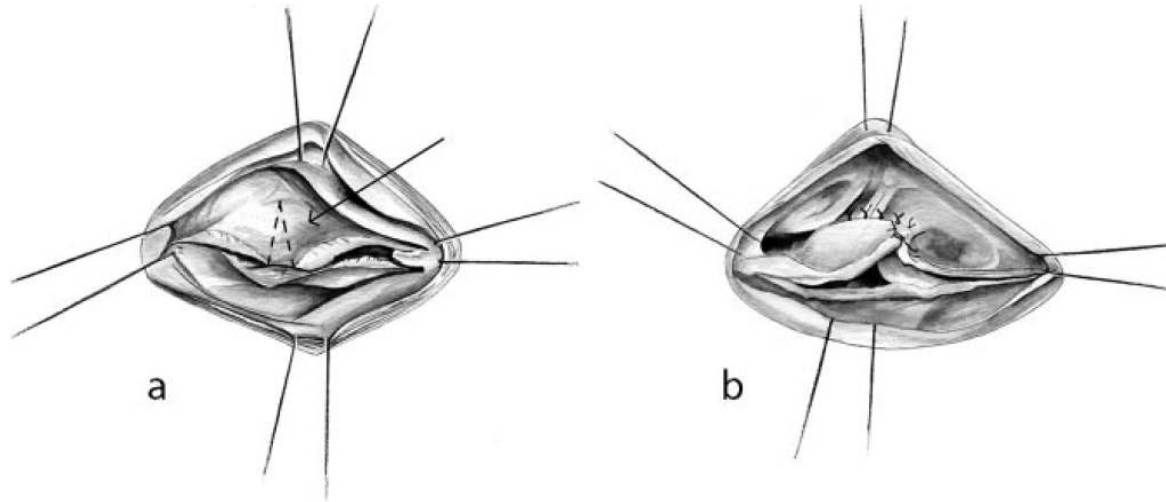


# ***BAV-Repair Technique***

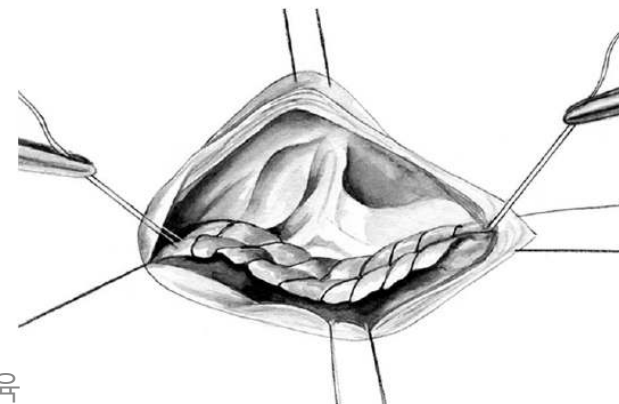
- STJ remodeling
- Valve-sparing root replacement
- Raphe resection
- Free margin plication
- Cusp extension
- Patch closure
- Subcommissural annuloplasty
- Free margin reinforcement

# ***BAV-Repair Technique***

- Triangular plication or resection



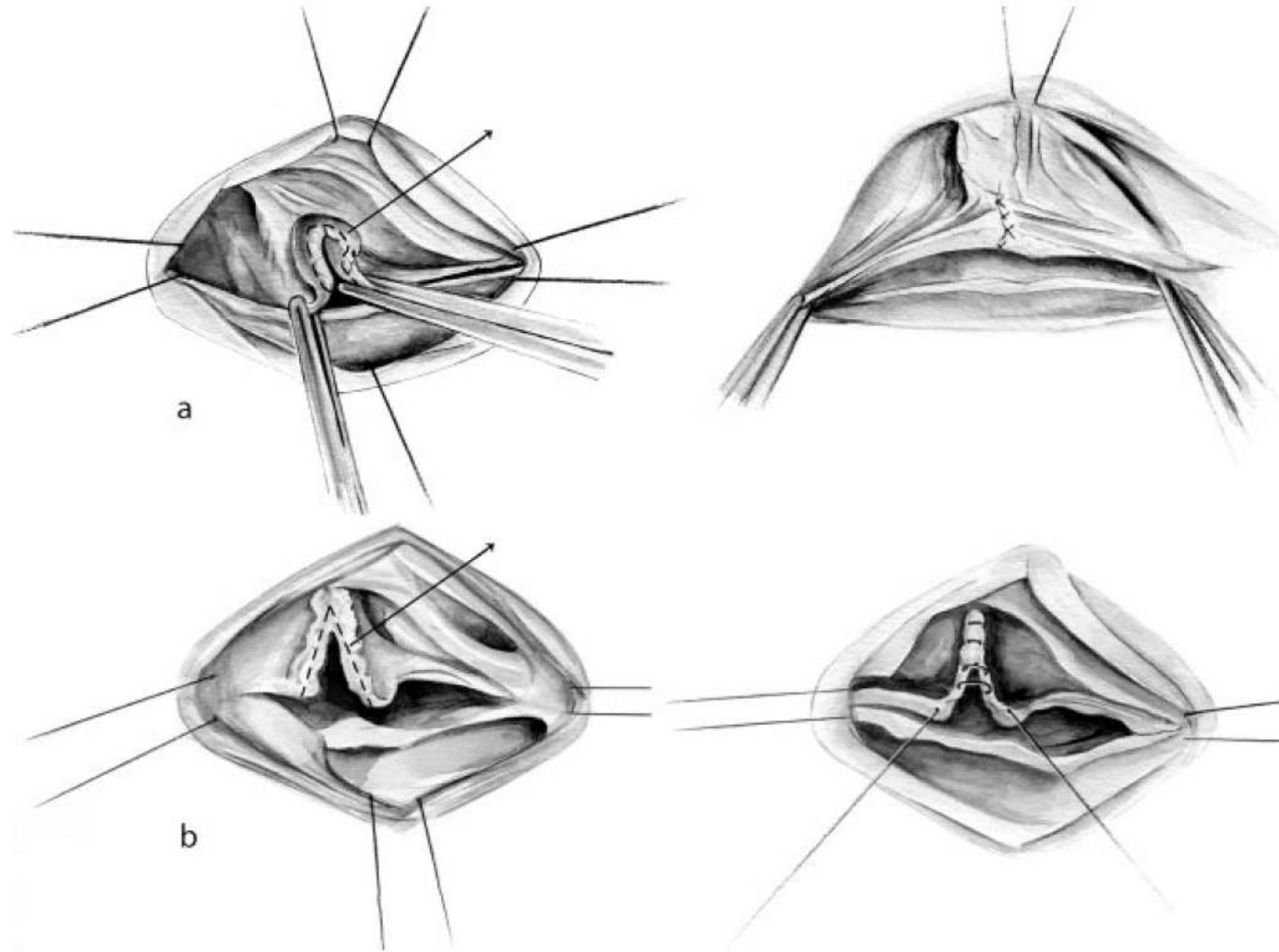
- Free margin reinforcement





# ***BAV-Repair Technique***

- Free margin shaving & suture



# Summary-MV

- MV prolapse
  - Post: triangular, quadrangular resection +/- sliding annuloplasty
  - Ant: artificial chordae
  - Commissural: plication, triangular resection
  - Others: chordae transfer, shortening, papillary m shortening, reimplantation, etc
- MV stenosis
  - Commissurotomy
  - 2ndary chordae resection, leaflet extension

# Summary-MV

- MV annuloplasty
  - Symmetric vs asymmetric
  - Rigid vs flexible
  - Complete vs partial
- Post-repair SAM
  - Medical: Volume loading, withdrawal of inotropes, slowing heart rate, increased afterload
  - Surgical: larger ring, sliding annuloplasty, anterior leaflet augmentation
- Alfieri: residual MR, bi-leaflet prolapse, etc

# Summary-TV

- Mostly functional TR
  - Anterior & posterior >> septal
- Ring annuloplasty >> suture annuloplasty
- Primary leaflet pathology:
  - similar with MV technique
- Edge-to-edge technique
  - Similar with MV Alfieri technique
- Pacemaker or defibrillator lead pathology

# Summary-AV

- Annuloplasty
- ST junction remodeling
- AV sparing root replacement
  - Root remodeling
  - Valve reimplantation
  - Using Valsalva grafts
- AR
  - Triangular resection, plication, patch closure, cusp extension, free margin reinforcement, etc
- Bicuspid AV: custom-made for each patients