

CONGENITAL MITRAL REPAIR

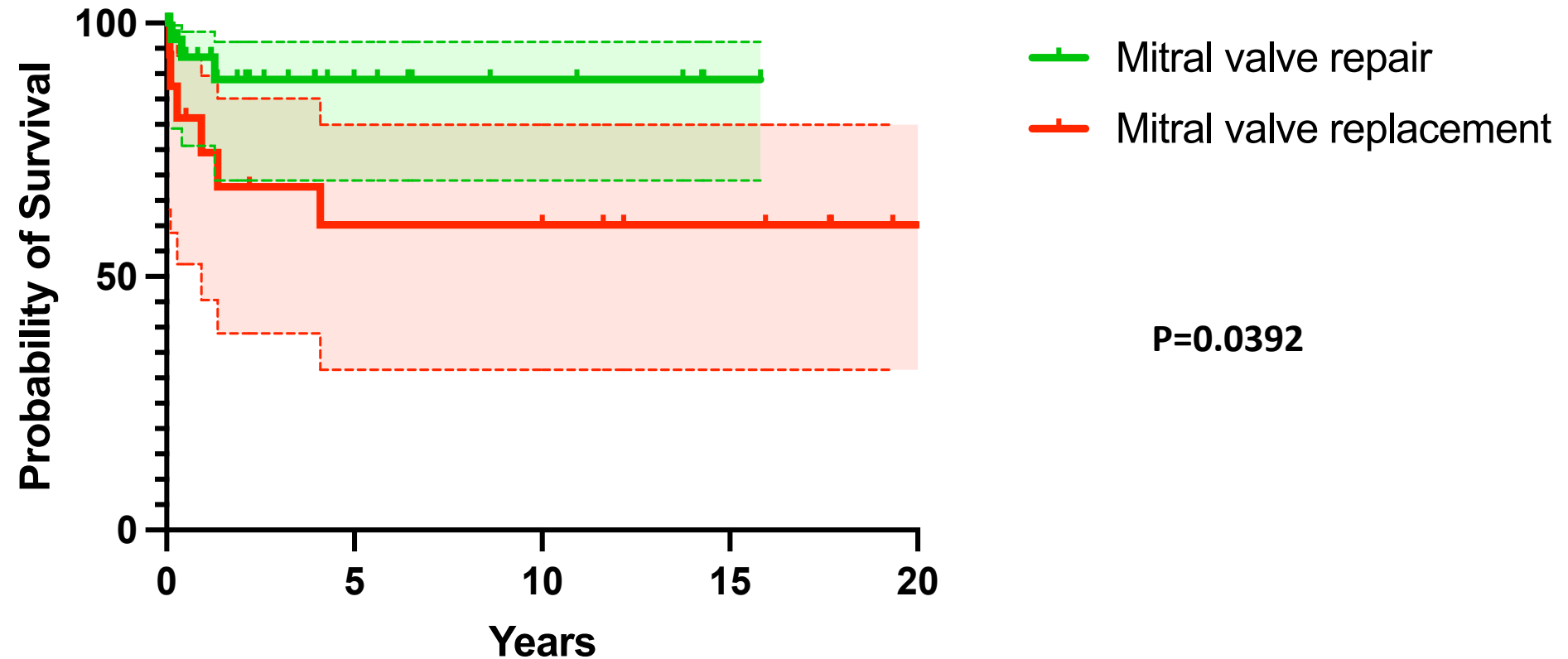
Olivier RAISKY
Paris

UTRECHT, FEB 2026

Mitral Valve Replacement Pediatric Population

- Patient-prosthesis mismatch
- LVOT obstruction
- AV-block
- Pacemaker insertion
- LV-dysfunction
- Heart failure
- Dismal long-term prognosis

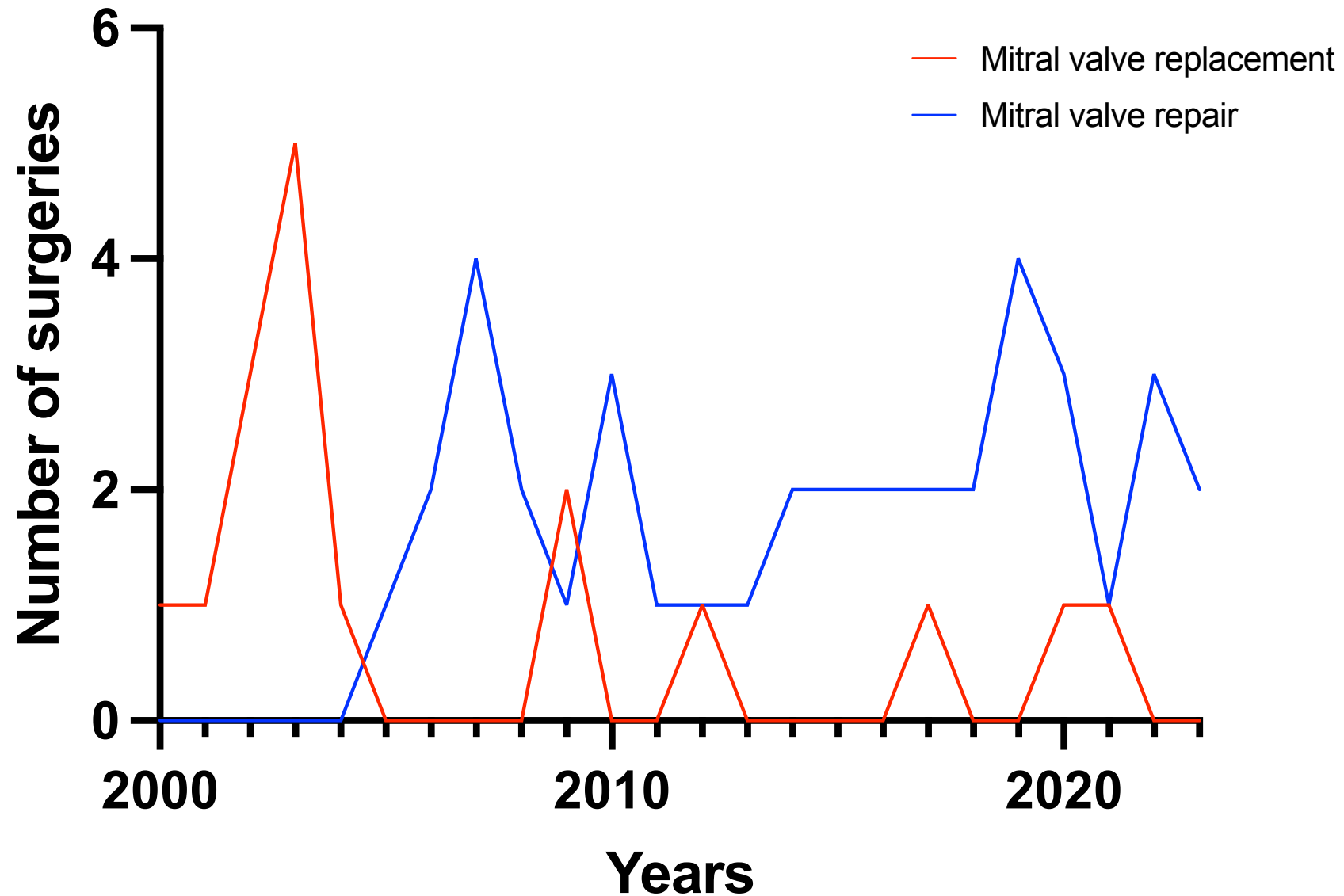
Overall survival



At risk

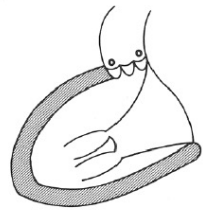
Repair	39	11	6	1	-
Replacement	16	9	8	6	2

Limits and evolution of the practice



CLASSIFICATIONS

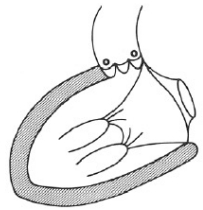
Ruckman and Van Praagh



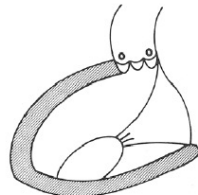
1. Typical Congenital MS



2. Hypoplastic MS



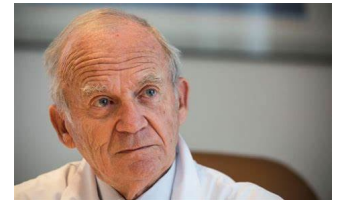
3. Supramitral Ring



4. Parachute Mitral Valve

Classification Carpentier

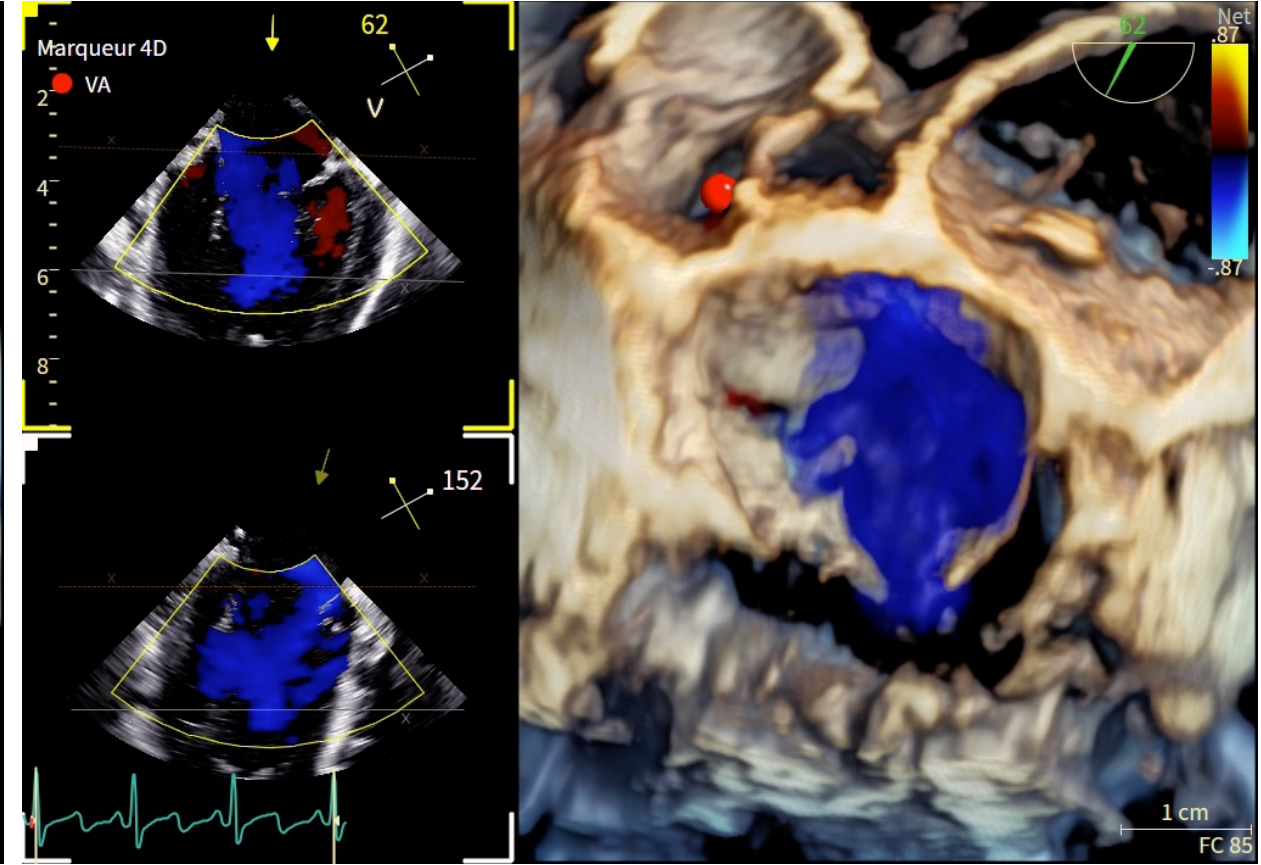
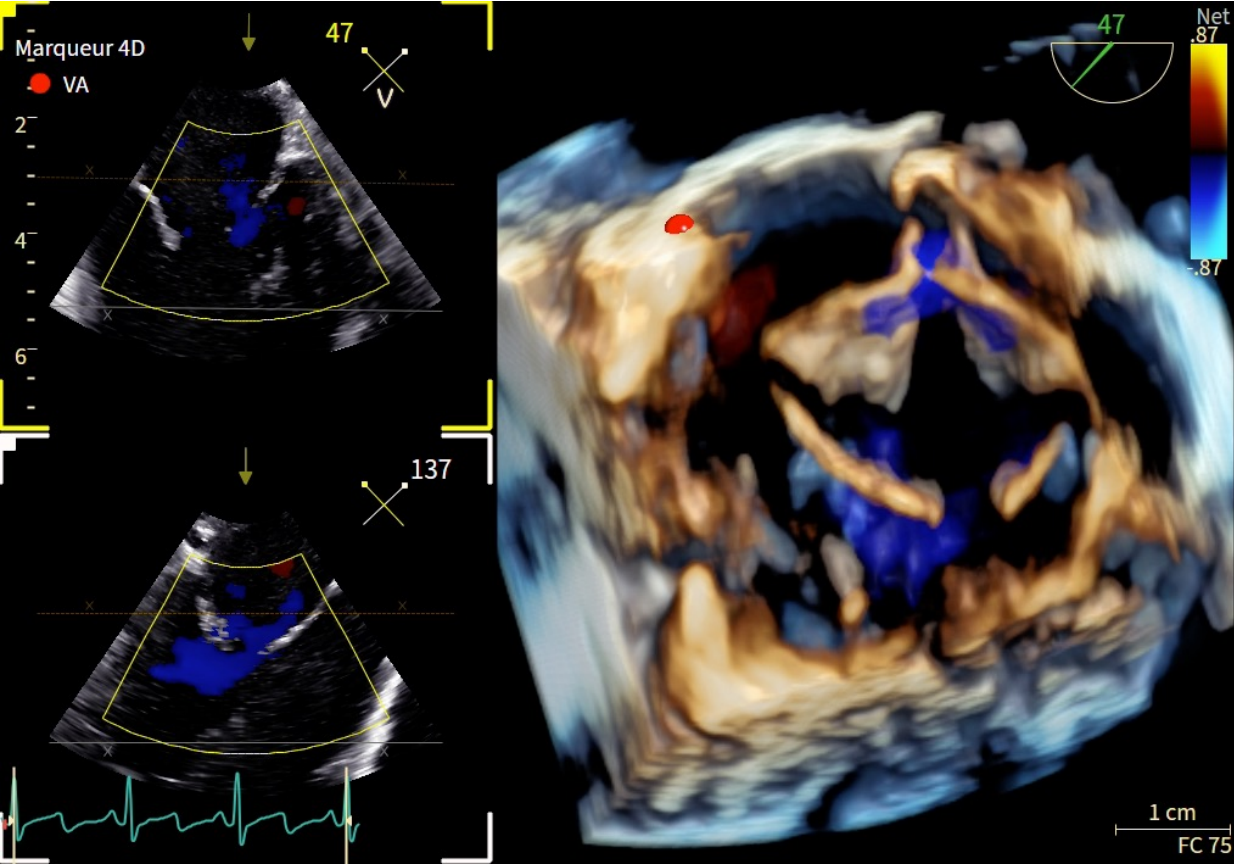
- **TYPE A : Normal papillary muscle**
 - *Fusion commissure/papillary muscle*
 - *Supra Mitral ring*
 - *Leaflet fusion (intra-leaflet ring)*
 - *Hypoplastic annulus*
- **TYPE B : Abnormal papillary muscle**
 - *Parachute*
 - *Hammock*



« SURGERY STARTS AT THE TIME OF ECHO »

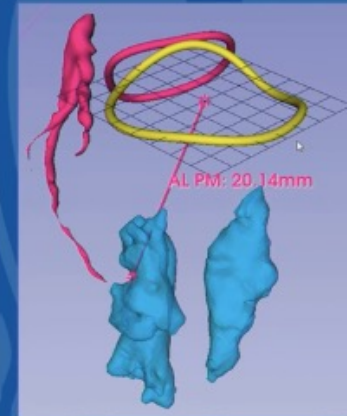
- FONCTIONNAL ANALYSIS
- SEGMENTAL ANALYSIS of the Anatomy of Mitrale Valve

1. SUPRA MITRAL zone: Left SVC, Cortriatriatum, supra mitral ring, intramitral ring
2. ANNULAR ZONE: Z-score
3. LEAFLET LEVEL: quality and commissures
4. SUB VALVULAR LEVEL: cordae and papillary muscles



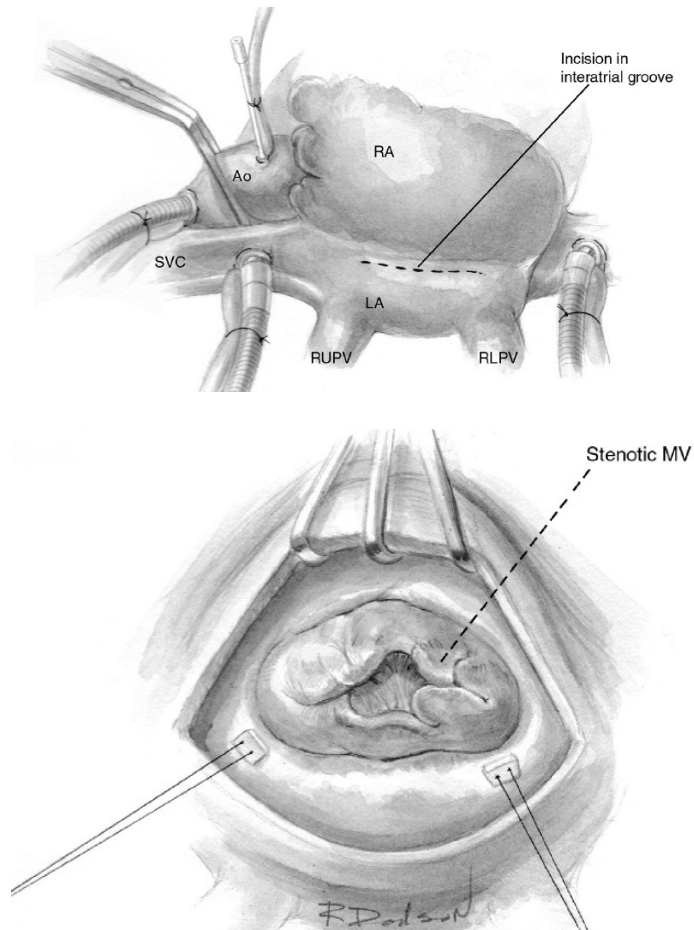
Preoperative imaging

- Component analysis (annulus, leaflet, subvalvular)
- Location of prolapsing segments (combination of long and short axis views)
- Relative prolapse vs. True prolapse
- Make measurements from preop imaging
- Use of 3D modeling for surgical planning



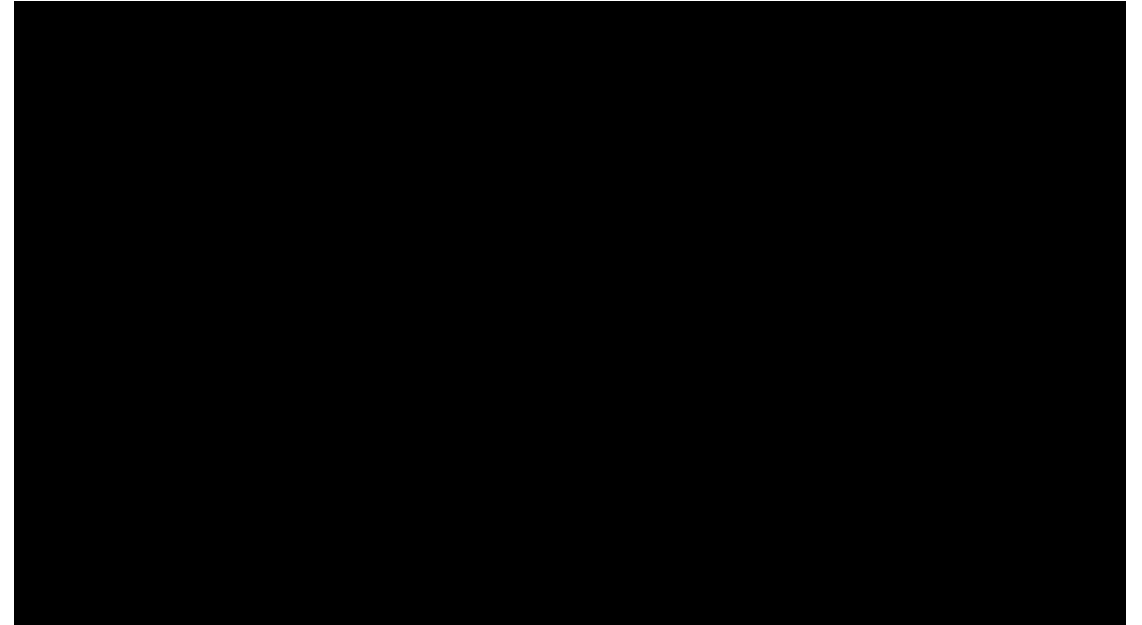
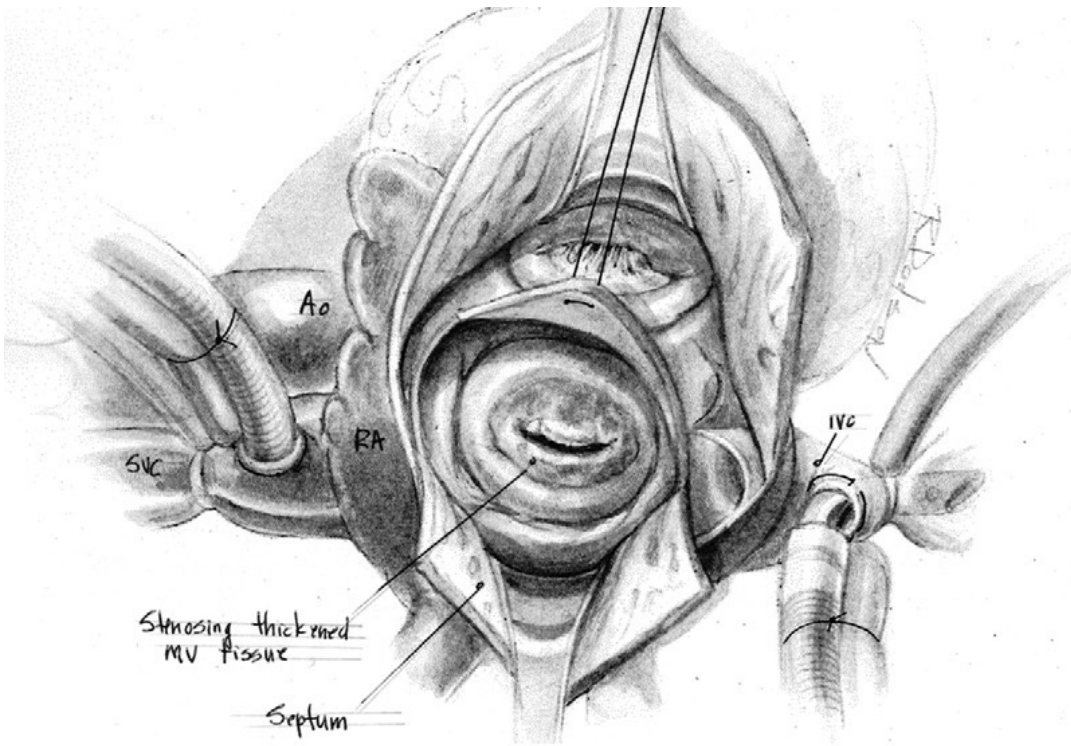
IDEAL SURGICAL APPROACH

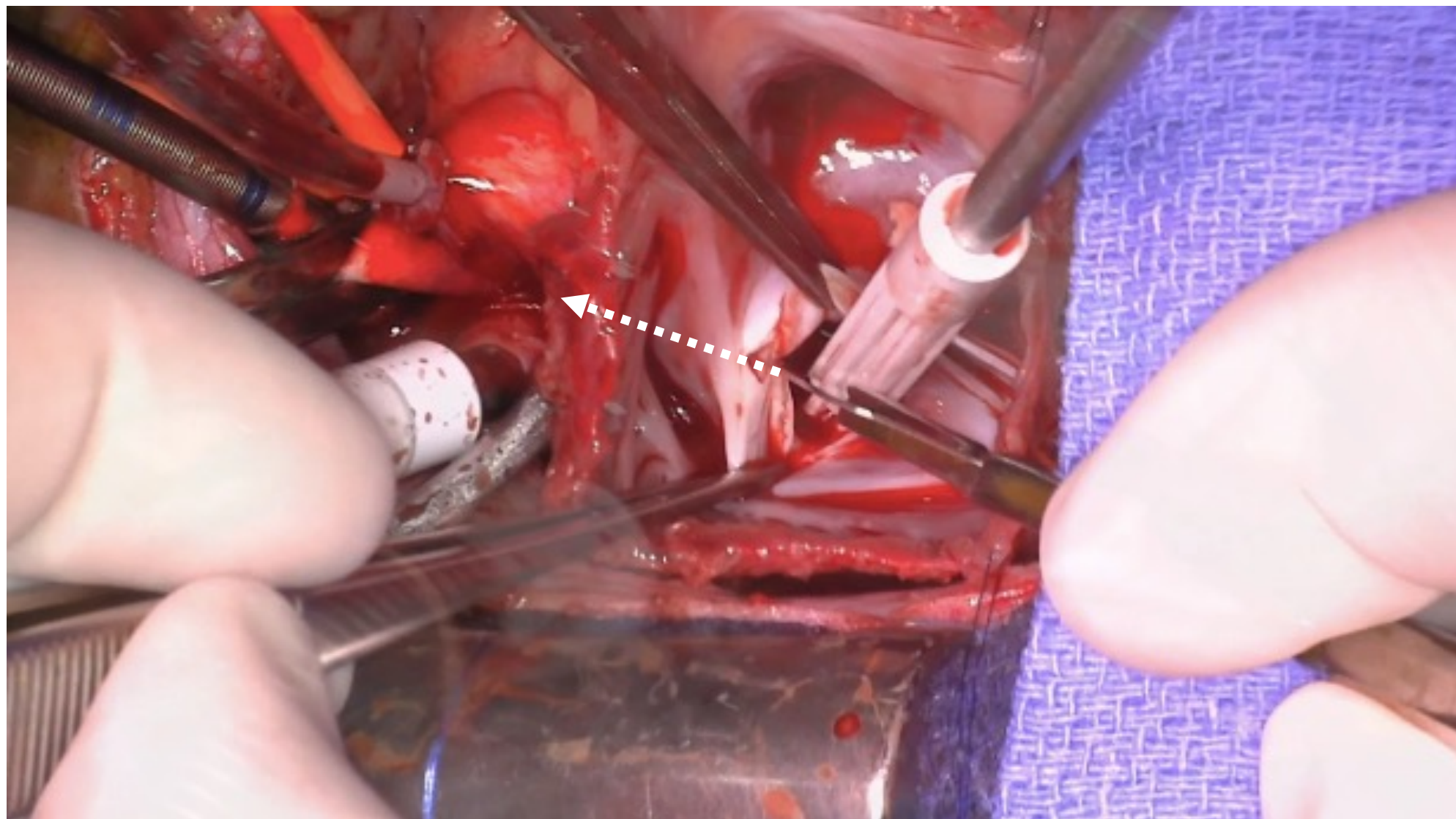
- INTER ATRIAL GROOVE



IDEAL SURGICAL APPROACH

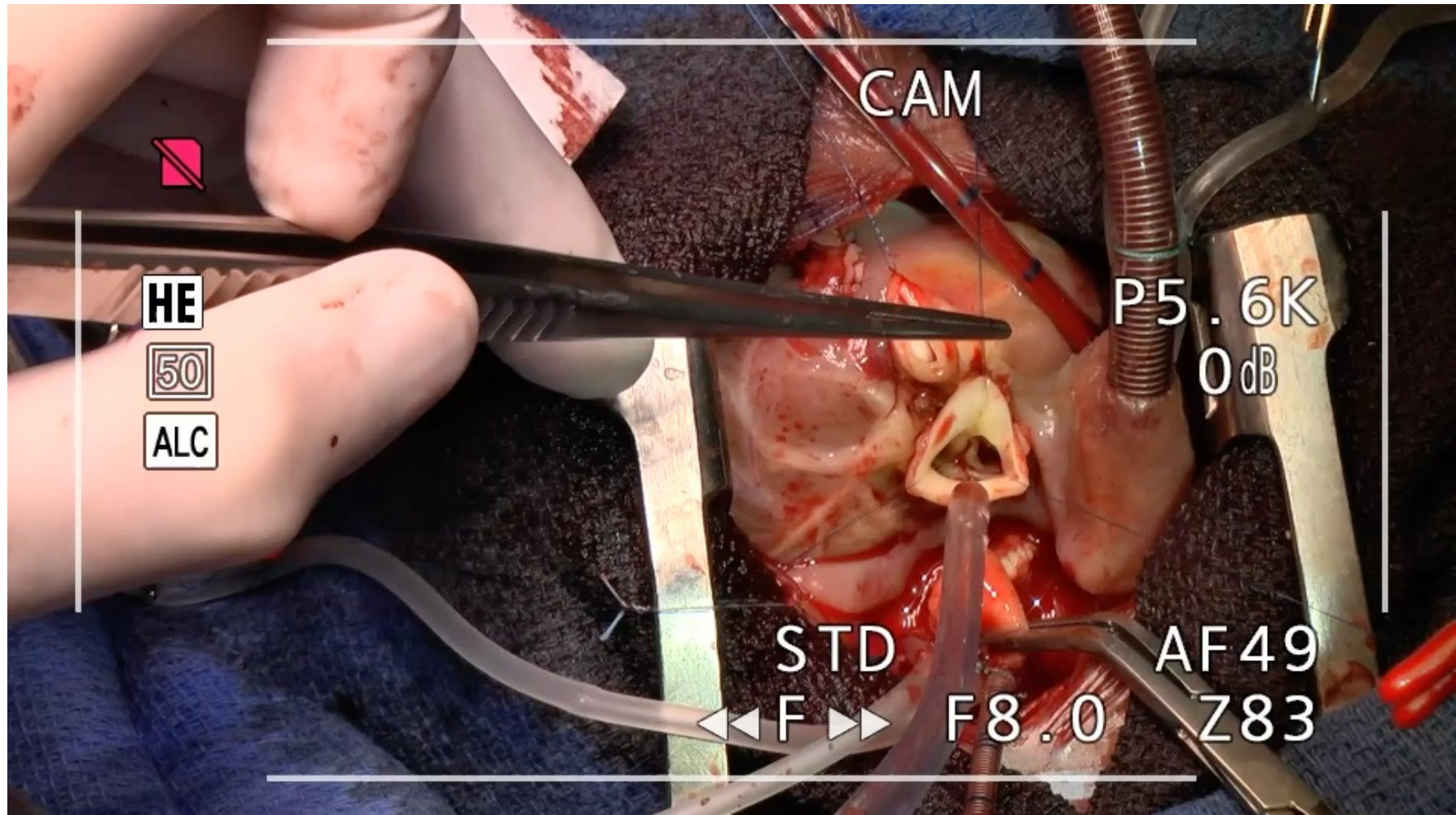
- TRANS SEPTAL
/EXTENDED





IDEAL SURGICAL APPROACH

- FROM THE LA ROOF TOP (TRANSPOSITION)



STEP BY STEP SURGICAL APPROACH

1. **SUPRA MITRAL ZONE:** VCSG, Cortriatriatum, supra mitral ring, intramitral ring
2. **ANNULAR ZONE:** Z-score
3. **LEAFLETS:** tissue quality and quantity, commissures
4. **SUBVALVULAR APPARATUS:** cordae and papillary muscles

ASSOCIATED LESIONS

Congenital Mitral Stenosis With or Without Associated Defects

An Evolving Surgical Strategy

Alain Serraf, MD; Joy Zoghbi, MD; Emré Belli, MD; François Lacour-Gayet, MD; Hakim Azr Lucile Houyel, MD; Virginie Lambert, MD; Dominique Piot, MD; Claude Planché, MD

(*Circulation*. 2000;102[suppl III]:III-166-III-171.)

Lesions Associated With CMS

Associated Lesions	n	%
Coarctation	32	44
VSD	28	39
Aortic stenosis	23	32
Subaortic stenosis	23	32
Multilevel LV obstruction	41	57
Shone's syndrome	25	35
"Small"* LV	17	24

Pediatric Cardiology

Current Management of Severe Congenital Mitral Stenosis Outcomes of Transcatheter and Surgical Therapy in 108 Infants and Children

Doff B. McElhinney, MD; Megan C. Sherwood, MBBS, FRACP; John F. Keane, MD; Pedro J. del Nido, MD; Christopher S.D. Almond, MD, MPH; James E. Lock, MD

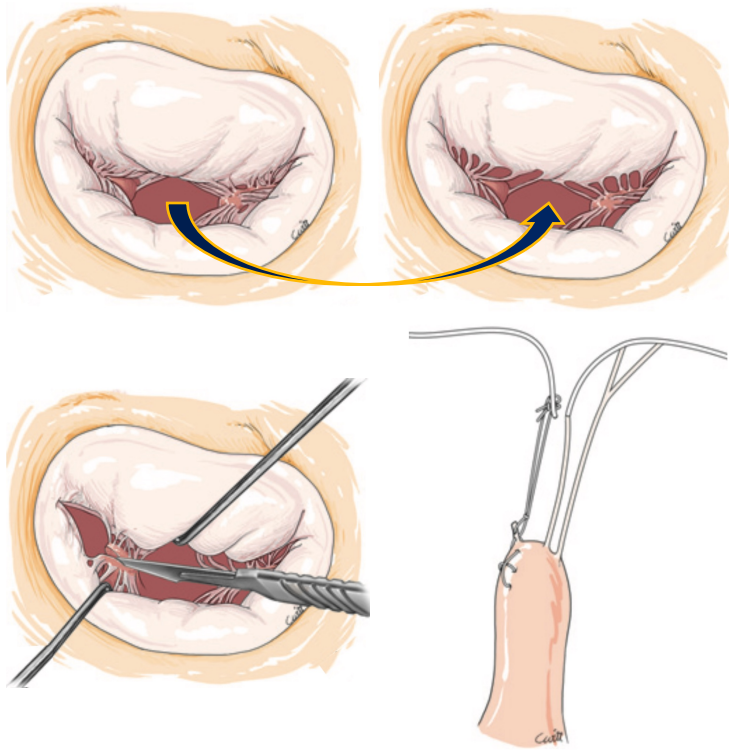
- Additional cardiovascular defects 86% of patients (n=93)
- Additional left heart anomalies were present in 76% (n=82).
- VSD was present in 38 patients (35%)

A standardized repair strategy

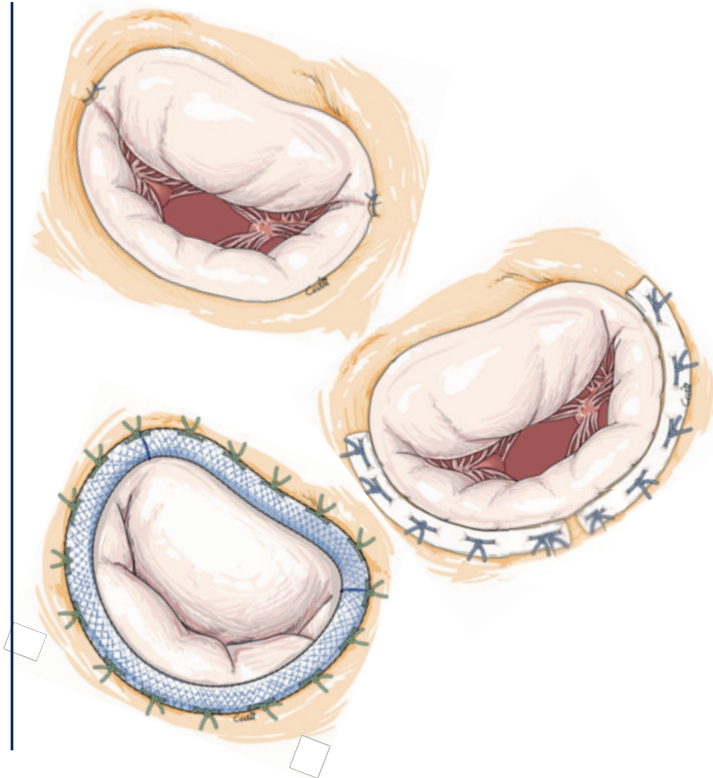


Kalfa D. *et al* J Thorac Cardiovasc Surg. 2014 Oct;148(4):1459-66

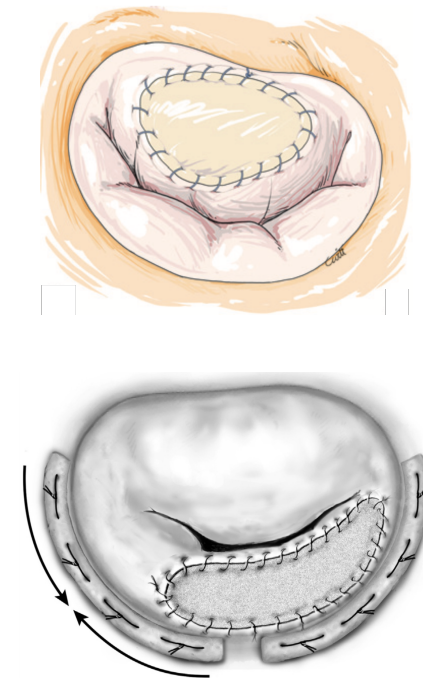
STEP A



STEP B



STEP C

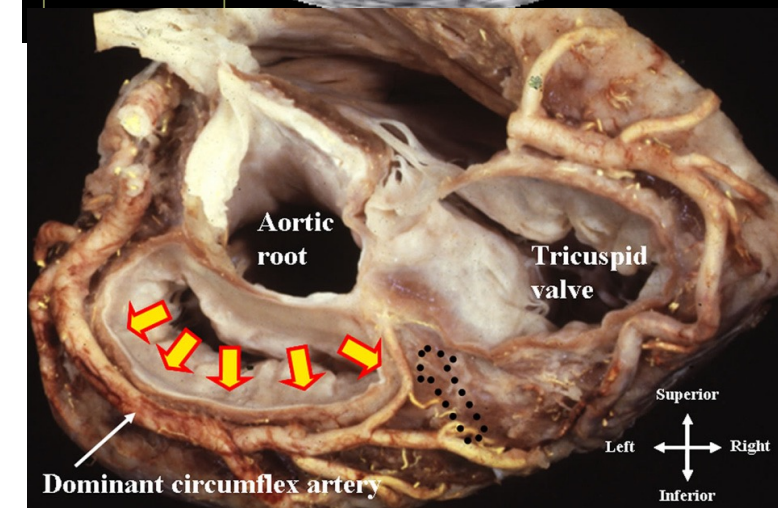
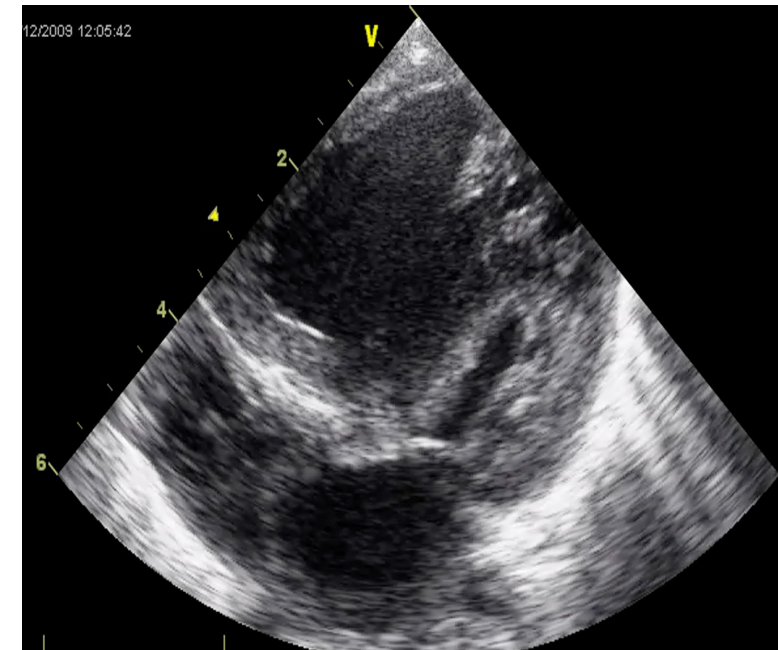
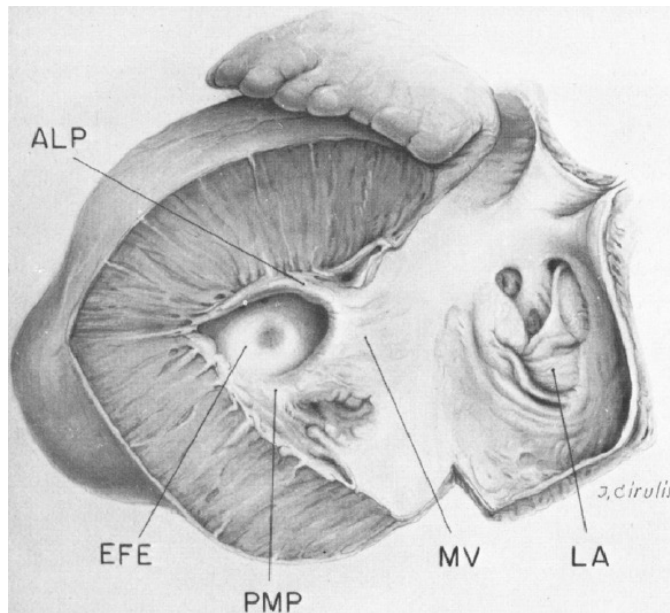


ANNULUS HYPOPLASIA

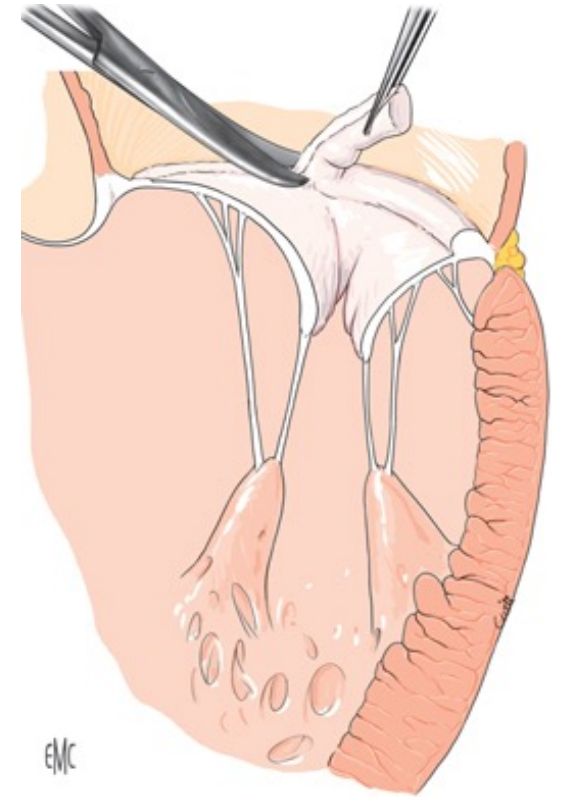
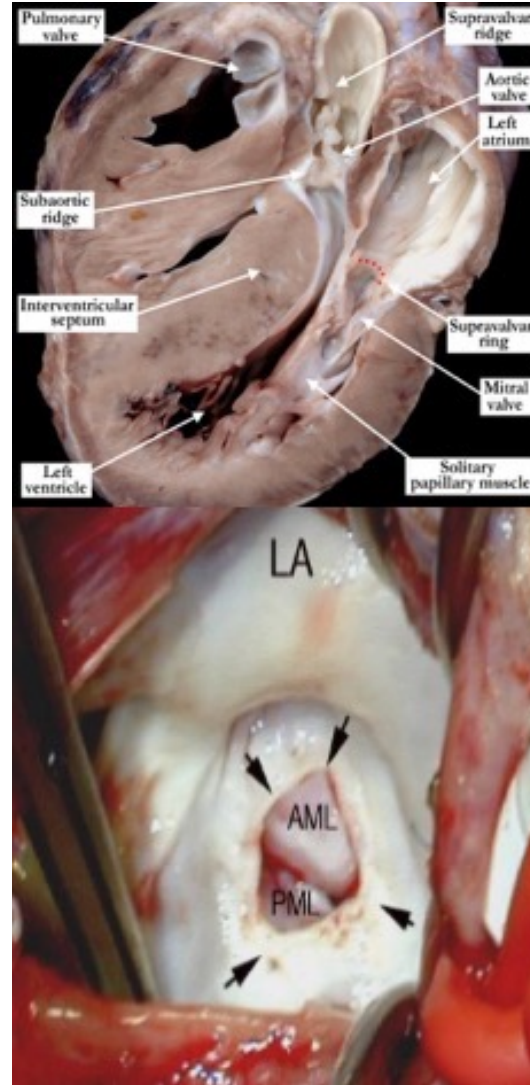
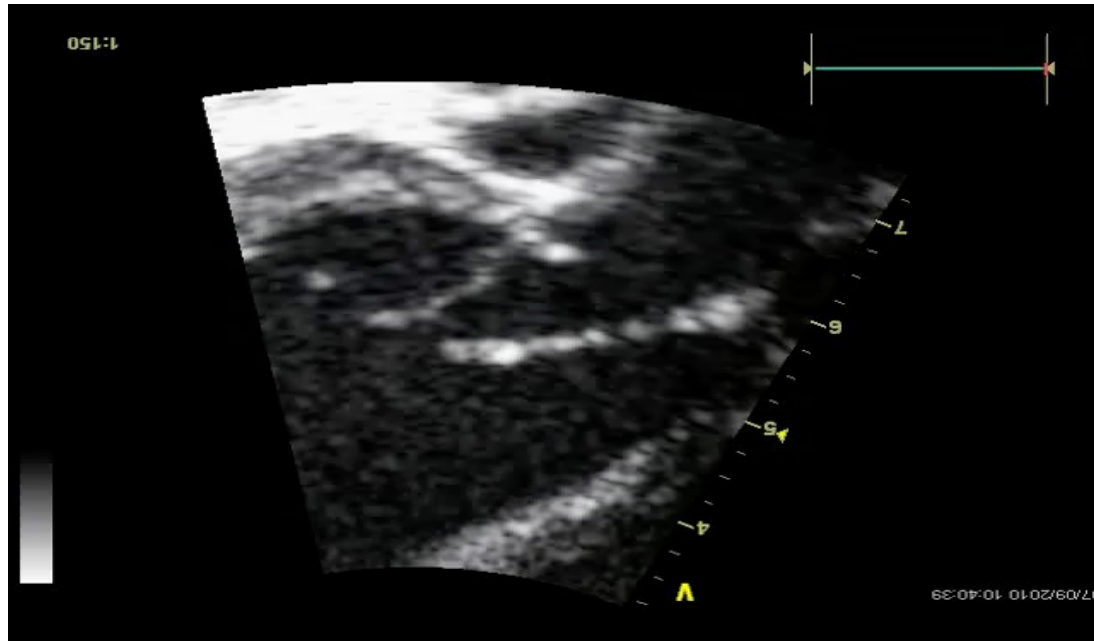
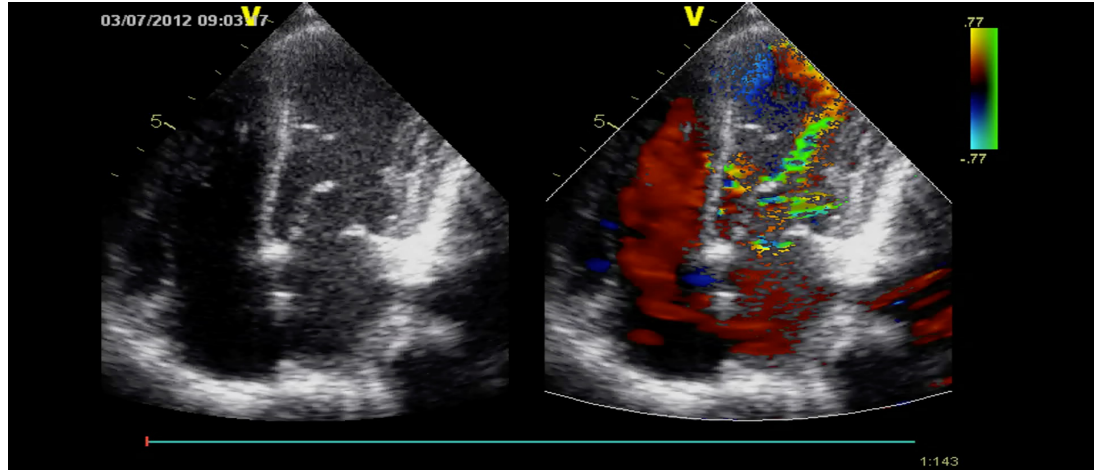


2. Hypoplastic MS

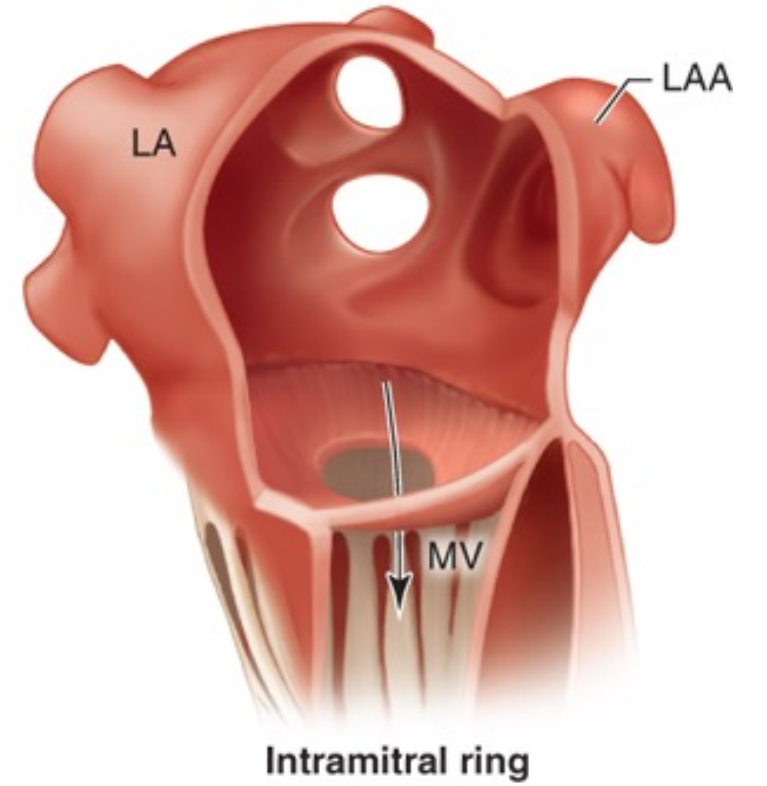
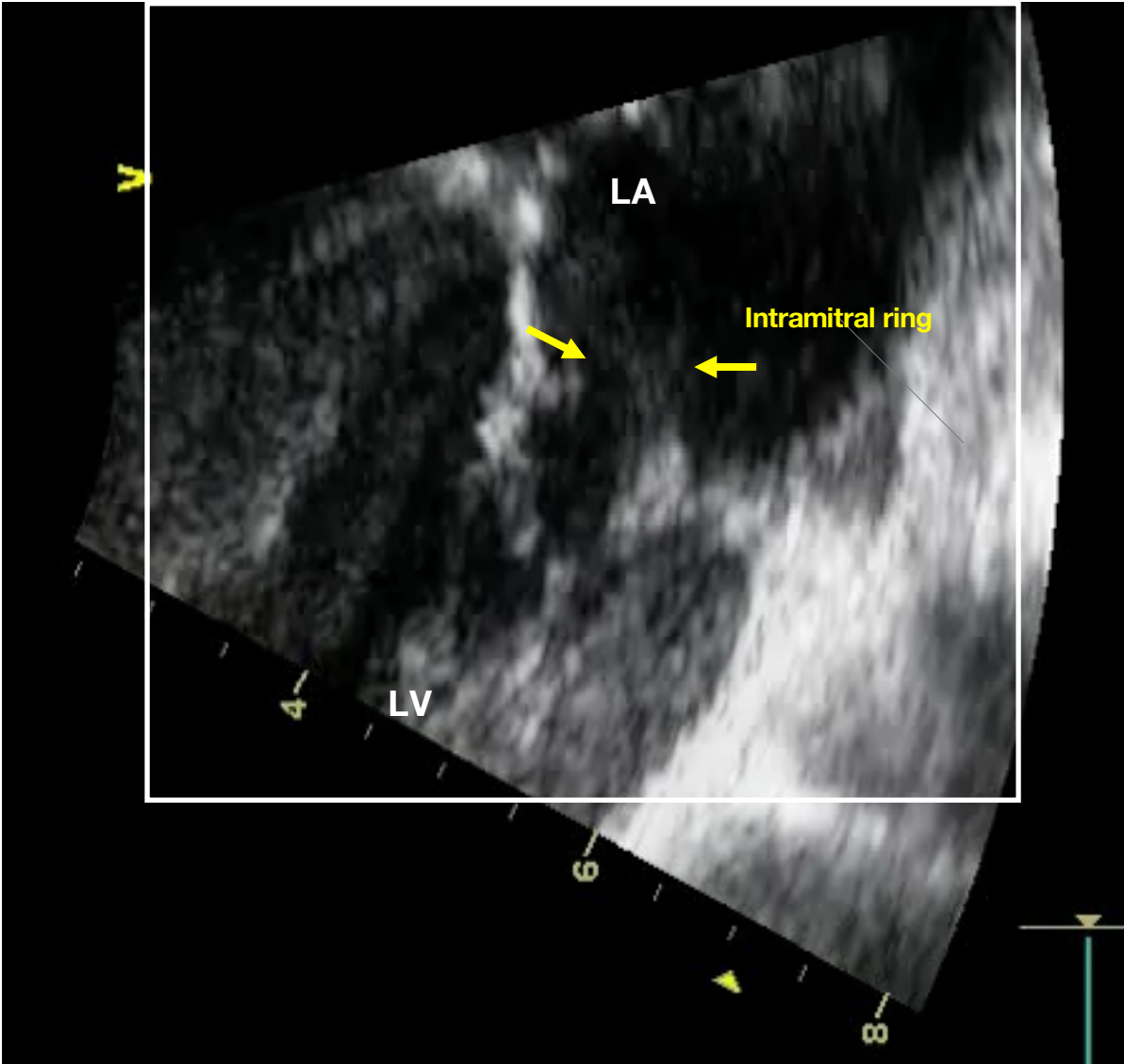
- Small LV
- Fibro-élastosis
- Sub valvular anomalies
- Associated lesions: aortic stenosis / coarctation



Supra-mitral ring/ Intra leaflet ring



Intramitral ring



Mitral hypoplasia and commissural fusion

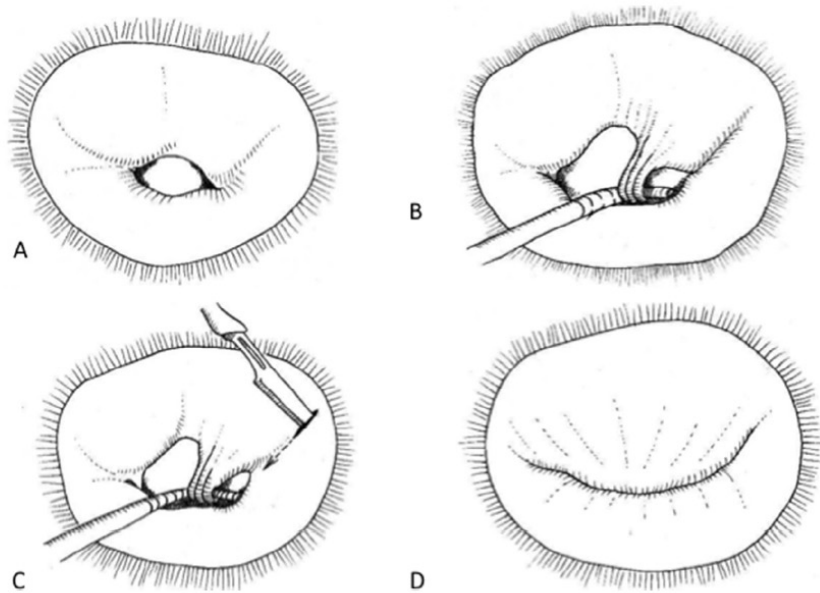
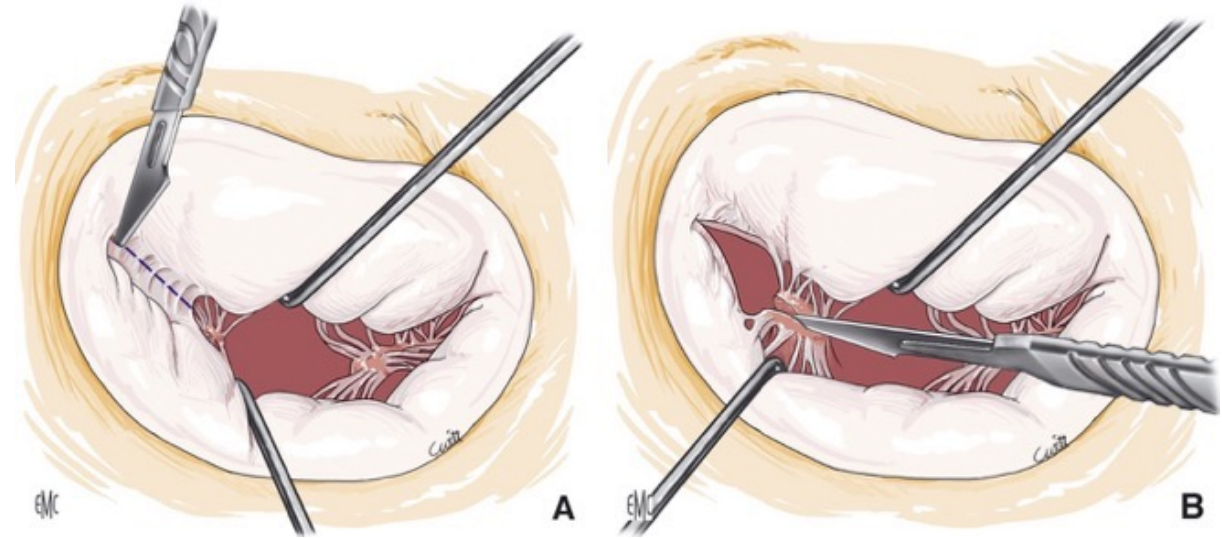
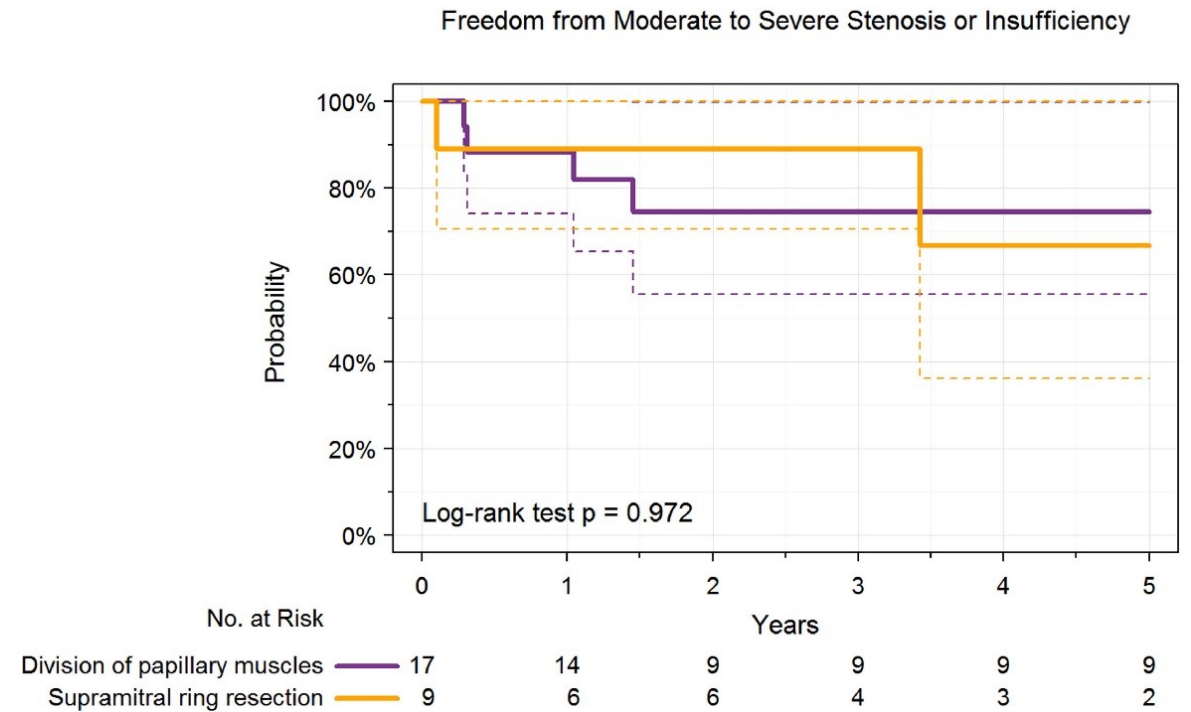
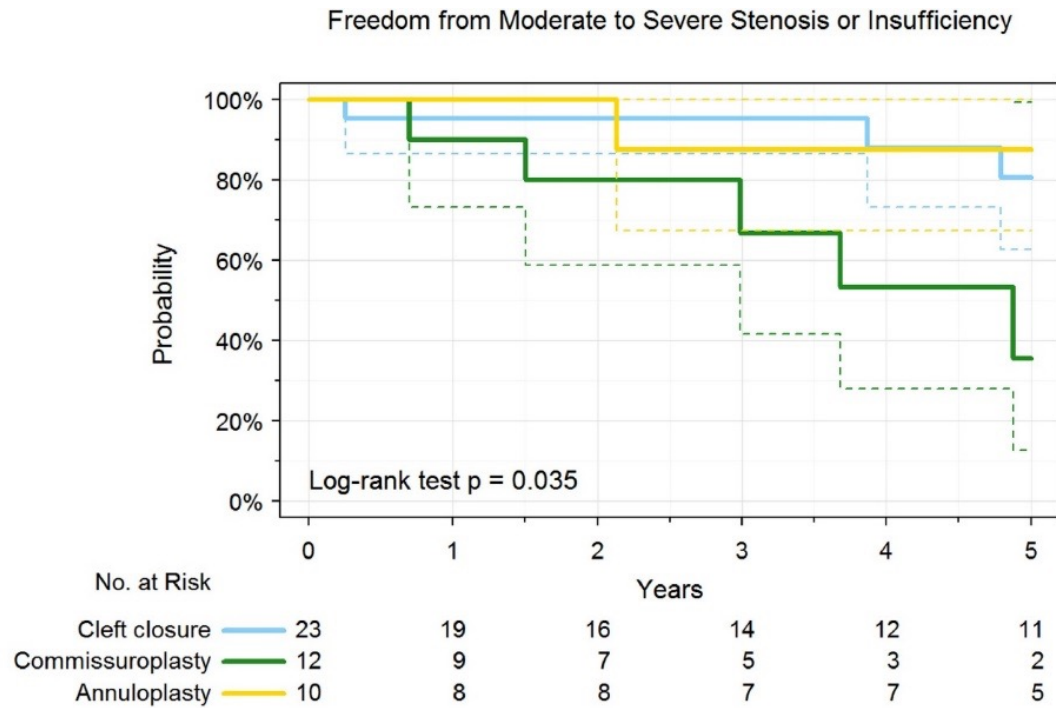


Figure 6 Type II congenital mitral stenosis. (A) Hypoplastic mitral valve with minute orifice. (B) Commissural incision starting from the papillary muscle. (C) Commissurotomy. (D) After repair.



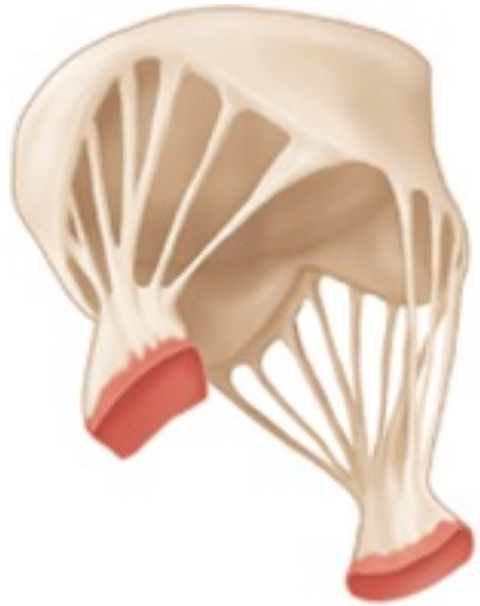
SURGICAL RESULTS

Type of repair



Isaacson E, Lucjak C, Johnson WK, et al. Mitral valve surgery in neonates, infants, and children: surgical approach, outcomes, and predictors. *Sem Thorac Cardiovasc Surg* 2020;32: 541-550

TYPICAL CONGENITAL MITRALE STENOSIS/ARCADE



Normal



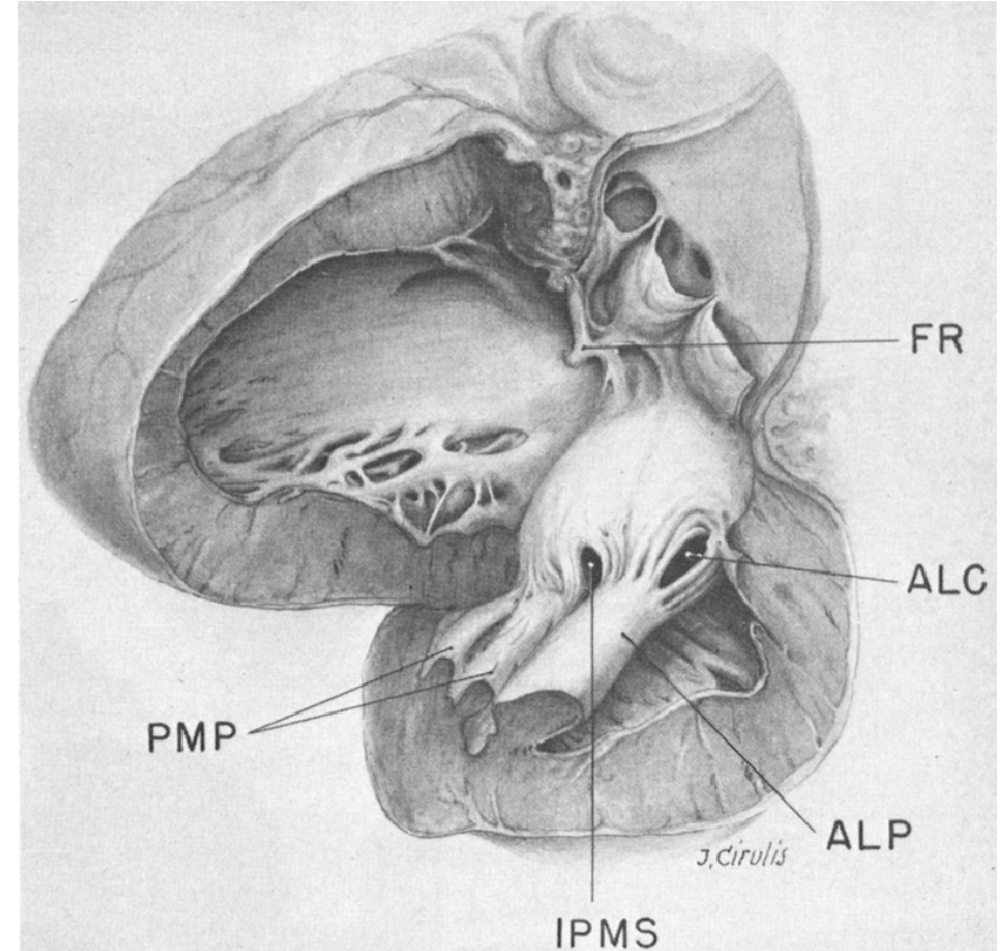
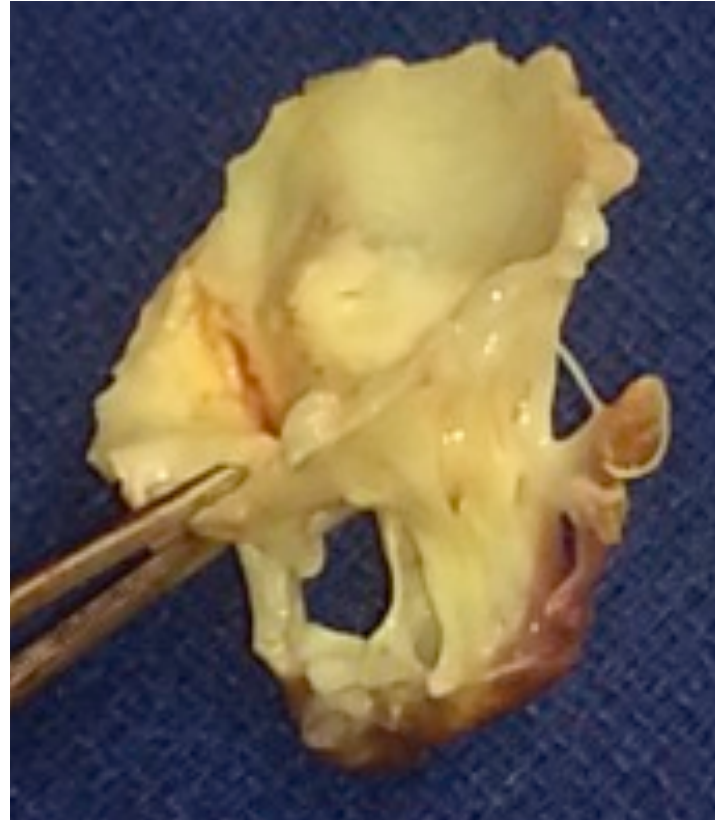
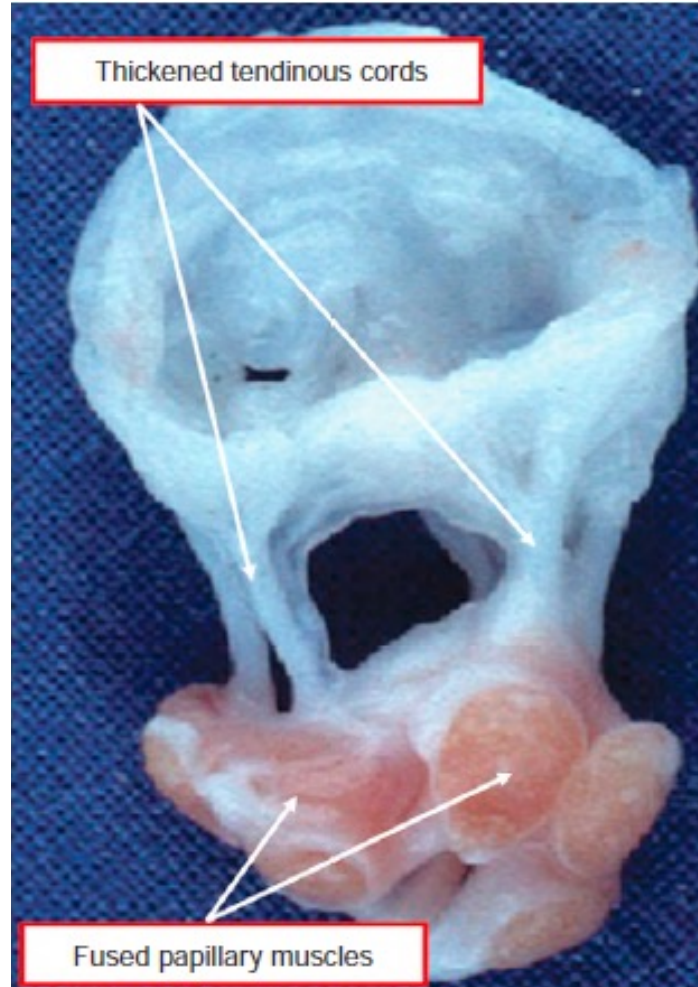
"Typical"



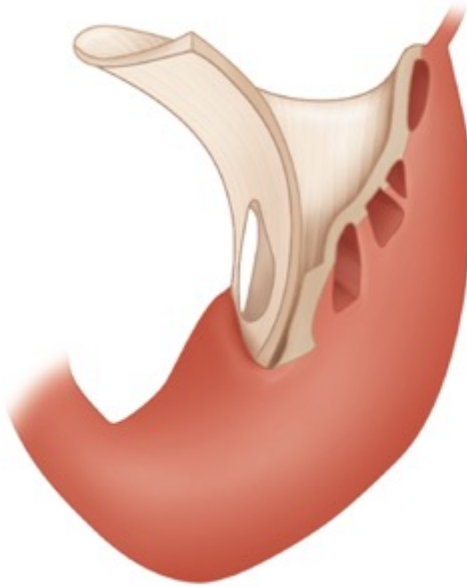
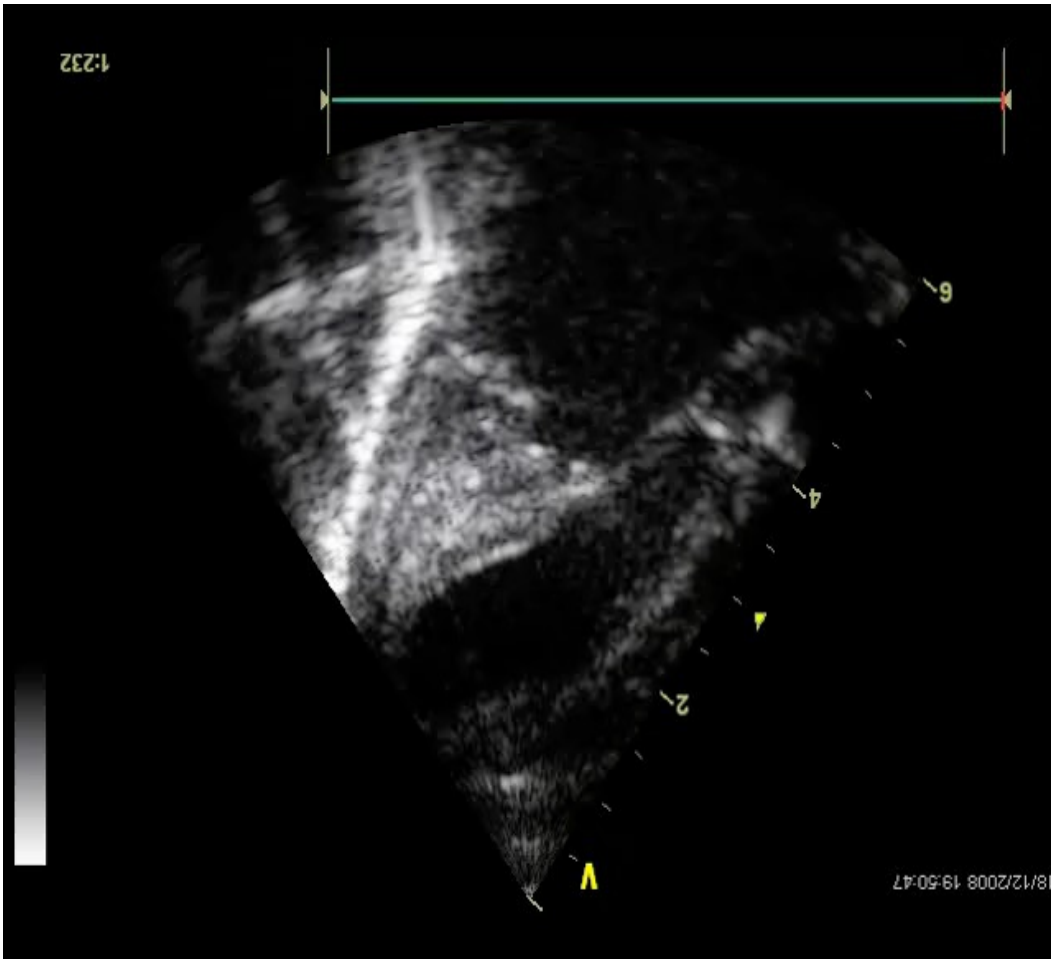
Parachute



ARCADE/TYPICAL MITRAL STENOSIS

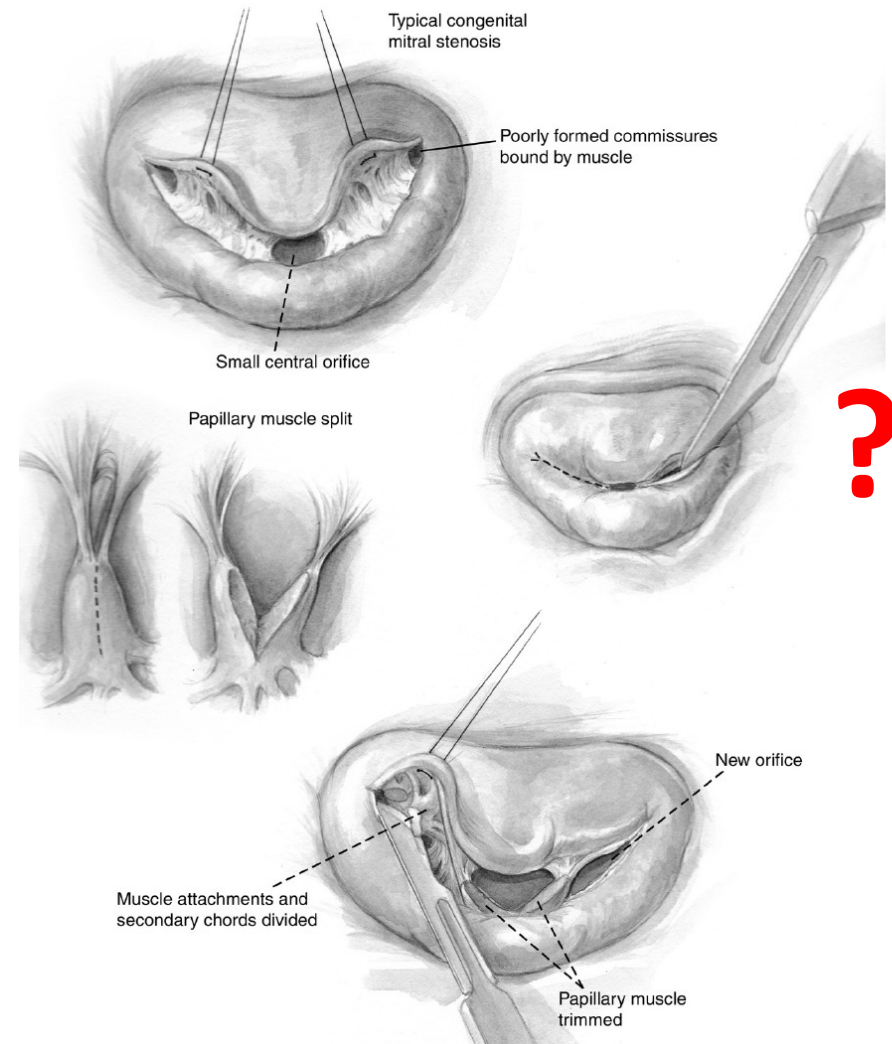


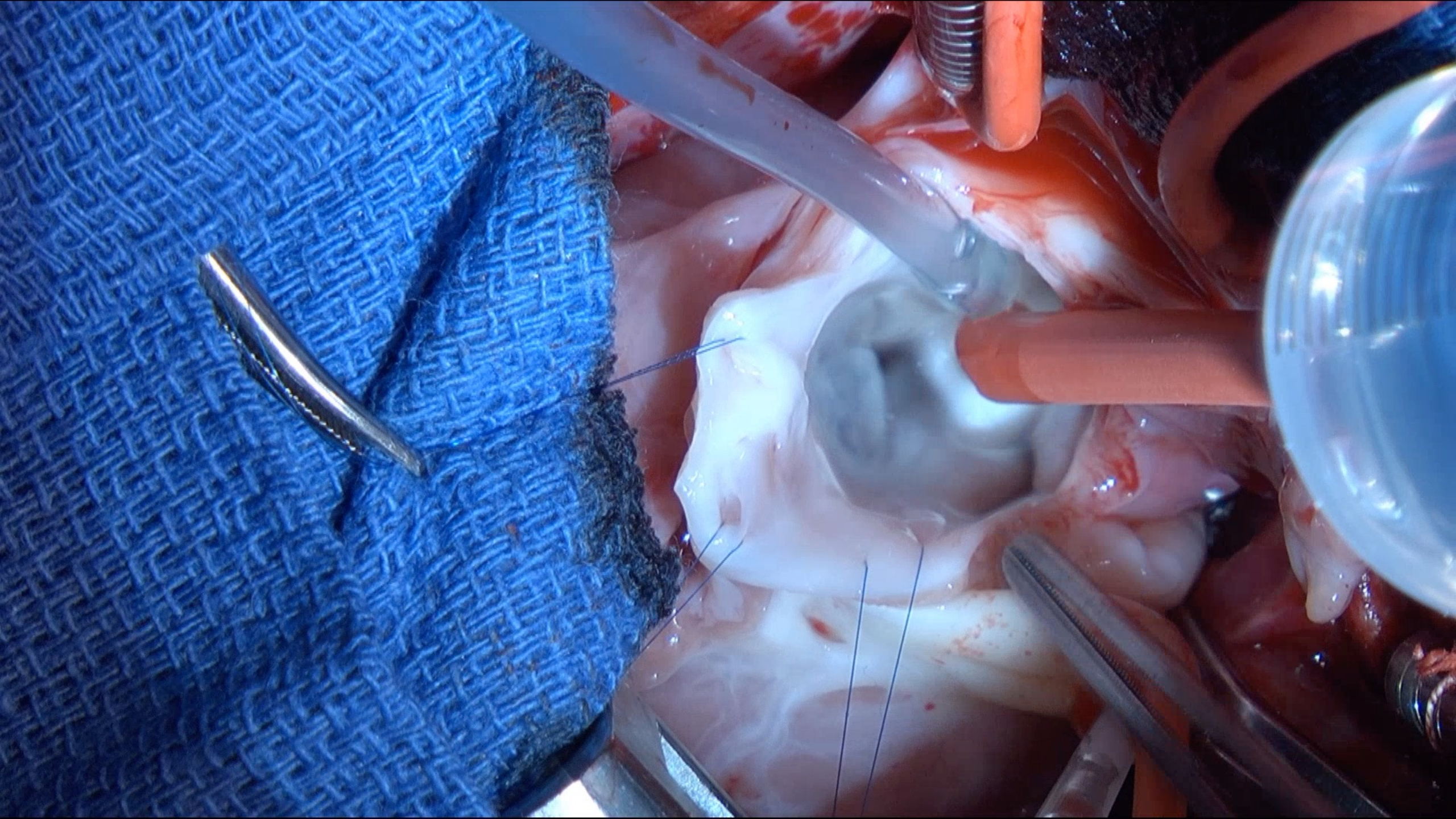
Hammock and Arcade valve



Commissure Fusion/Short Chordae

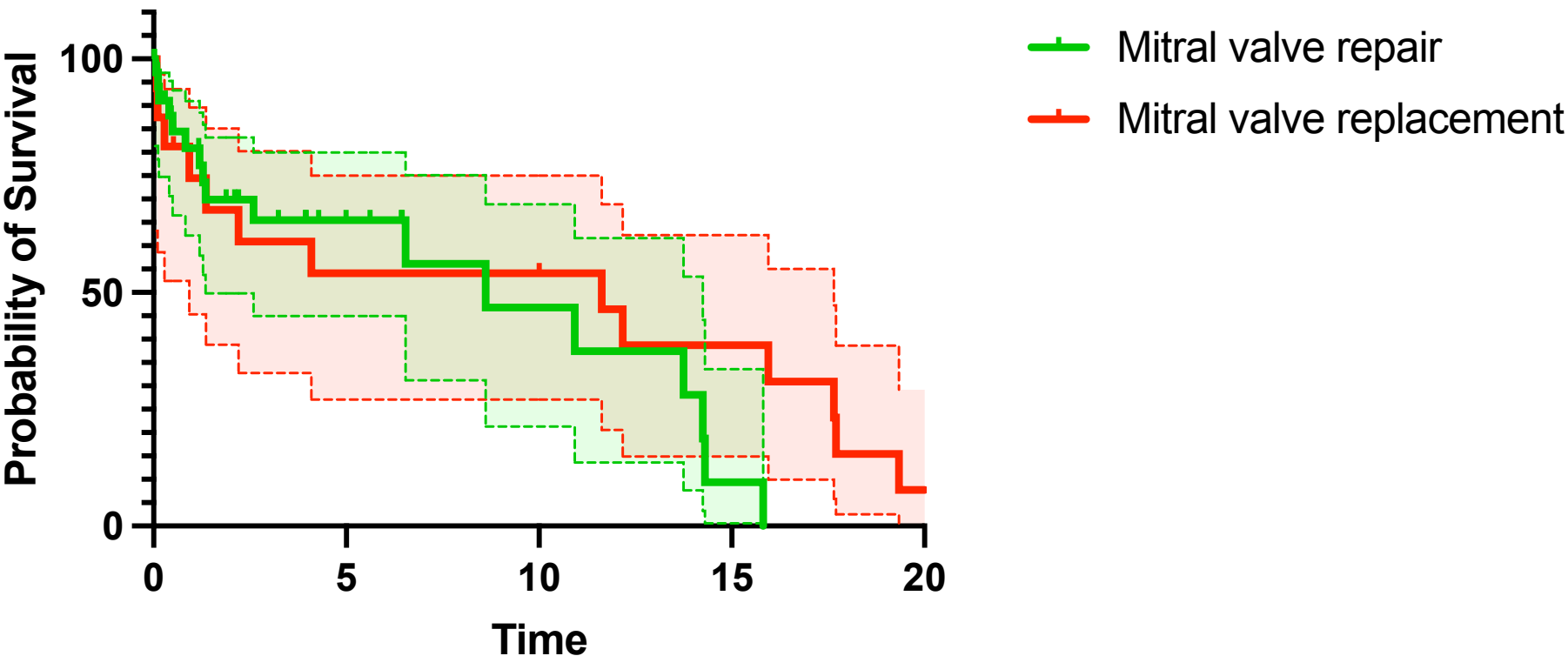
1. mobilization and longitudinal incision of the postero and antero lateral papillary muscles
2. Division of the secondary cordae of the posterior leaflet
3. Patch enlargement of the anterior or posterior leaflet
4. Annular stabilization with an open posterior « ring »





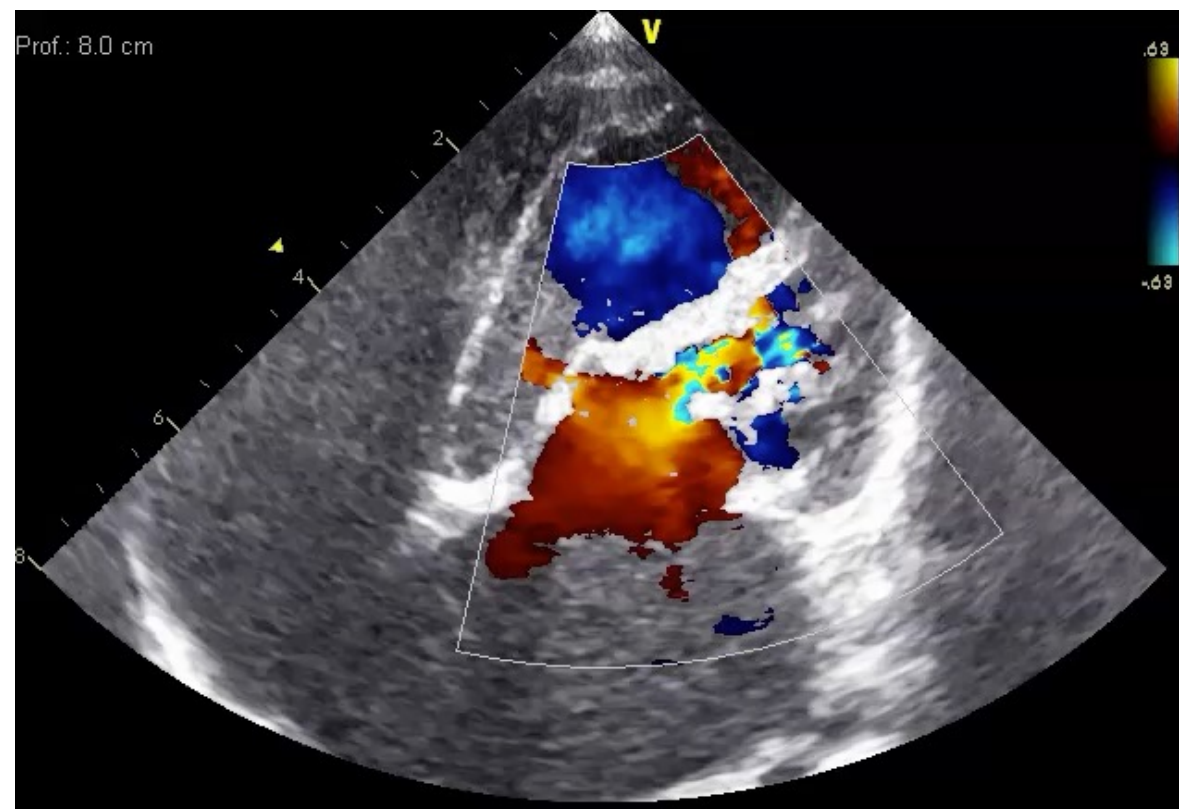
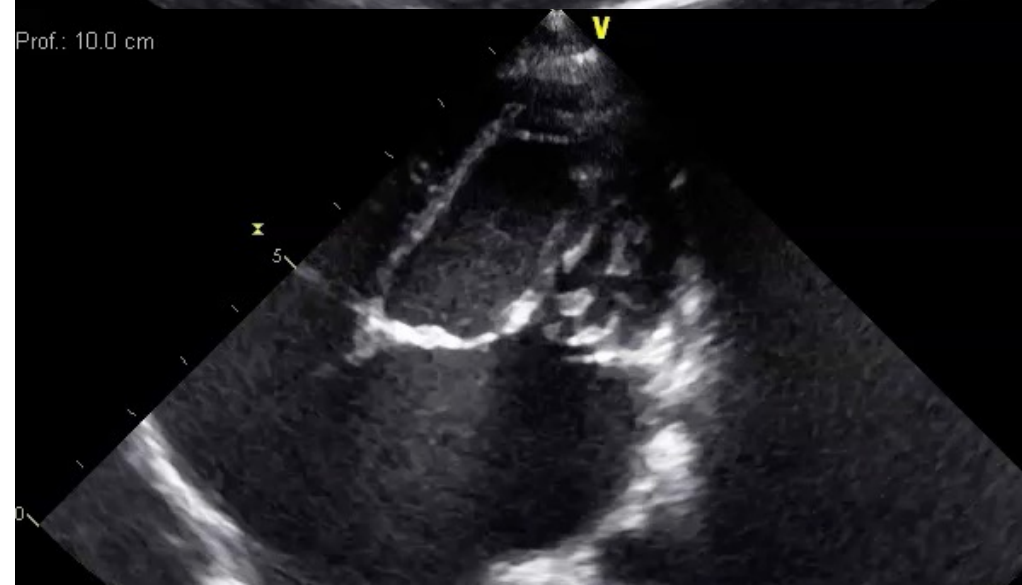
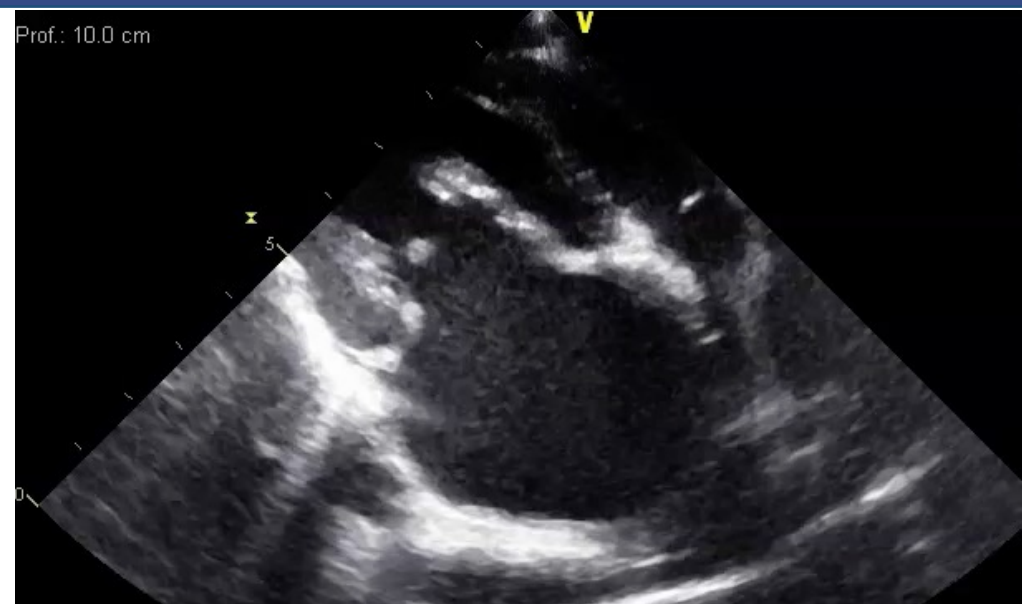
Survival without reintervention

Re intervention free survival



At risk

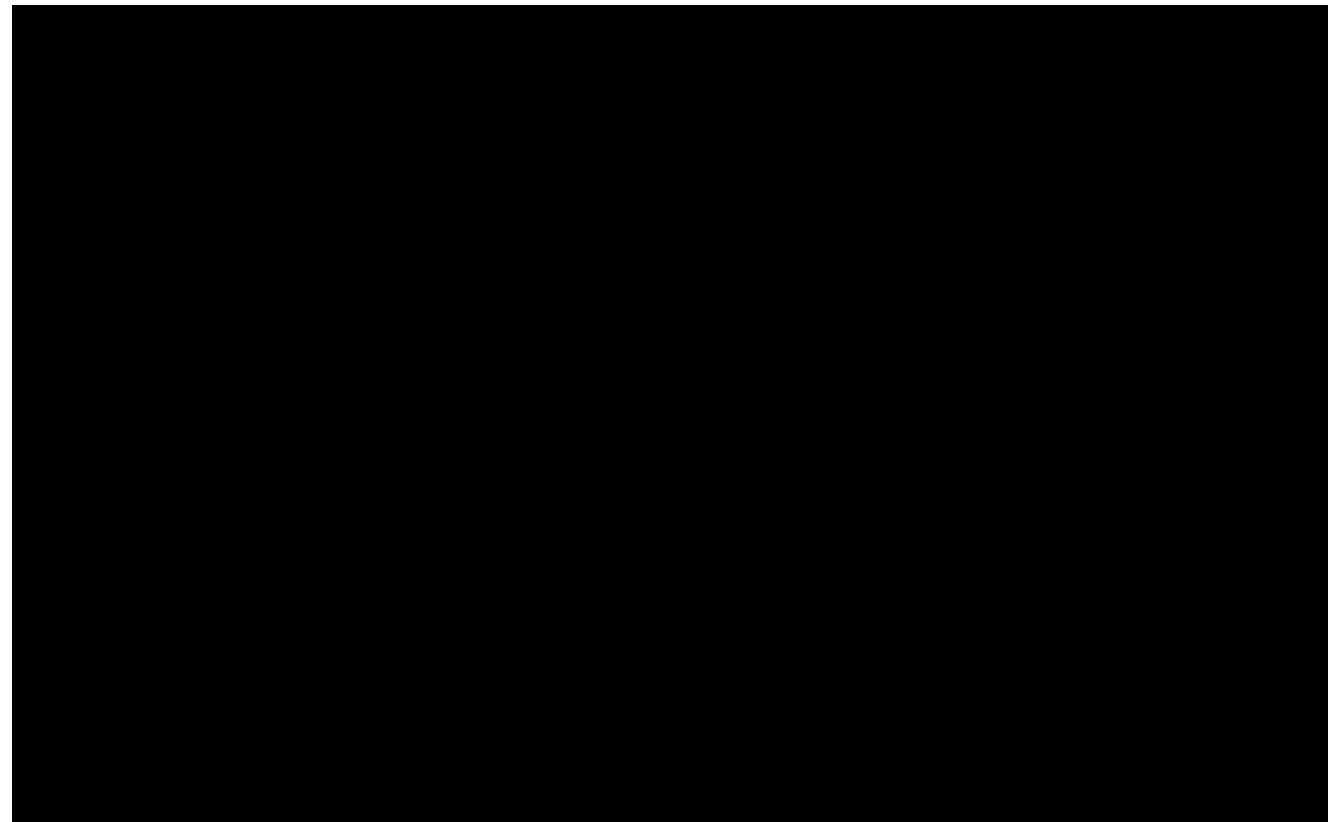
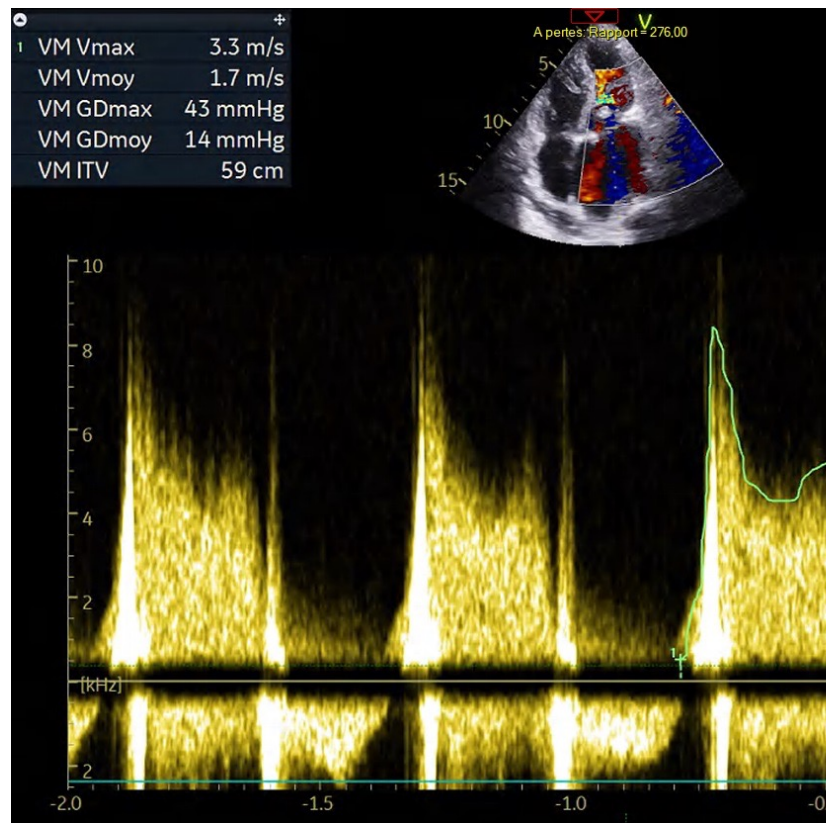
Repair	39	11	5	2	-
Replacement	16	8	8	5	1



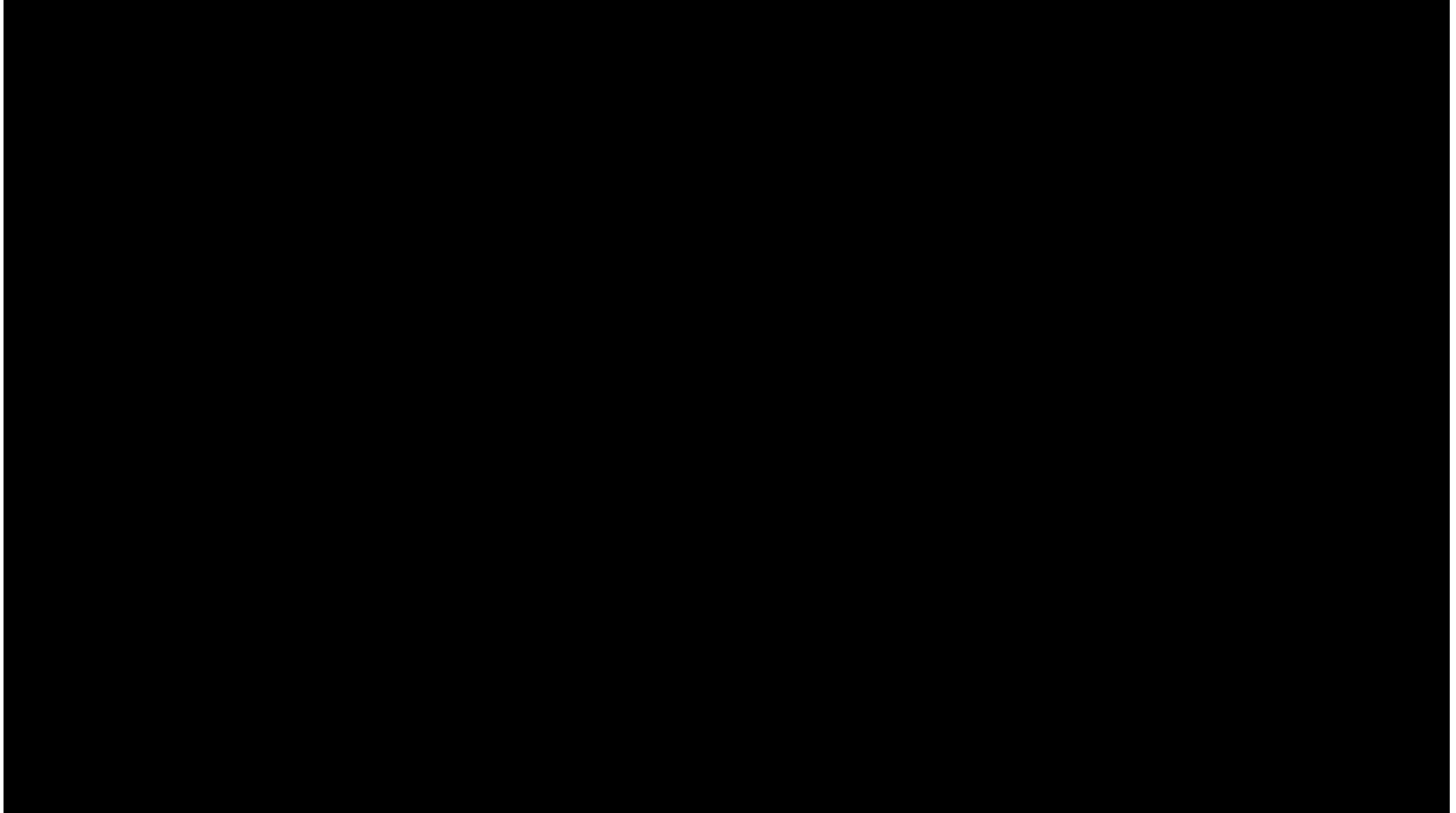
Re-Anterior leaflet augmentation



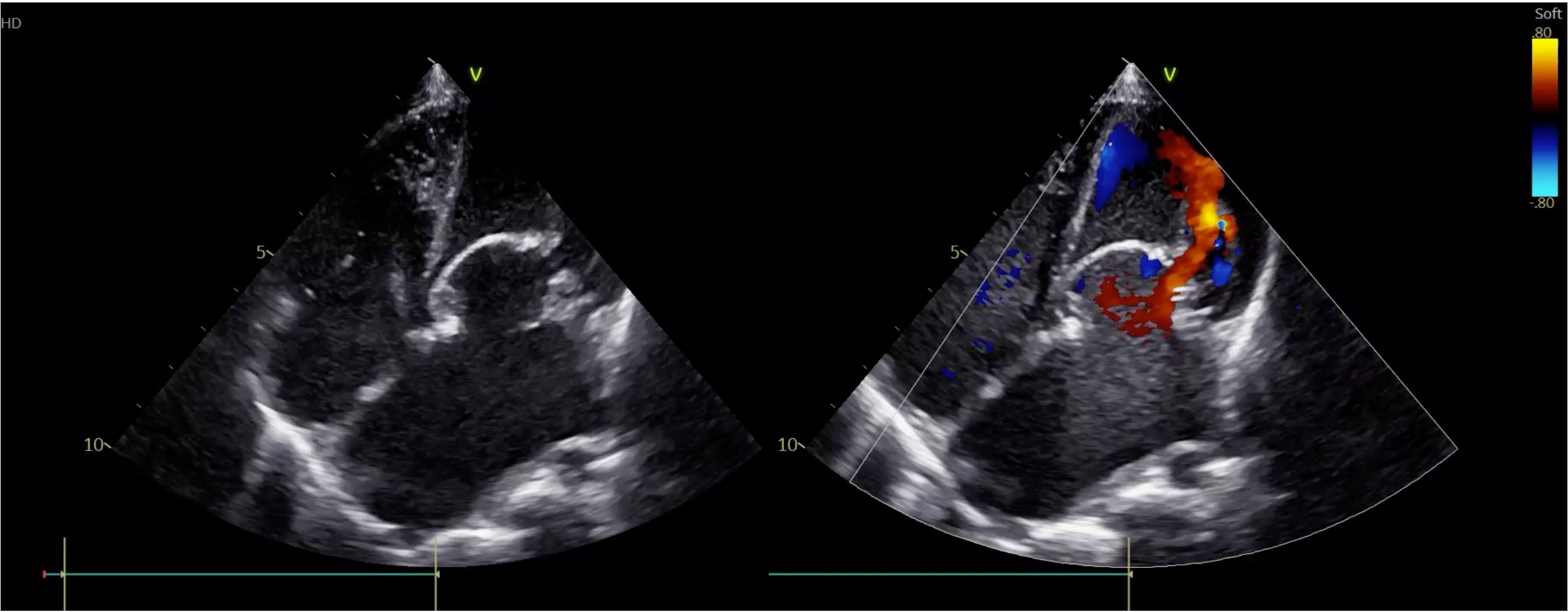
13 yo ♂ – Restricted anterior patch motion



RE- ANTERIOR LEAFLET AUGMENTATION



ECHO POST REPAIR



A standardized repair strategy

Moiroux-Sahraoui A. *et al* J Thorac Cardiovasc Surg. (to be submitted)



American Association for Thoracic Surgery

15/10/2024 00:12

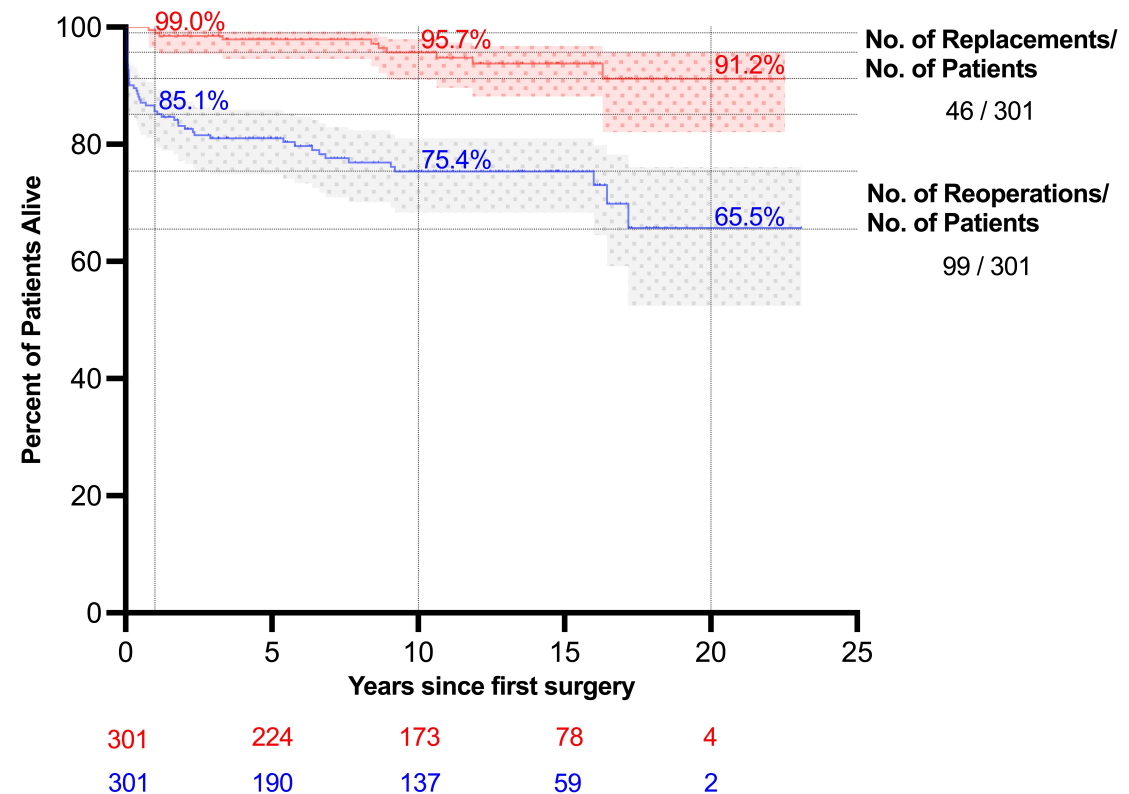
LONG-TERM OUTCOMES OF STANDARDIZED REPAIR-ORIENTED STRATEGY FOR MITRAL REGURGITATION IN CHILDREN

Objective. The surgical management of mitral valve regurgitation in children remains a surgical challenge. A standardized aggressive repair-oriented strategy allowed native valve preservation in almost all patients and had showed promising mid-term functional results. This study aims to provide updated and long-term results of our strategy.

Methods. All consecutive patients under 18 years of age who underwent surgery for moderate or more mitral regurgitation between January 2001 and December 2023 were studied retrospectively.

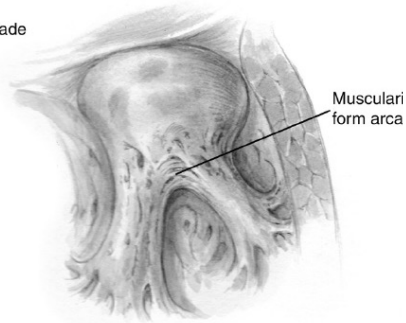
Results. A total of 301 patients were included. Median age at surgery was 6.0 years (range: 3 days-18 years). Sixty-six patients (21.9%) were younger than 1 year of age and 39 patients (13.0%) had coexistent mitral stenosis. Mean follow-up was 11.9 years (range: 1.3 years-22.5 years). The proportion of congenital and left ventricular outflow obstruction-related etiologies was 67.8% (n = 204) and 22.6% (n = 68), respectively. Mitral valve repair was achieved in 97.0% (n = 292) of patients. In-hospital mortality rate was 2.3% (n = 7). Fifty-five patients (18.3%) underwent 99 mitral valve reoperations, resulting in mechanical valve replacement in 41 patients (13.6%). The 20-year overall survival and survival free of mitral valve reoperation rates were $94.2\% \pm 4.2\%$ and $65.7\% \pm 11.2\%$. Freedom from mitral valve replacement was $99.0\% \pm 1.4\%$, $95.7\% \pm 3.3\%$ and $91.2\% \pm 6.6\%$ at 1, 10 and 20 years, respectively.

Conclusions. The vast majority of regurgitant mitral valves were initially repaired. When definitive native valve preservation failed, mitral valve replacement was the major predictor of mortality (p = 0.03). The probability of mitral valve replacement was less than 5% and 10% at 10 and 20 years, respectively.



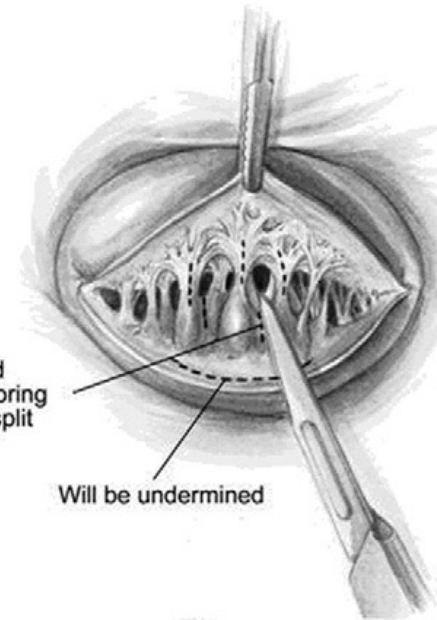
ARCADE Detachment of the posterior leaflet

Subvalve arcade



Multiple conjoined papillary m. anchoring post. leaflet are split

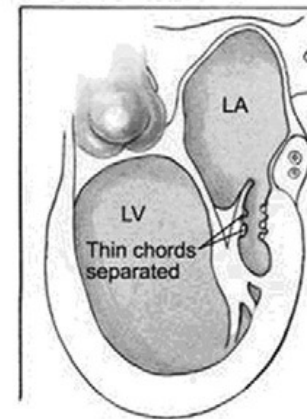
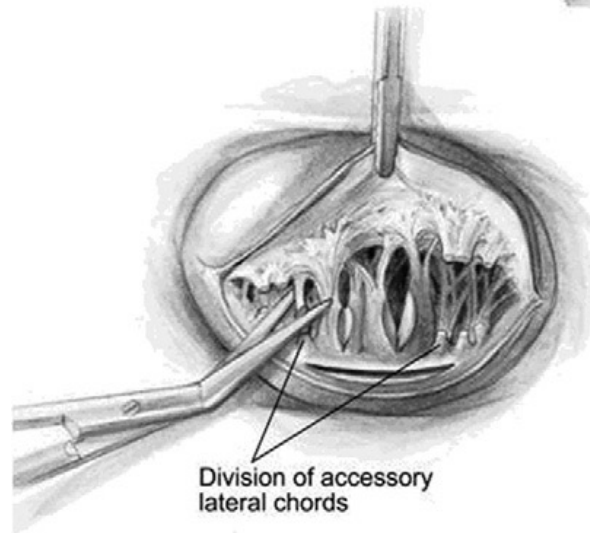
Will be undermined



Post. leaflet incised



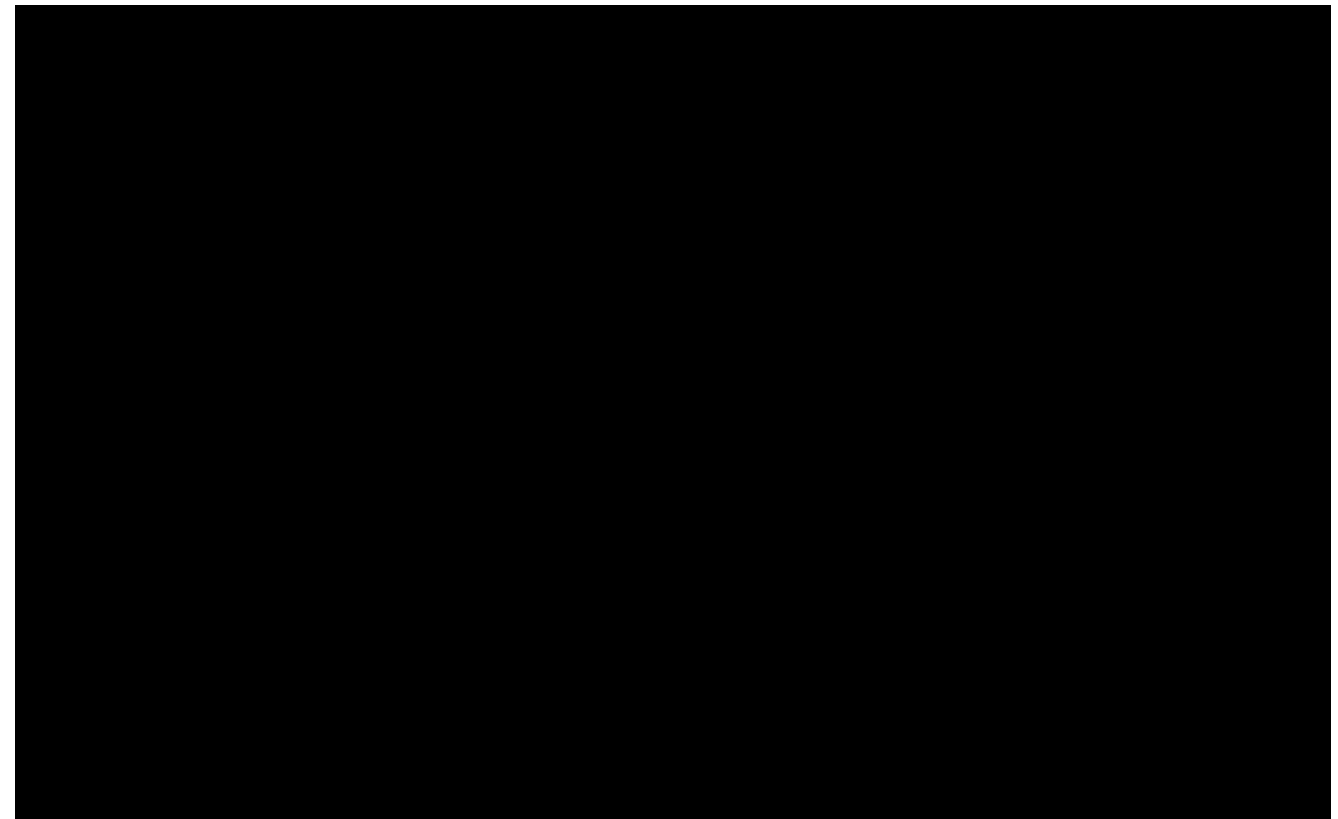
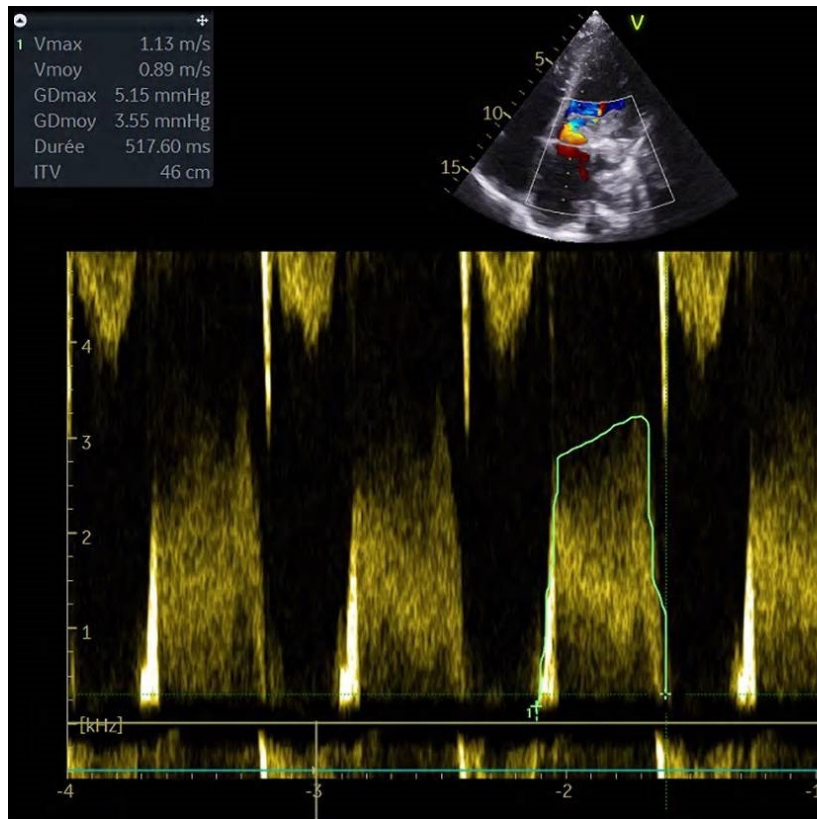
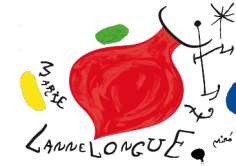
Division of accessory lateral chords



Posterior leaflet augmentation



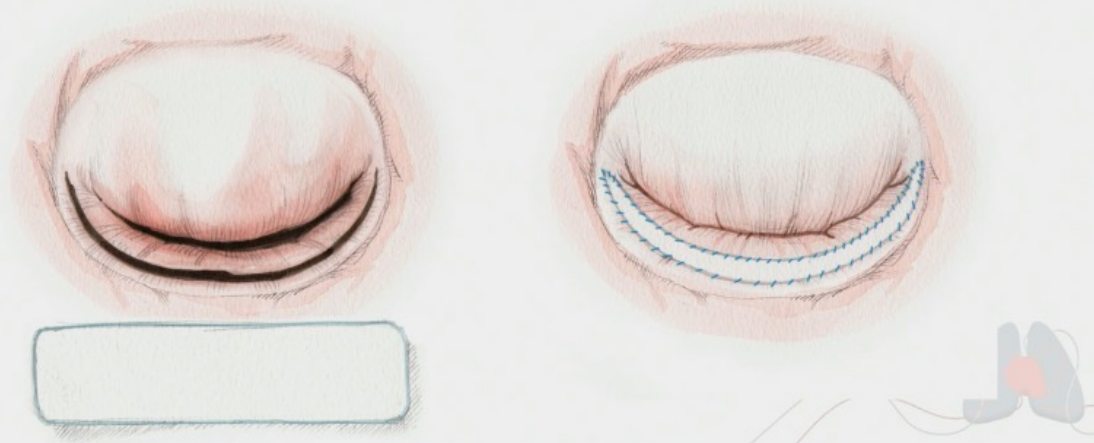
16 yo ♂ – Restricted posterior leaflet motion



COURTESY EMRÉ BELLI

Discrete Leaflet Expansion

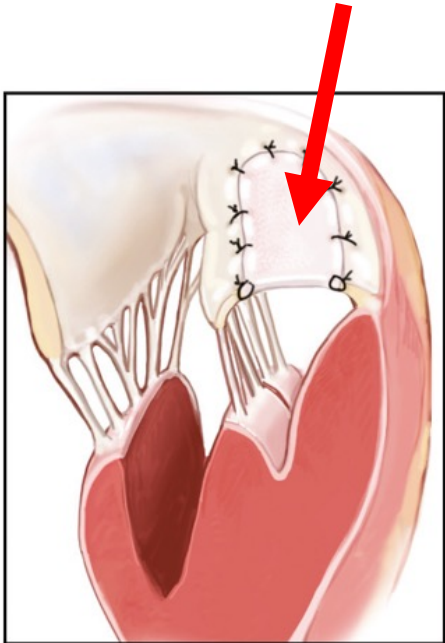
Autologous pericardium



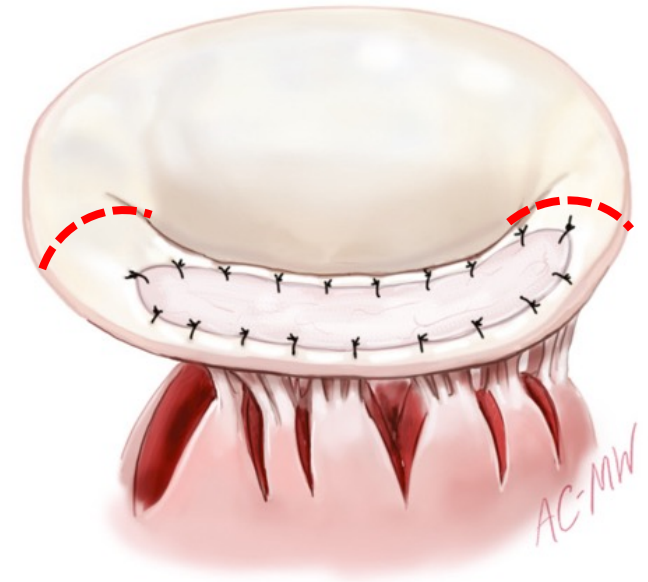
Per Wierup

sweeden

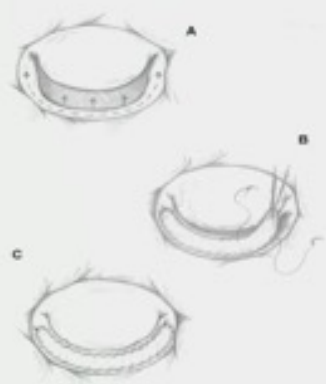
Hammock: POST LEAFLET EXTENSION



PAY ATTENTION
« GUTTER EFFECT »
Patch behaves like a cusp in
the aorta



Posterior Leaflet Augmentation (PLA)



Goal: Autologous fresh pericardium as a patch, restores leaflet mobility and surface area of coaptation and its is an adaptable technique that supports somatic growth

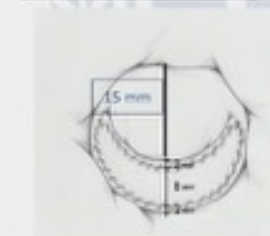
Posterior Leaflet Augmentation: Patch size

$$H_{\text{patch}} \approx (APL - PHL) + (7 - CL_{\text{curr}})$$

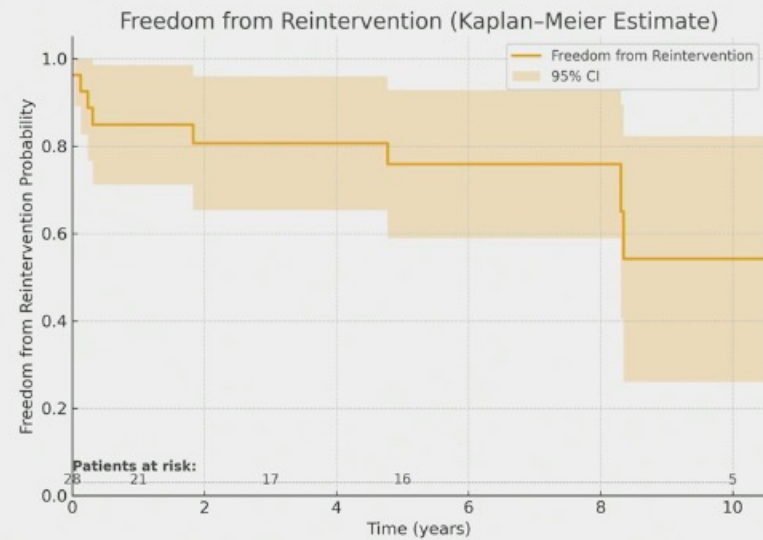
•APL = annulus → anterior leaflet free-edge distance (proto-meso-systole)
 •PHL = posterior leaflet height
 •CL_{curr} / CL_{target} = current / desired coaptation (7 mm as target).

Example:

APL = 15 mm, PHL = 11 mm → need 4 mm to "reach" AML
 CL_{curr} = 3 mm, CL_{target} = 7 mm → need 4 mm coaptation
 H_{patch} = 4 + 4 = 8 mm

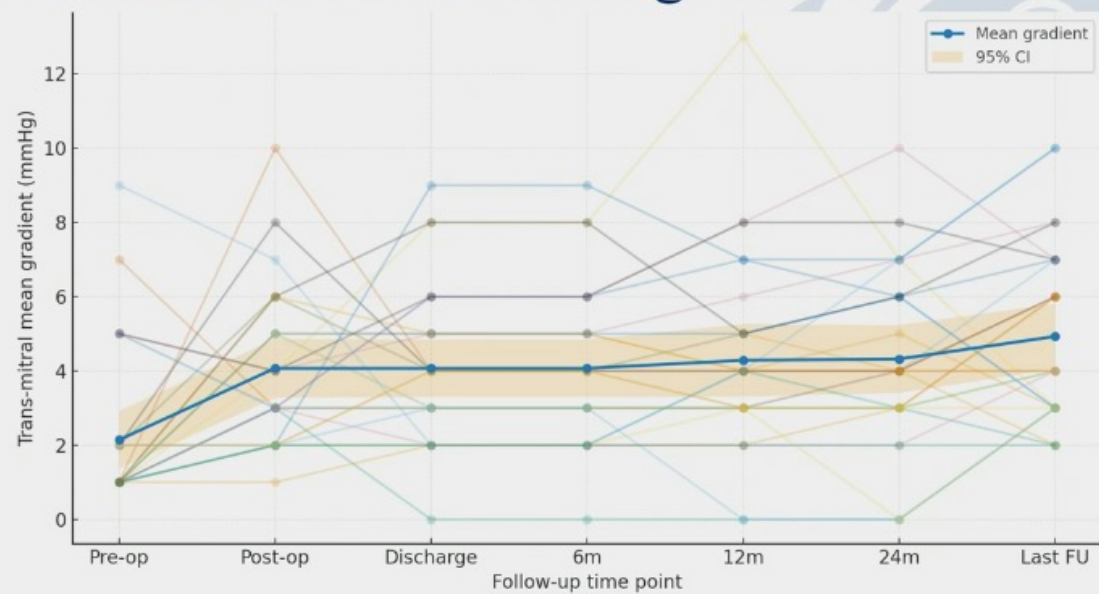


Freedom from reintervention



At 1, 3, 5 and 10 years, the estimated cumulative freedom from reintervention was 84.9%, 80.6%, 75.9%, and 54.2%

Evolution of trans-mitral gradient



RESULTS



Pediatric Cardiac
Surgery Annual

Congenital Mitral Valve Stenosis: Anatomic Variants and Surgical Reconstruction

Pedro J. del Nido and Christopher Baird

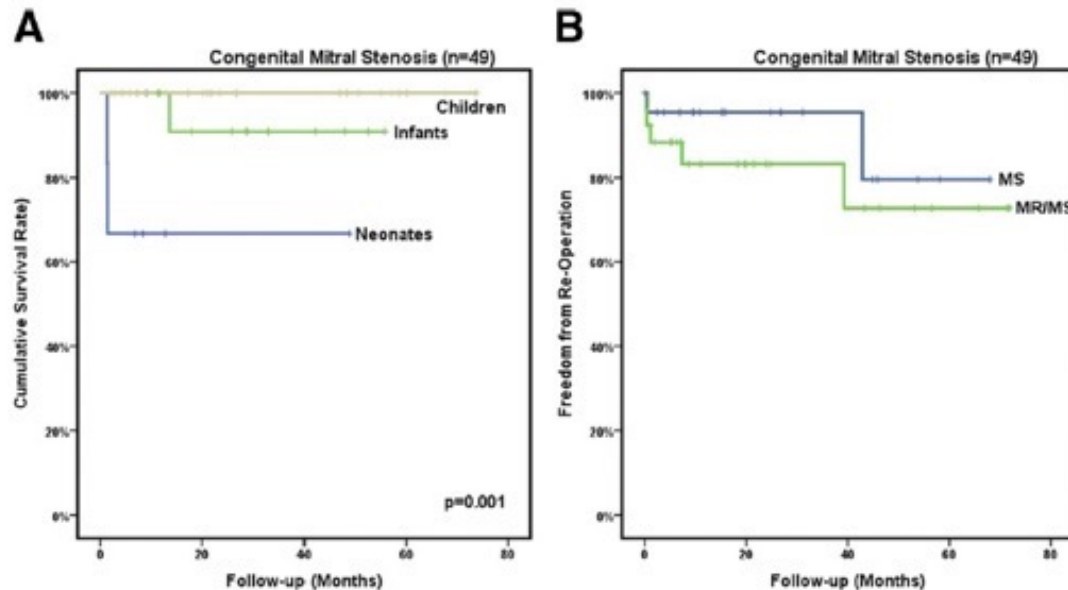
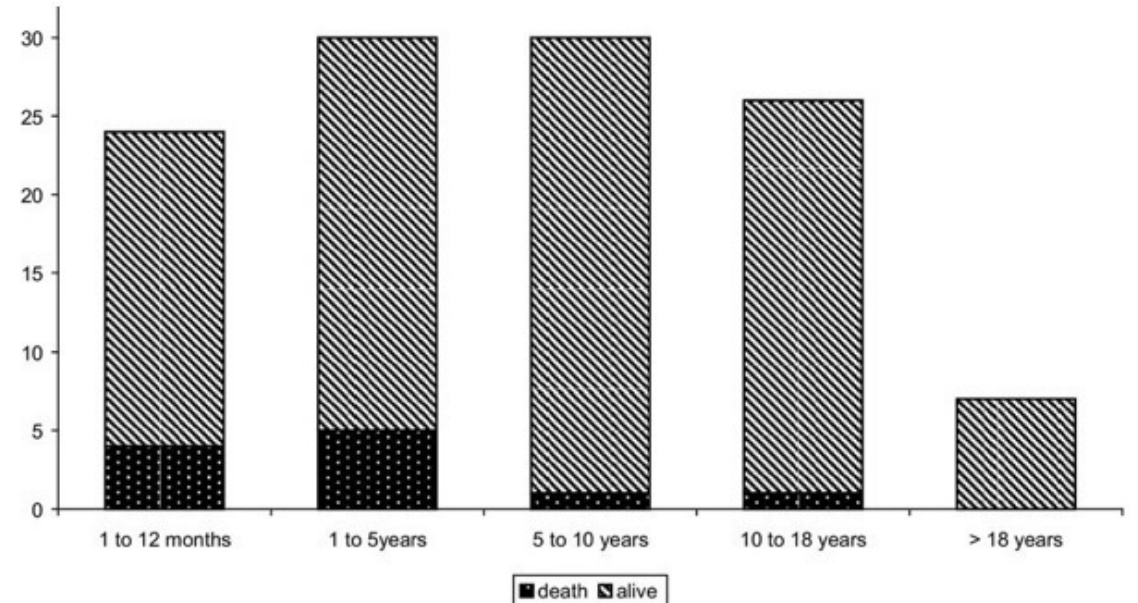


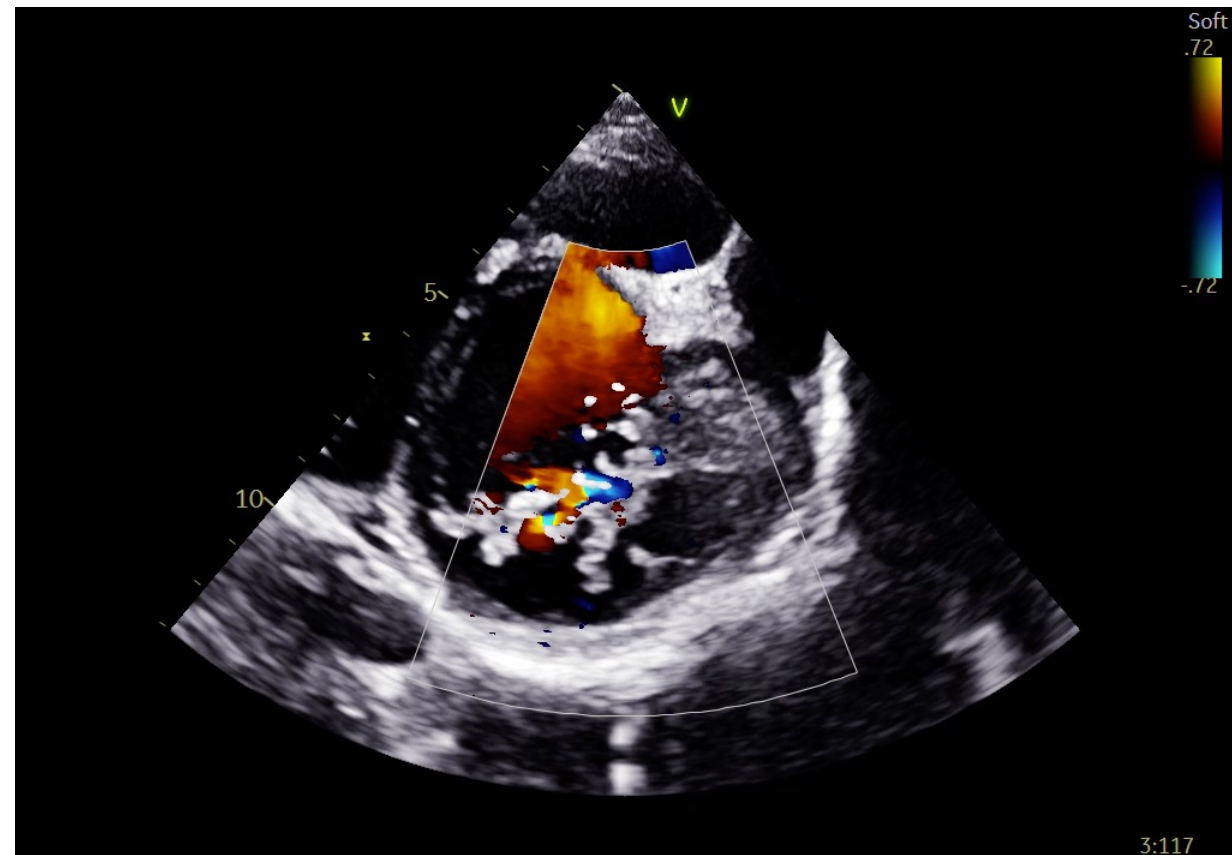
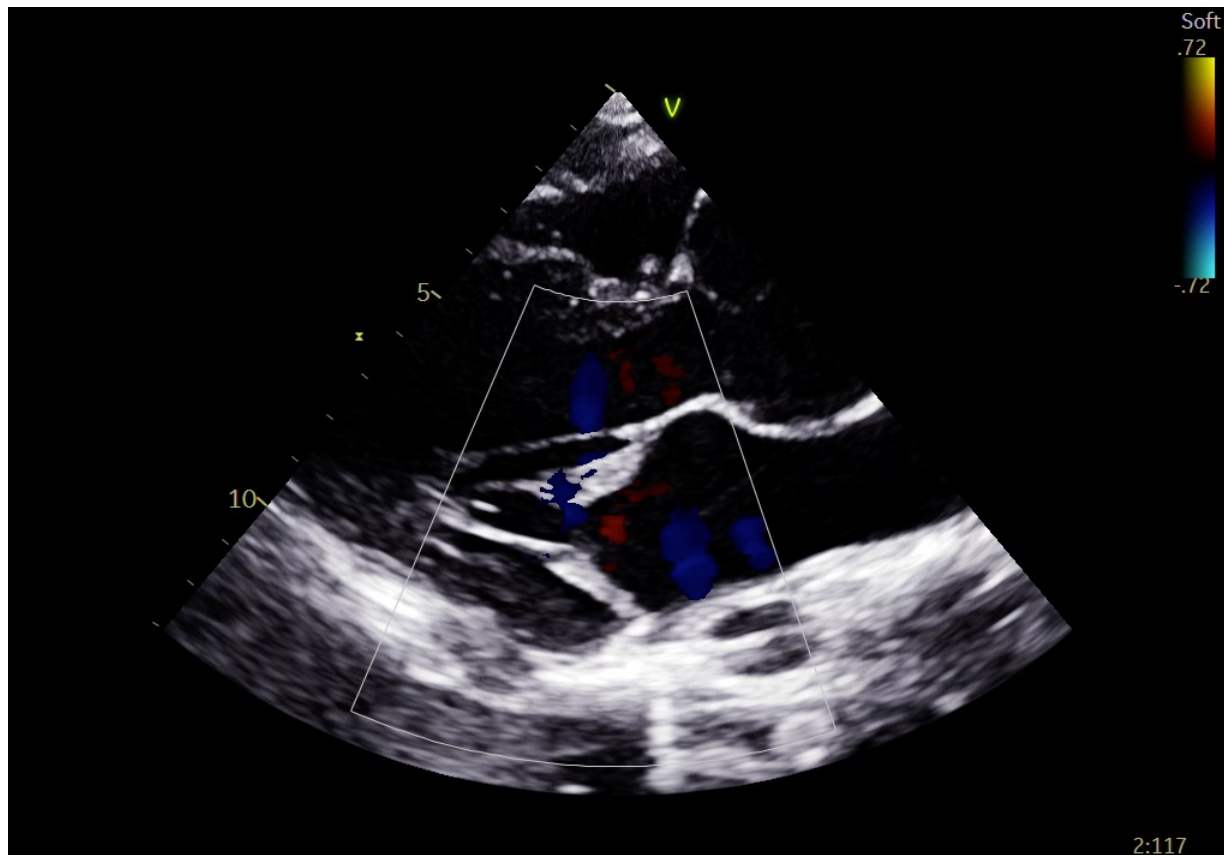
Figure 7 Freedom from reoperation in children following mitral valve reconstructive surgery shown by primary indication for surgery. Mixed lesion with significant mitral valve stenosis and regurgitation (*left*). Freedom from reoperation shown by age group (*right*). MR, mitral valve regurgitation; MS, mitral valve stenosis; MS/MR, mixed lesion with significant mitral valve stenosis and regurgitation.

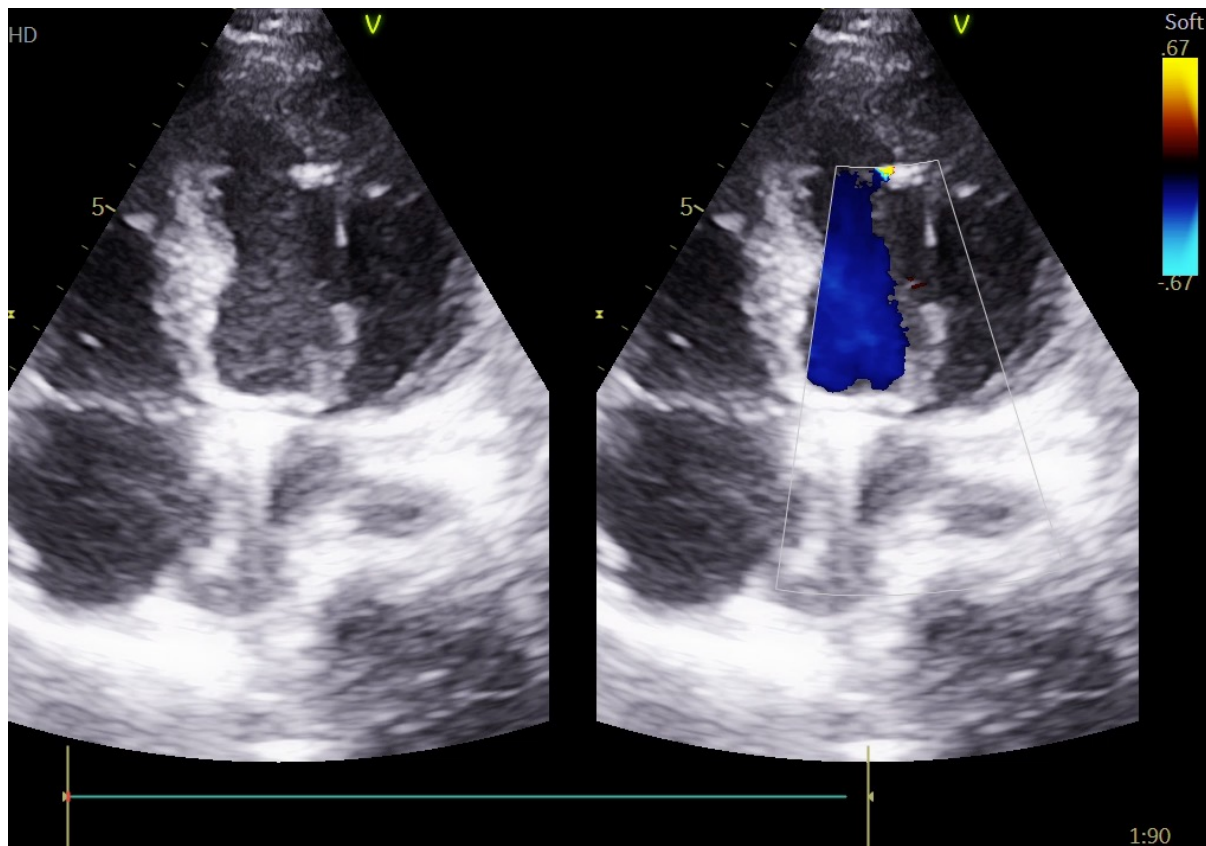
How I Manage Mitral Stenosis in the Neonate and Infant

Stephanie Fuller and Thomas L. Spray



Age < 3 months
Pulmonary hypertension
Shone syndrome
Annular size and staged repair



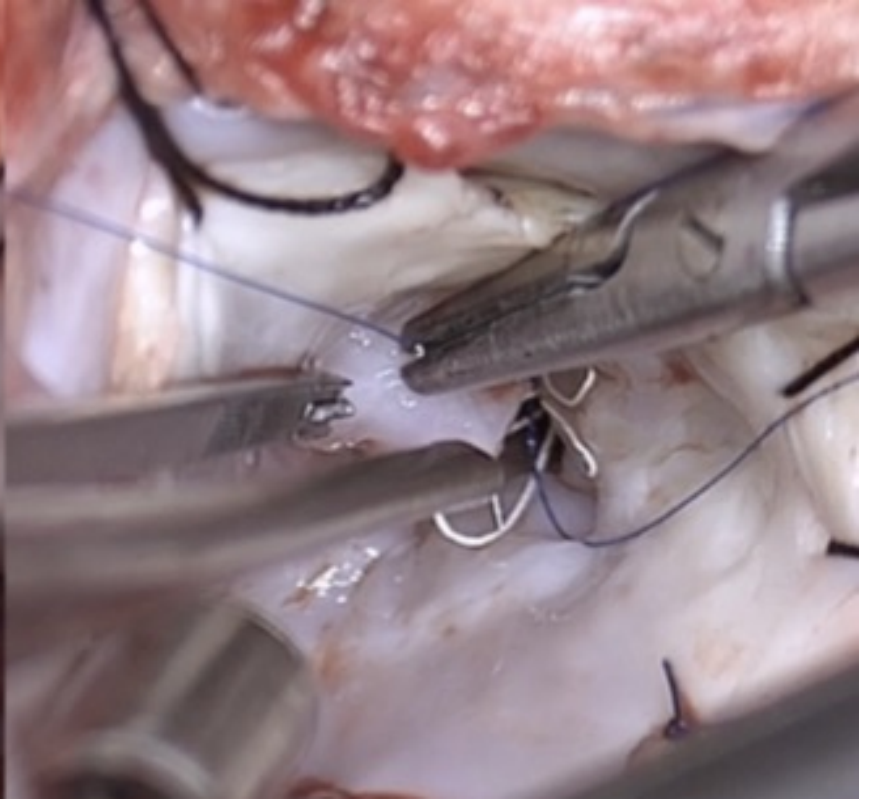
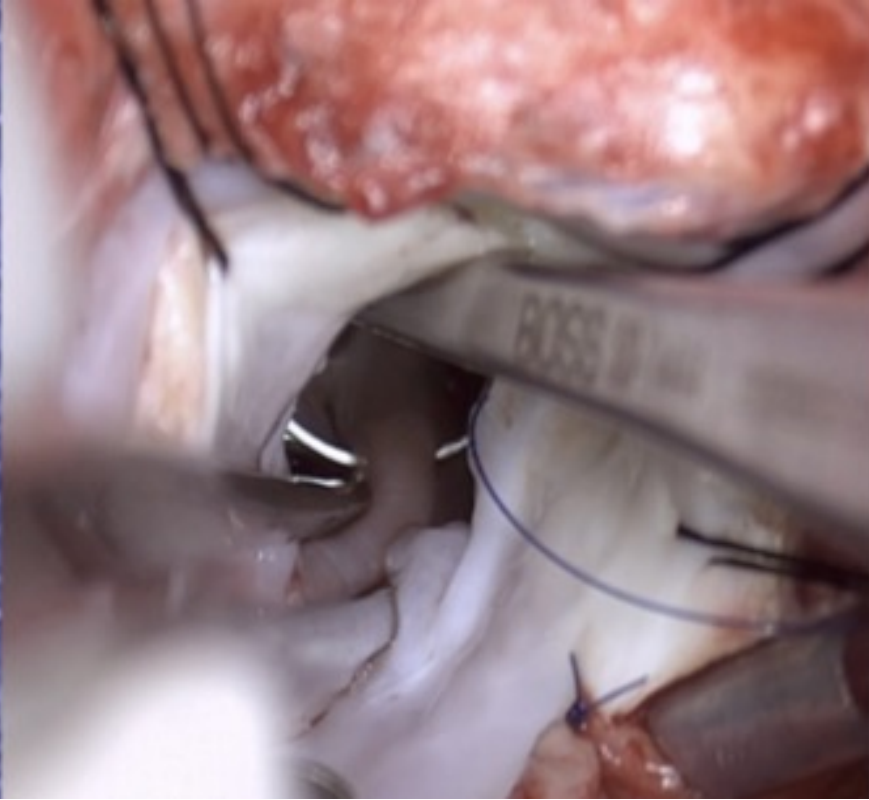
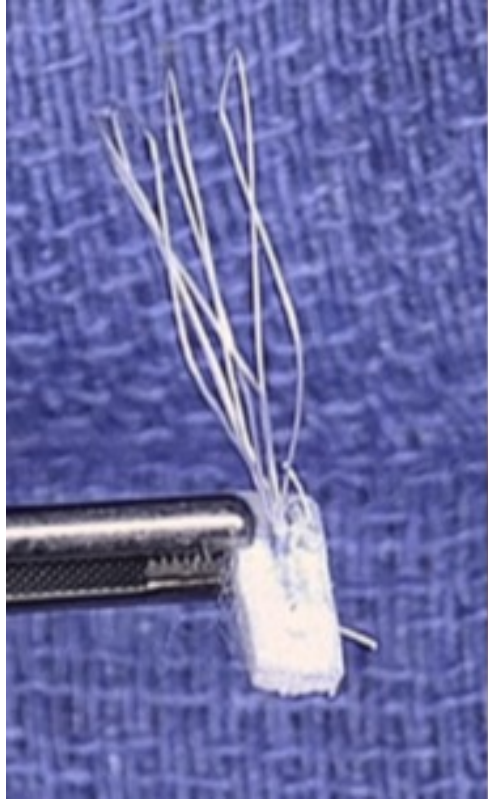


EXTENSIVE USE OF ARTIFICIAL CORDAE

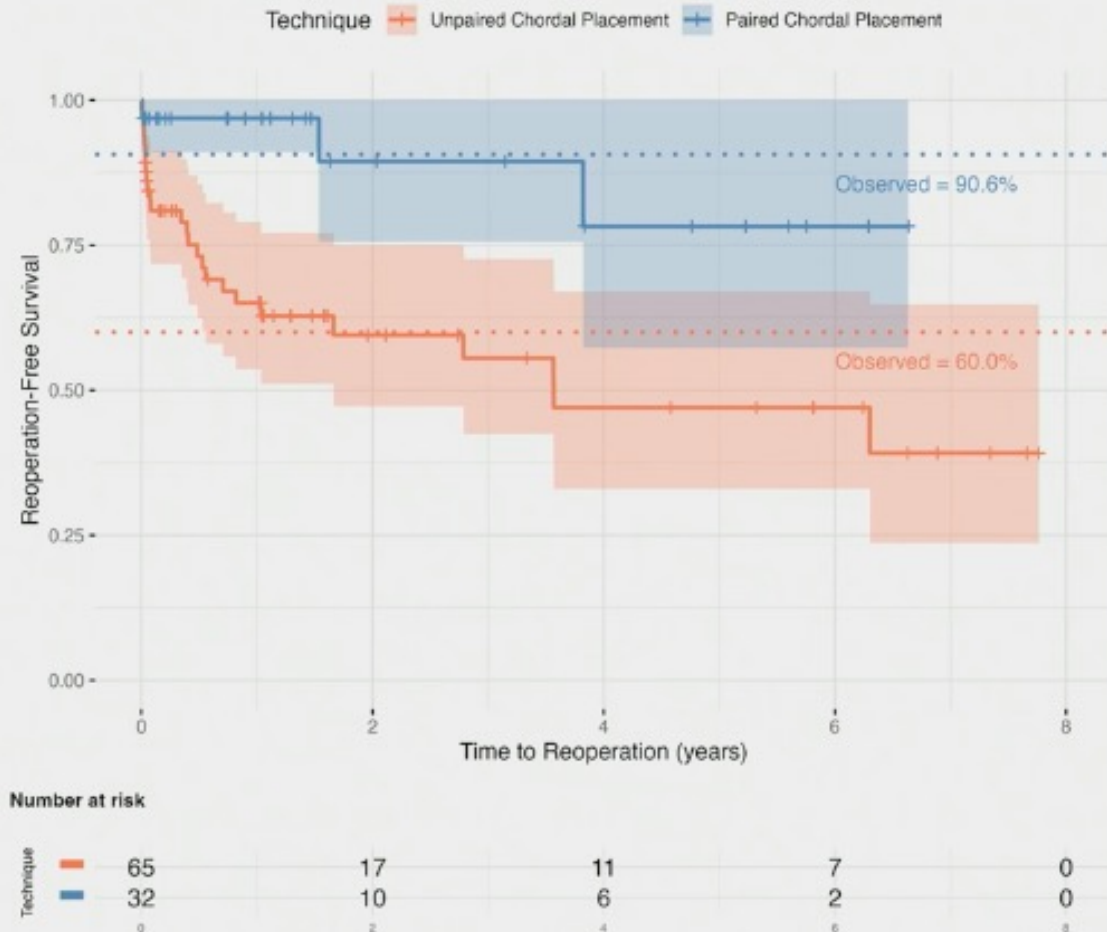
When are Chordal Techniques necessary?

- Leaflet Prolapse (single or multiple)
- Leaflet Immobilization (shortened, thickened or absent chordae)
- Useful techniques
 - Artificial chords
 - Chord Transfer
 - Chord shortening
 - Papillary approximation
- Right or left AV valve





Surgical Technique is Associated with Reintervention Rate



- MULTIMODAL IMAGING AND 3 D MODELING
- POSTERIOR PATCH ENLARGEMENT
- EXTENSIVE USE OF ARTIFICIAL CHORDAE AFTER RESECTION OF SUB VALVULAR APPARATUS
- SUPERIORITY OF MITRAL REPAIR DESPITE NEED FOR REOPERATION

NEED FOR PROPER TRAINING

Baird CW, Myers PO, Marx G, del Nido PJ. Mitral valve operations at a high-volume pediatric heart center: evolving techniques and improved survival with mitral valve repair versus replacement. Ann Ped Cardiol 2012;5:13-20

Brescia AA, Watt TMF, Murray SL et al. Rheumatic mitral valve repair or replacement in the valve-in-valve era. J Thorac Cardiovasc Surg 2020

