DOUBLE PATCH VENTRICULAR SEPTAL RUPTURE REPAIR WITH INFARCT EXCLUSION FOR NFEROPOSTERIOR MYOCARDIAL INFARCTION

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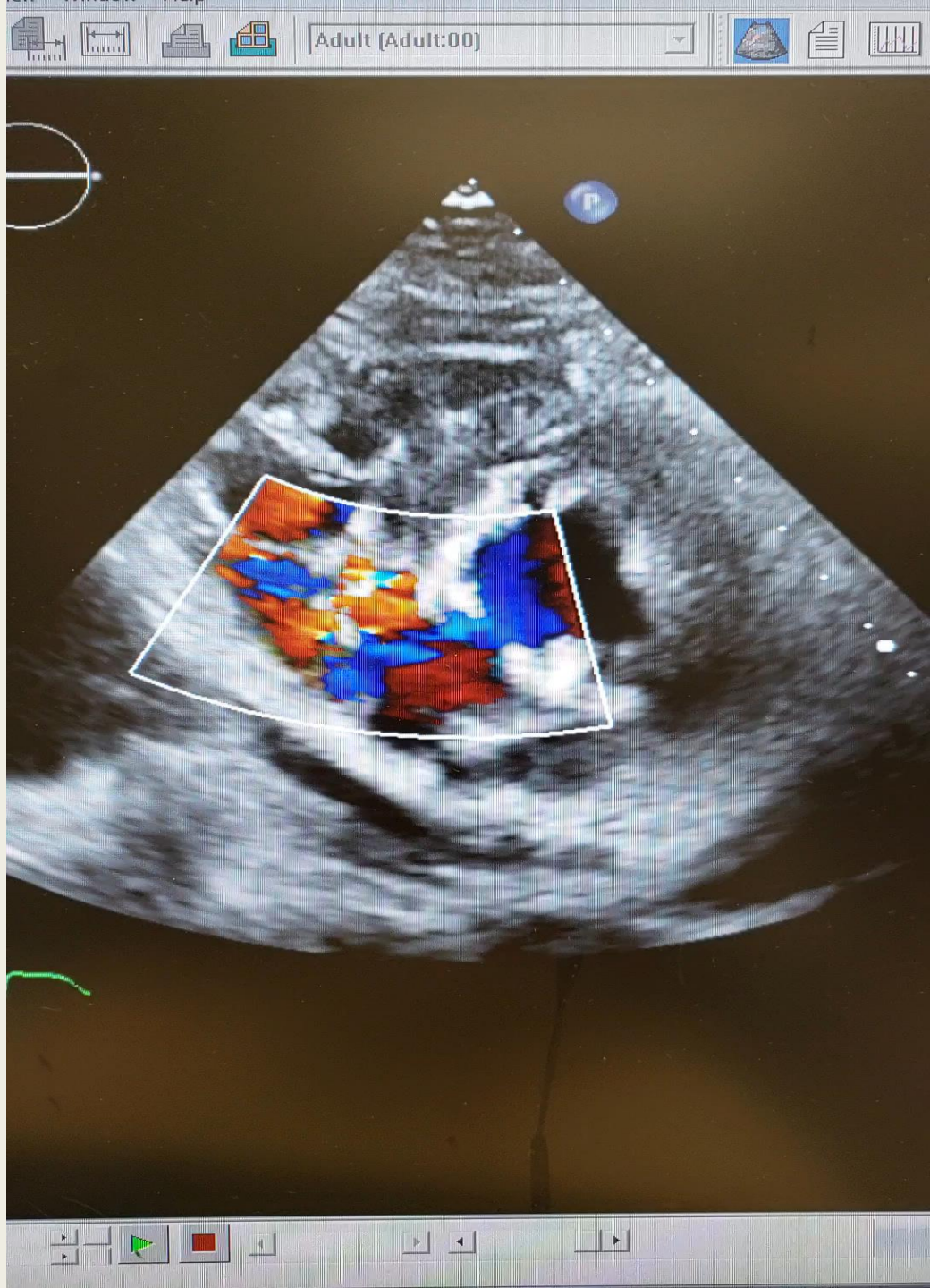
73/M

- Ex-smoker
- Present 10 days after onset of chest pain on 24/6/2020
- Admit x heart failure symptoms: shortness of breath, bilateral ankle edema
- BP 145/87, P 110, SpO2 94% on 5L O2
- P/E: harsh systolic murmur over precordium, bilateral crepitations
- ECG: inferior leads Q waves
- Peak TnT 610 (delayed presentation), CK 369
- CXR: congestion with bilateral pleural effusion
- Cardiogenic shock with IABP inserted → stabilized

- Echocardiogram:
  - *LVEF 40%*
  - *2cm VSR at inferoseptal segment, left-to-right shunt*
  - *inferior wall akinesia*
  - *Mild MR*
  - *Moderate TR, PASP 60mmHg*
- Coronary angiogram
  - *mLAD 80%*
  - *om1 80%*
  - *PDA 99% (culprit)*



How to Manage?

- Initial stabilization
- Early vs Delayed Intervention
- Surgery vs Transcatheter closure
- Surgical techniques
  - *→Our technique combining Double-patch and Infarct Exclusion provides robust repair*

Post-infarct Ventricular Septal Rupture

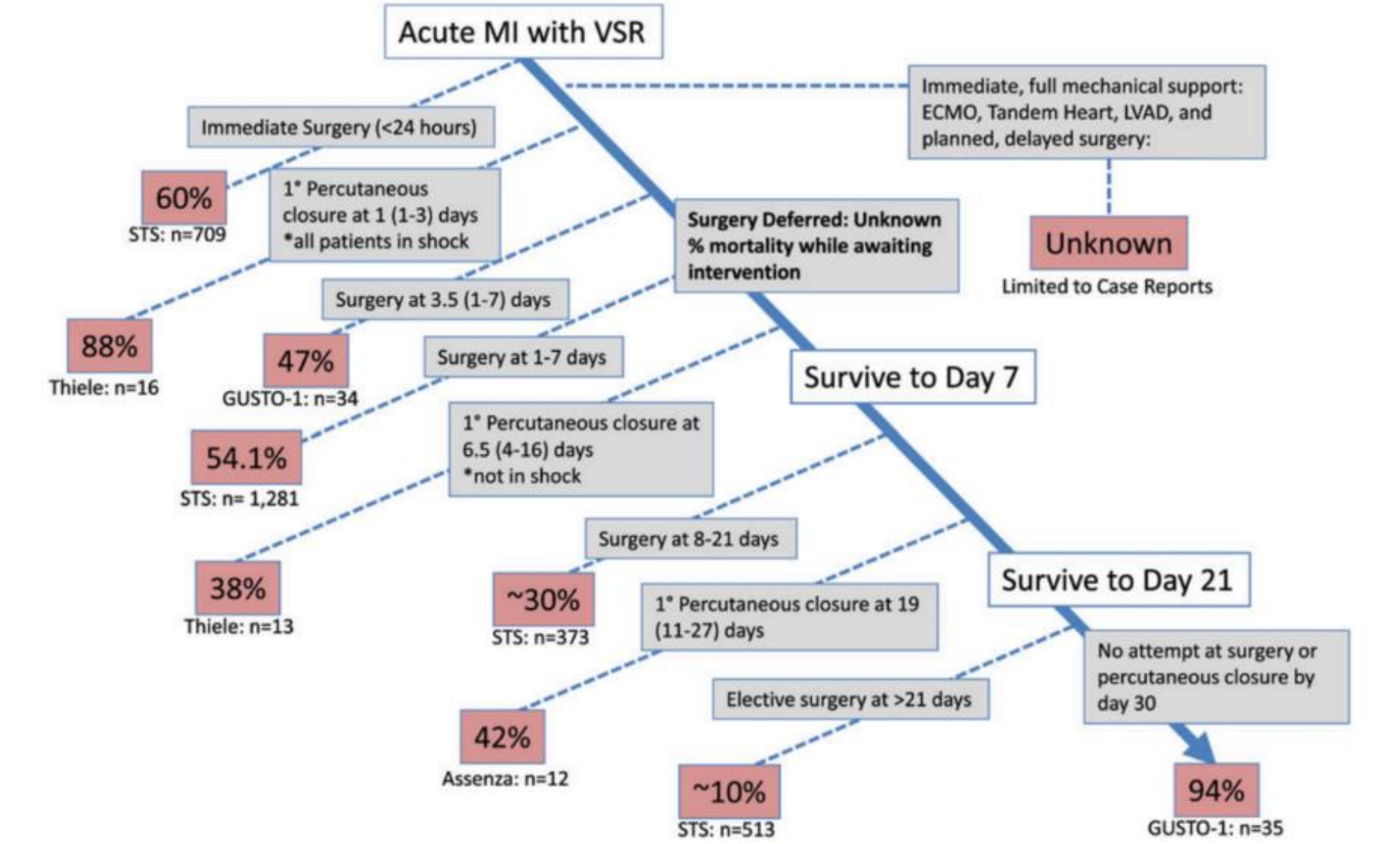
- Following transmural infarcts, usually STEMI
- Incidence
  - *Pre-reperfusion era: 1-3%*
  - *Primary PCI era: 0.17-0.31%*
- LAD (anterior infarct) and RCA (inferior/posterior) similar frequency
  - *LAD 42%, RCA 46% (SHOCK registry)*
  - *Anterior infarction: apical VSR, usually simple, smaller, more likely surrounded entirely by septum*
  - *Inferior infarction: complex, intramyocardial dissection, serpiginous routes through necrotic septum, more likely involve free wall also, often with MR secondary to papillary muscle dysfunction*

Principles of Management

- Afterload reduction
- Vasodilators (e.g. GTN) +/- inotropes
- Diuretics
- IABP
- Mechanical circulatory support, e.g. VA ECMO, Tandem Heart
  - *Aim: reverse end-organ dysfunction, allow time for maturation of infarct leading to firmer tissue, recovery of stunned myocardium*

Figure 1: Mortality and Timing of Repair

Jones BM, Kapadia SR, Smedira NG, et al. Ventricular septal rupture complicating acute myocardial infarction: a contemporary review. *Eur Heart J*. 2014;35(31):2060-2068.



Published series suggest a graded decline in mortality with greater delay in VSR repair. This ubiquitous finding is likely both a true association due to increased stability of peri-infarct myocardium rending repair more successful as well as an artifact from survivorship bias. *Reproduced with permission from Jones et al.*[1]

Timing of repair: Delayed if able to stabilize

- Support for delaying surgery
  - *Improve tissue fragility*
    - MMP and tissue breakdown peak by day 7, deposition of new collagen begins by day2-4, necrotic myocytes replaced by collagen by 28 days
    - Delay allows friable tissue to organize, strengthen, well-demarcated from surrounding healthy tissue
  - *Washout of DAPT effects*
  - *2017 European Society of Cardiology guidelines:* ***support delayed elective repair*** *in patients initially responding to aggressive conservative management*

Surgical Repair

- Definitive treatment
- Medical management alone: 94% mortality
- STS National Database: 2876 VSR
  - *30-day mortality after operation: 42.9% (highest mortality rate of all cardiac surgeries)*
  - *Sharp decrease in mortality with delay in repair:*
    - 54.1% mortality for repair within 7 days of MI
    - 18.4% mortality for repair after 7 days of MI
    - Selection and survivorship bias

Transcatheter Septal Closure (TSC)

- Stable but inoperable patients, Anatomy suitable (antero-apical defects without valve involvement)
- Procedure success rate 89%
- 30-day or in-hospital mortality rate: 88% (pre-op shock) vs 38% (pre-op stable)
- Higher mortality with earlier closure
- Complications: arrhythmias, device embolization, ventricular rupture, ， residual shunt, hemolysis

Transcatheter Septal Closure (TSC)

- Amplatzer PI Muscular VSD Occluder
  - *max waist size 24mm, max disc size 34mm*
- Optimal for TSC: defects <15mm
- Challenges
  - *inferior defects due to lack of circumferential septal rim*
  - *basal defects due to proximity to tricuspid valvular apparatus, serpiginous defects, too early closure due to tissue instability*
- A role as salvage therapy for residual defects after initial surgical repair

SURGICAL REPAIR: TECHNICAL ASPECTS

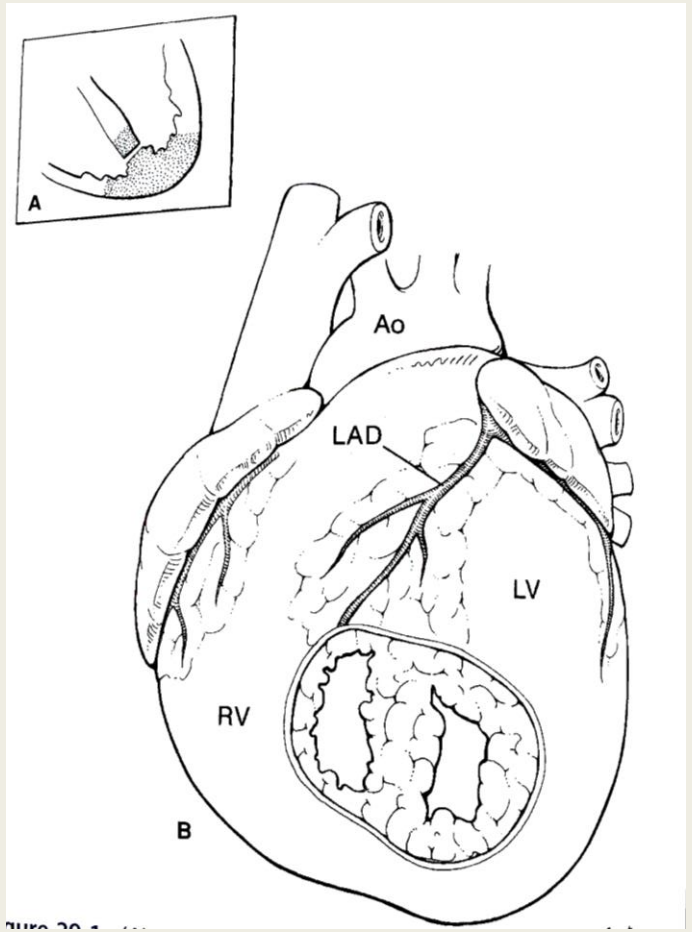
Techniques

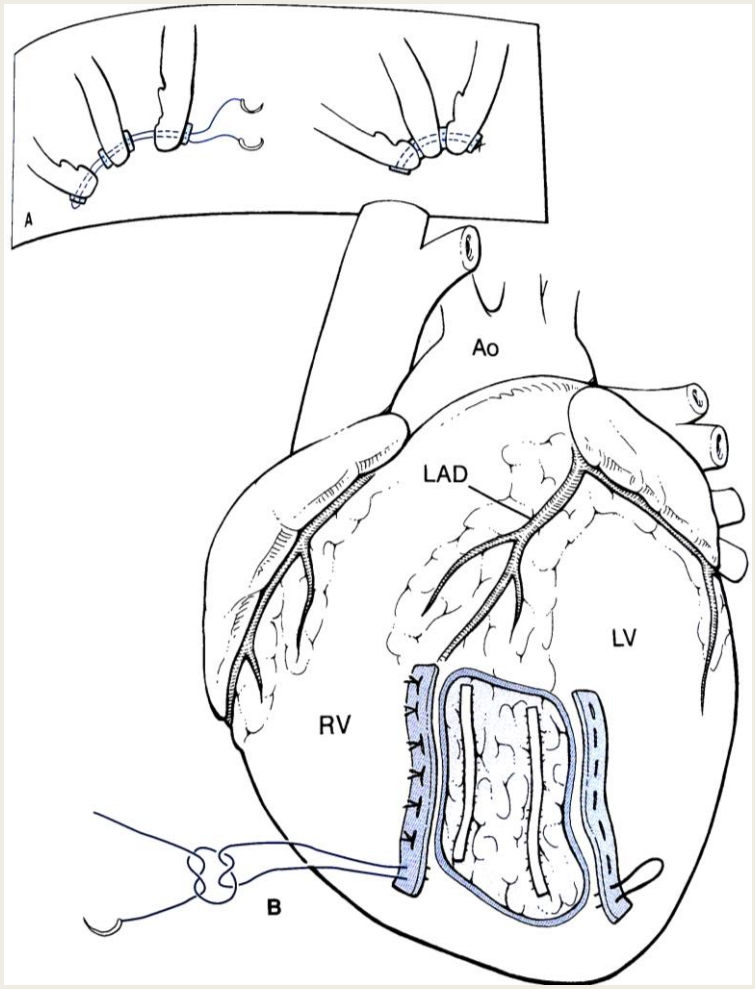
- Aim: Robust repair to avoid complications of residual shunt, suture cut-through, bleeding, ventricular dysfunction

- Direct closure vs Patch closure
- Single Patch vs Double Patch
- Direct closure of ventriculotomy vs Infarct Exclusion
- Trans-infarct approach vs RV approach
- Continuous sutures vs Interrupted sutures
- Anterior vs posterior VSR

Traditionally

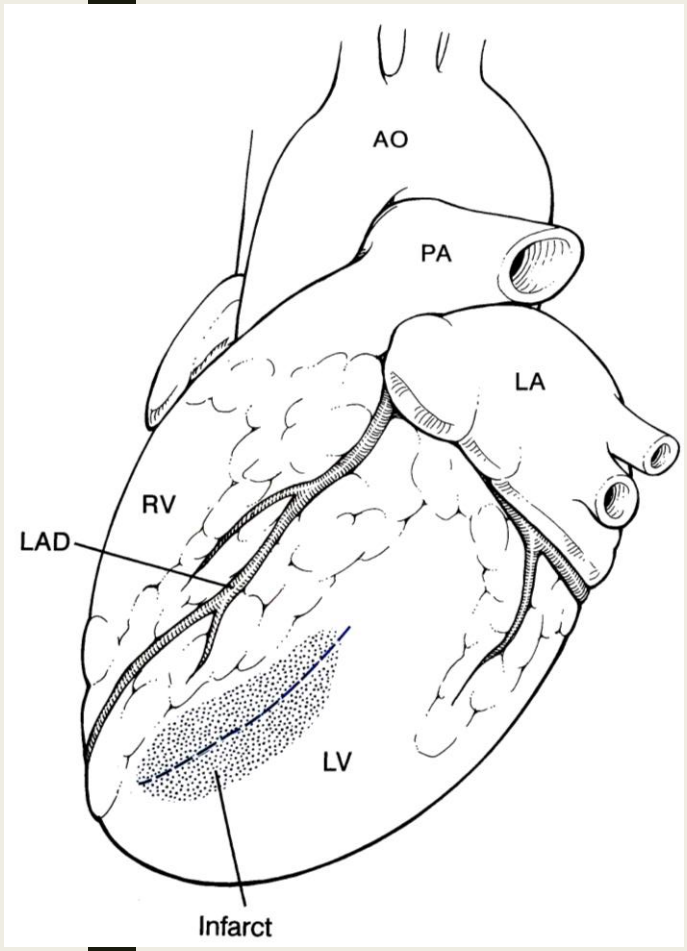
- Daggett Repair
- David Repair

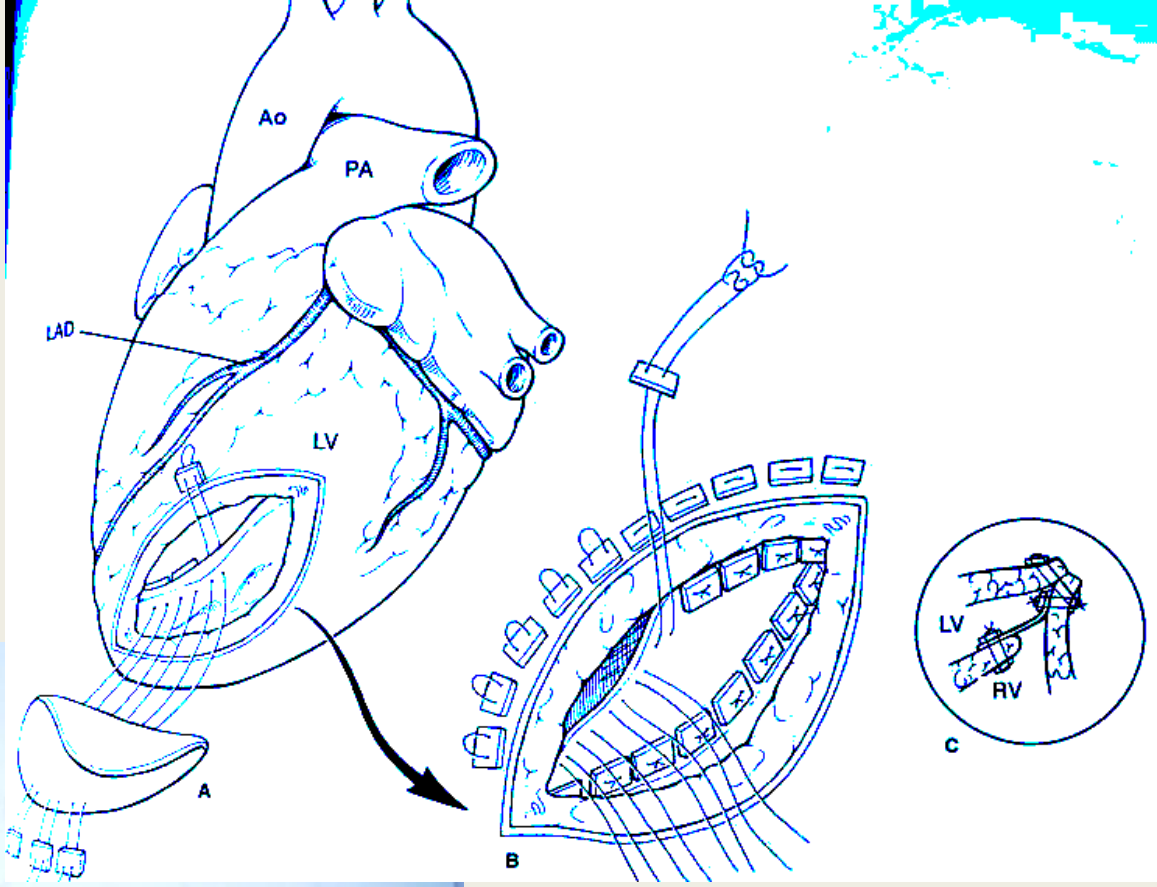


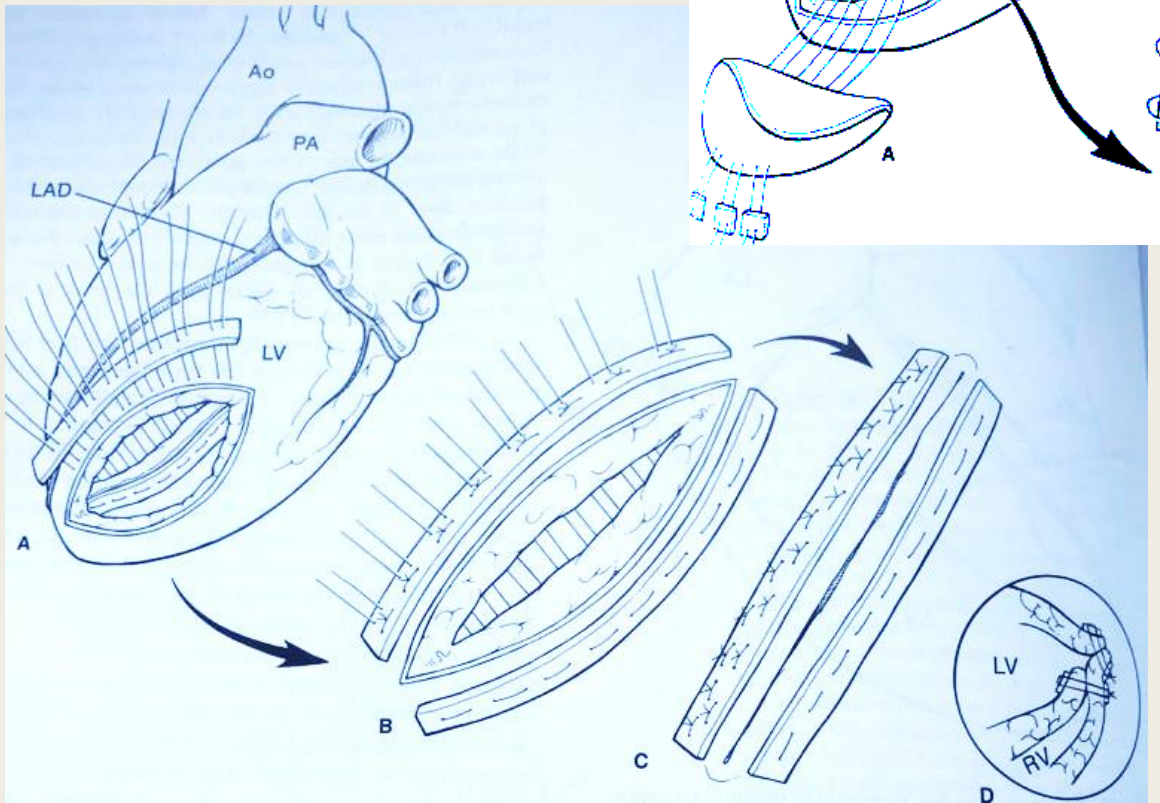


Daggett et al, 1970
Apical amputation (LV, RV, septum)
For apical VSR

With or without patch

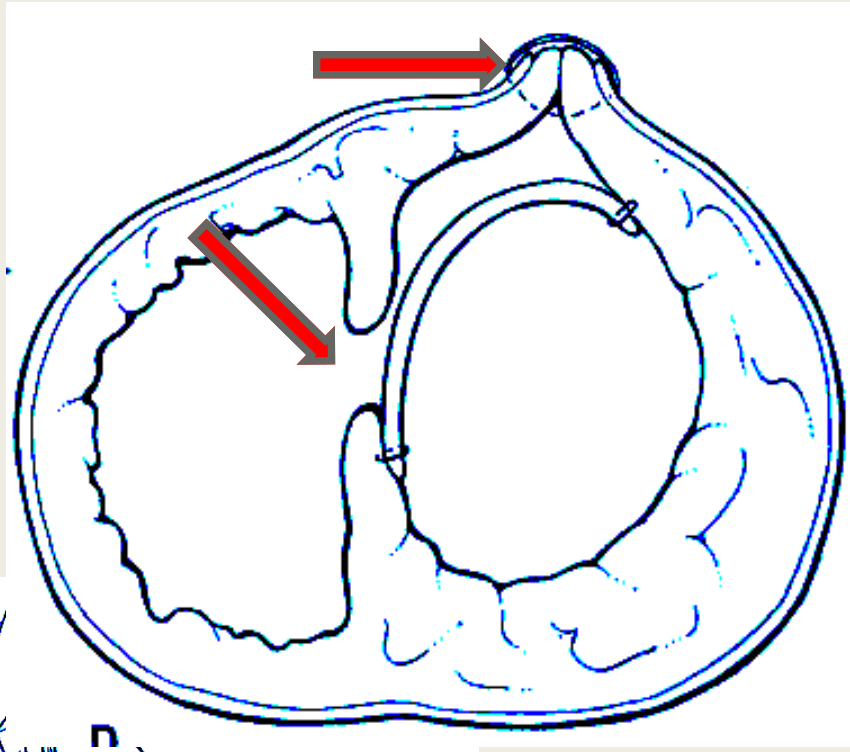


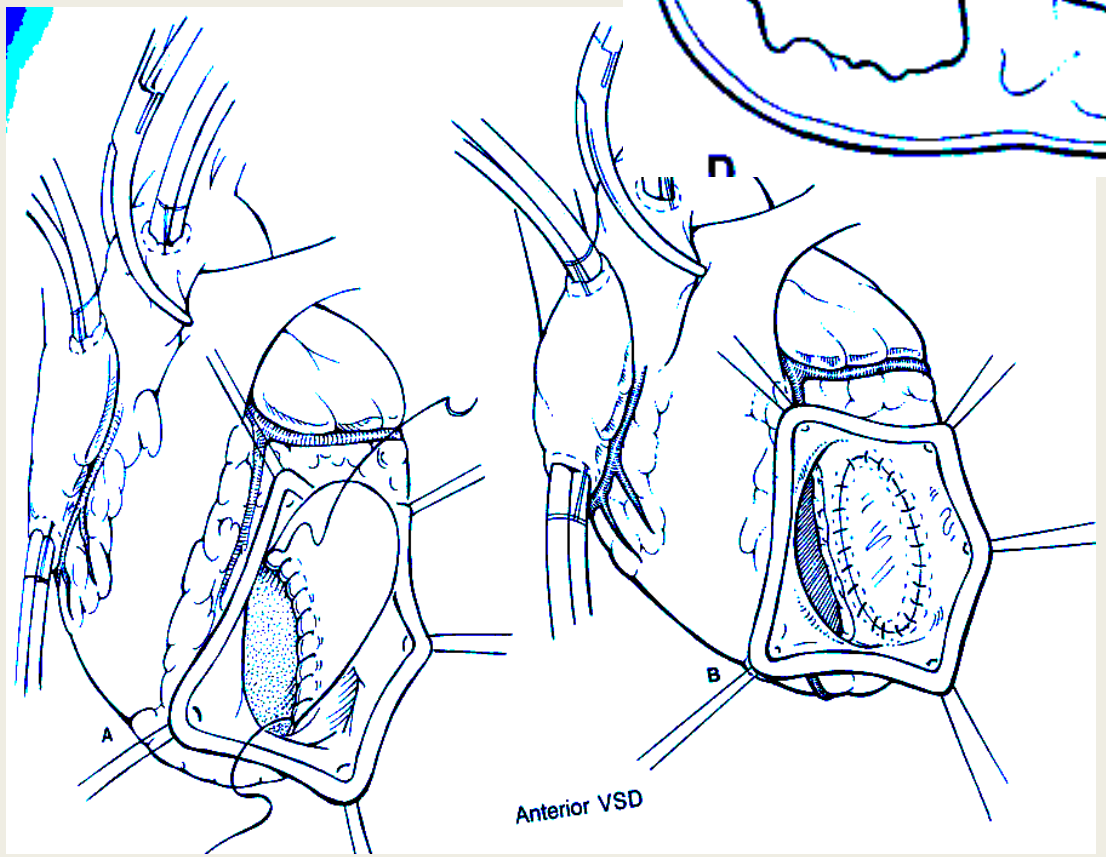




Infarct exclusion technique

- Endocardial patch repair with infarct exclusion
- Instead of closing the septal defect, the defect is simply EXCLUDED from high-pressure zone of LV



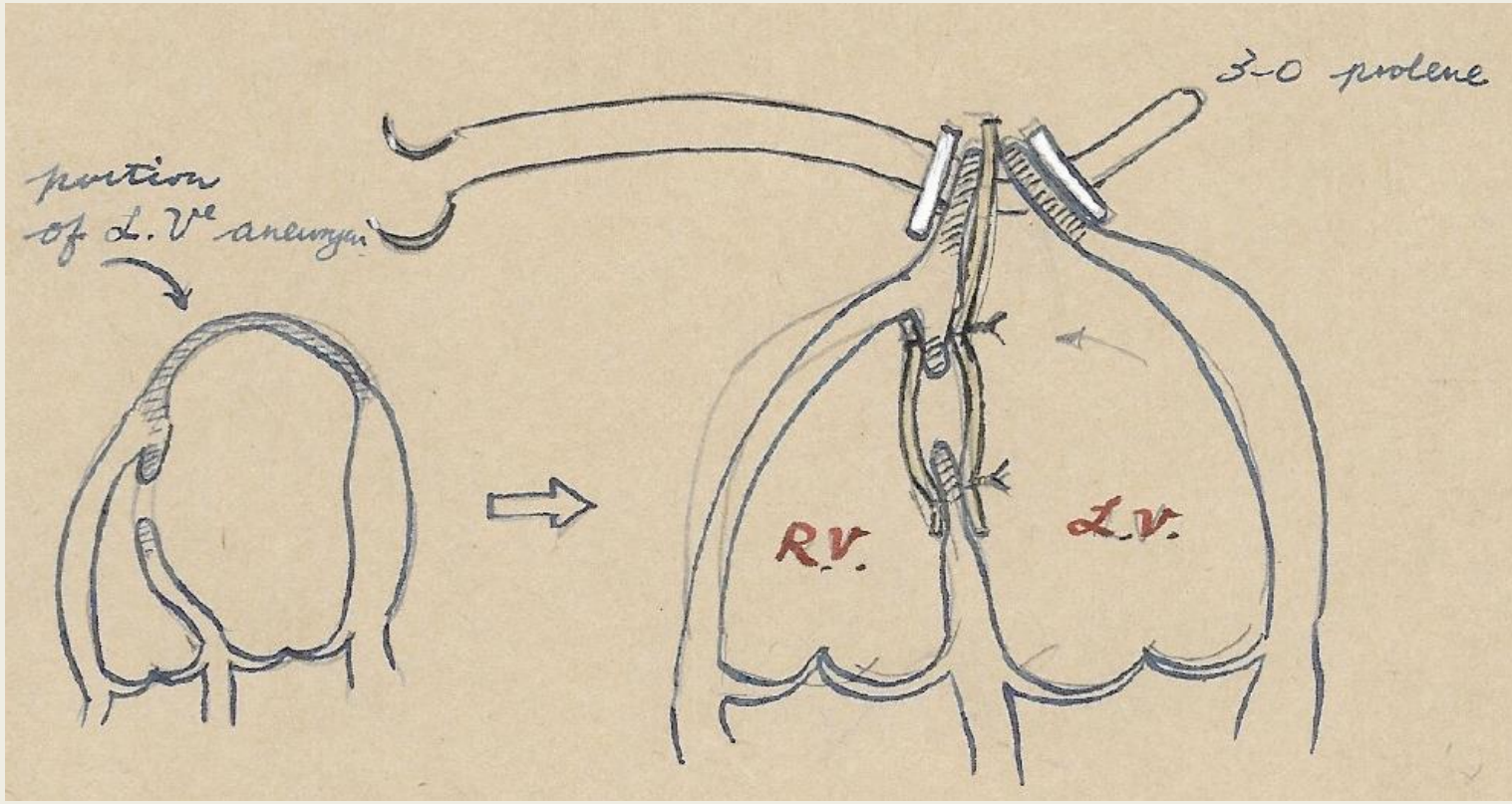


Advantages of infarct exclusion

- Does not require resection of myocardium (excessive resection reduces ventricular function; insufficient resection predisposes to septal rupture)
- Maintains ventricular geometry and enhances ventricular function
- Avoids tension on friable muscle, and reduces postop bleeding

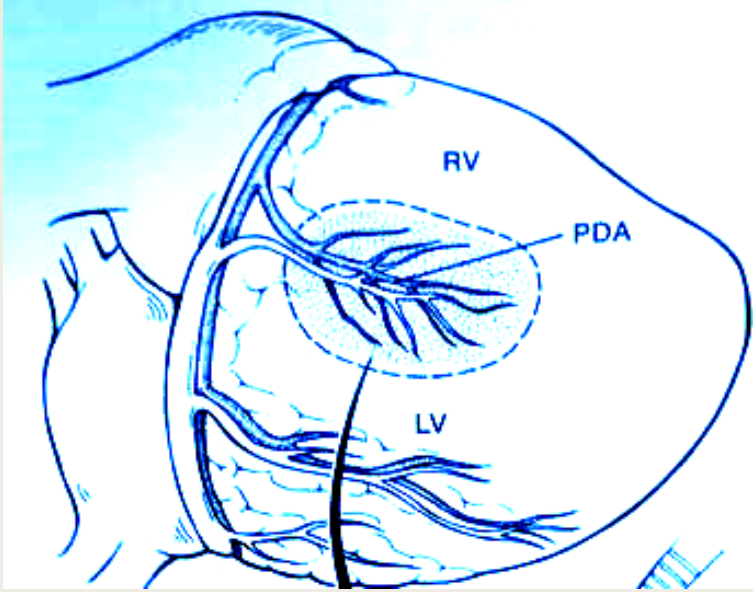
Sandwich double patch repair

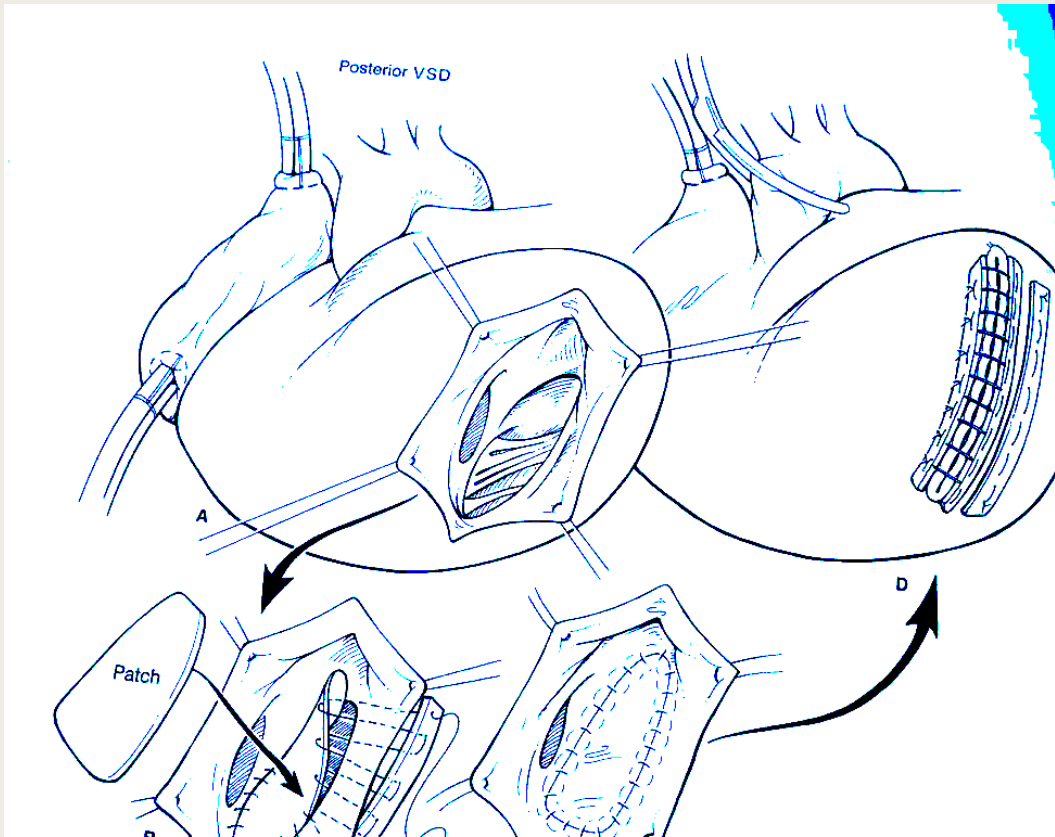
- Reduces residual VSR leak by securing closure of VSR bilaterally
- Patch also reinforces the fragile myocardium
- Double patch sustains pressure from both RV and LV better than a single patch



Posterior VSR

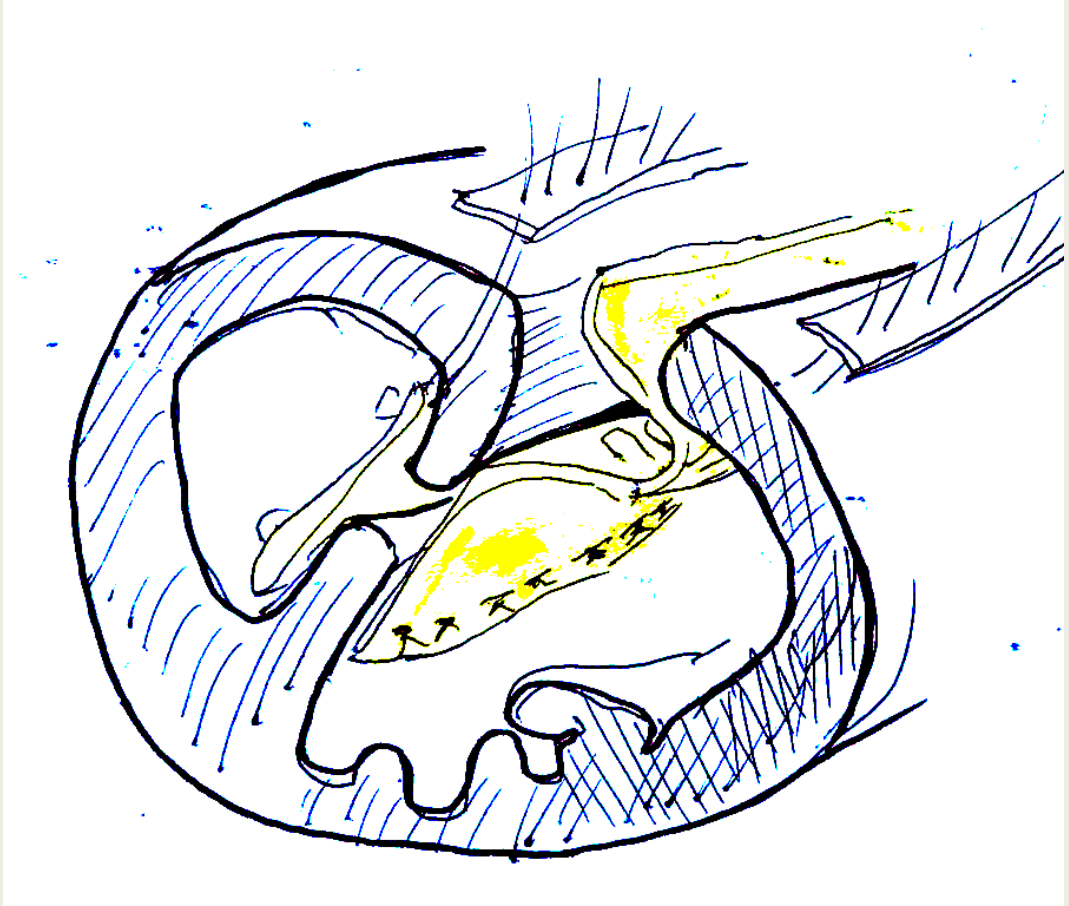
- More challenging
- PDA and posteromedial papillary muscle of MV in close proximity
- Trans-infarct ventriculotomy made 1cm lateral to PDA

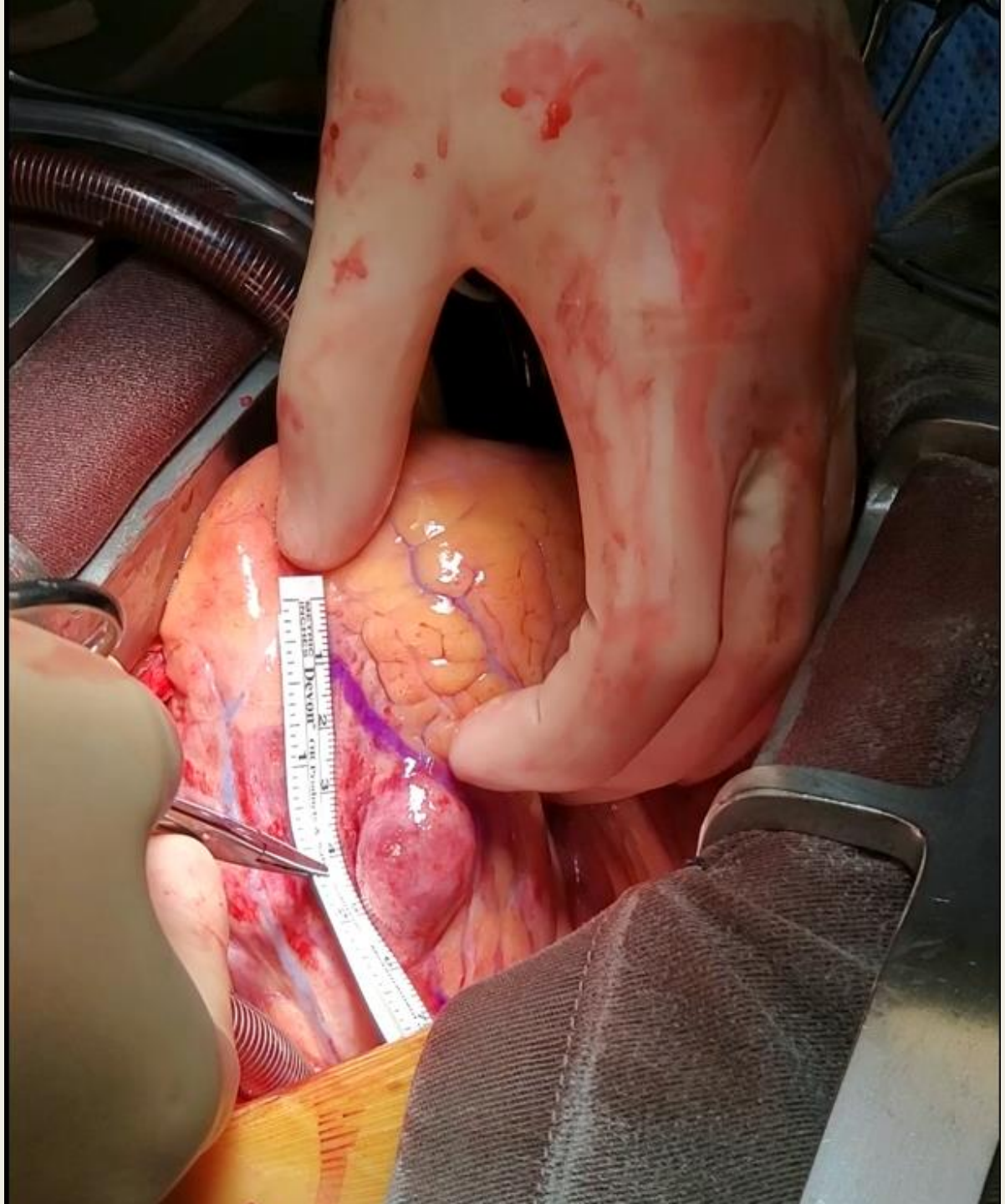


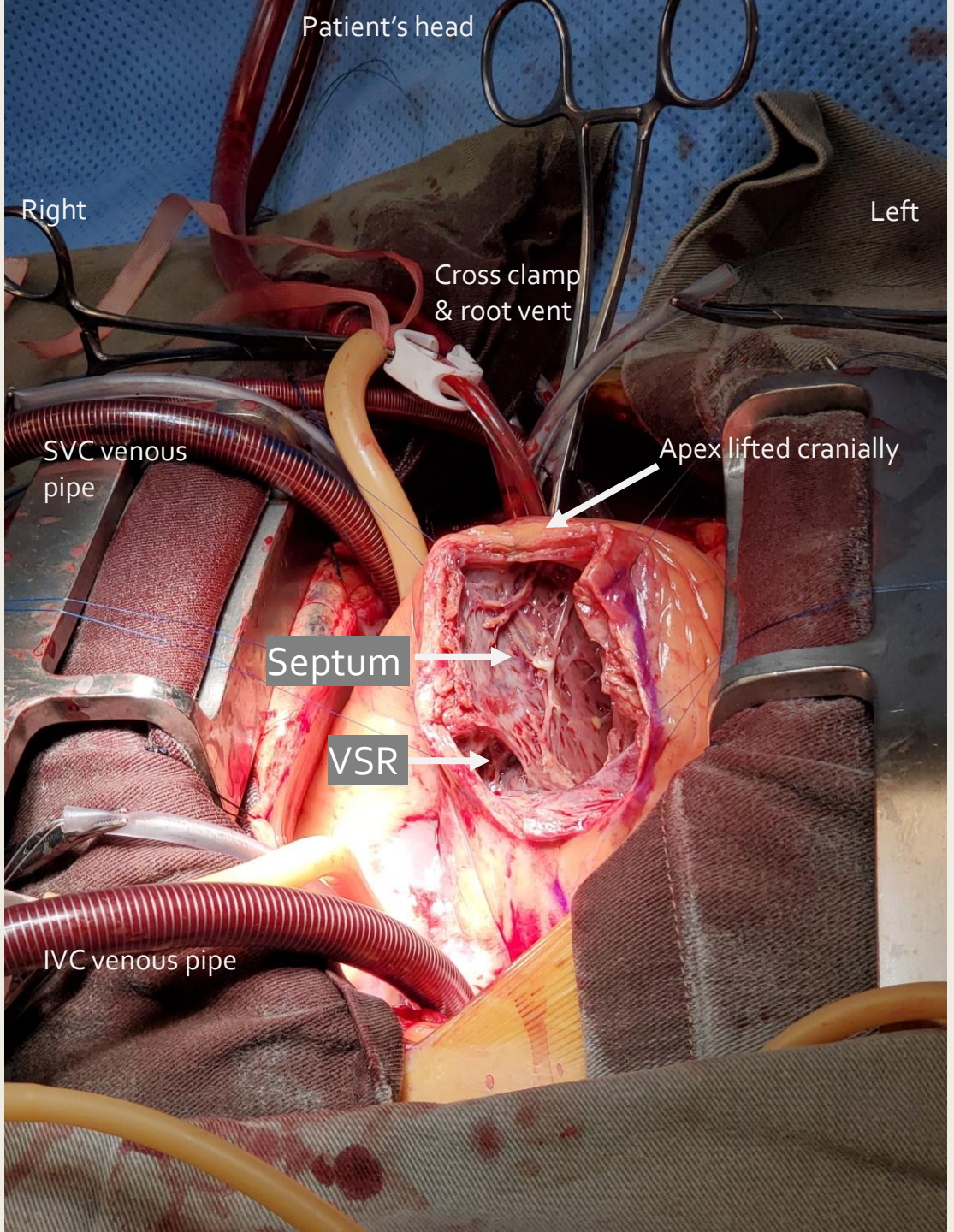


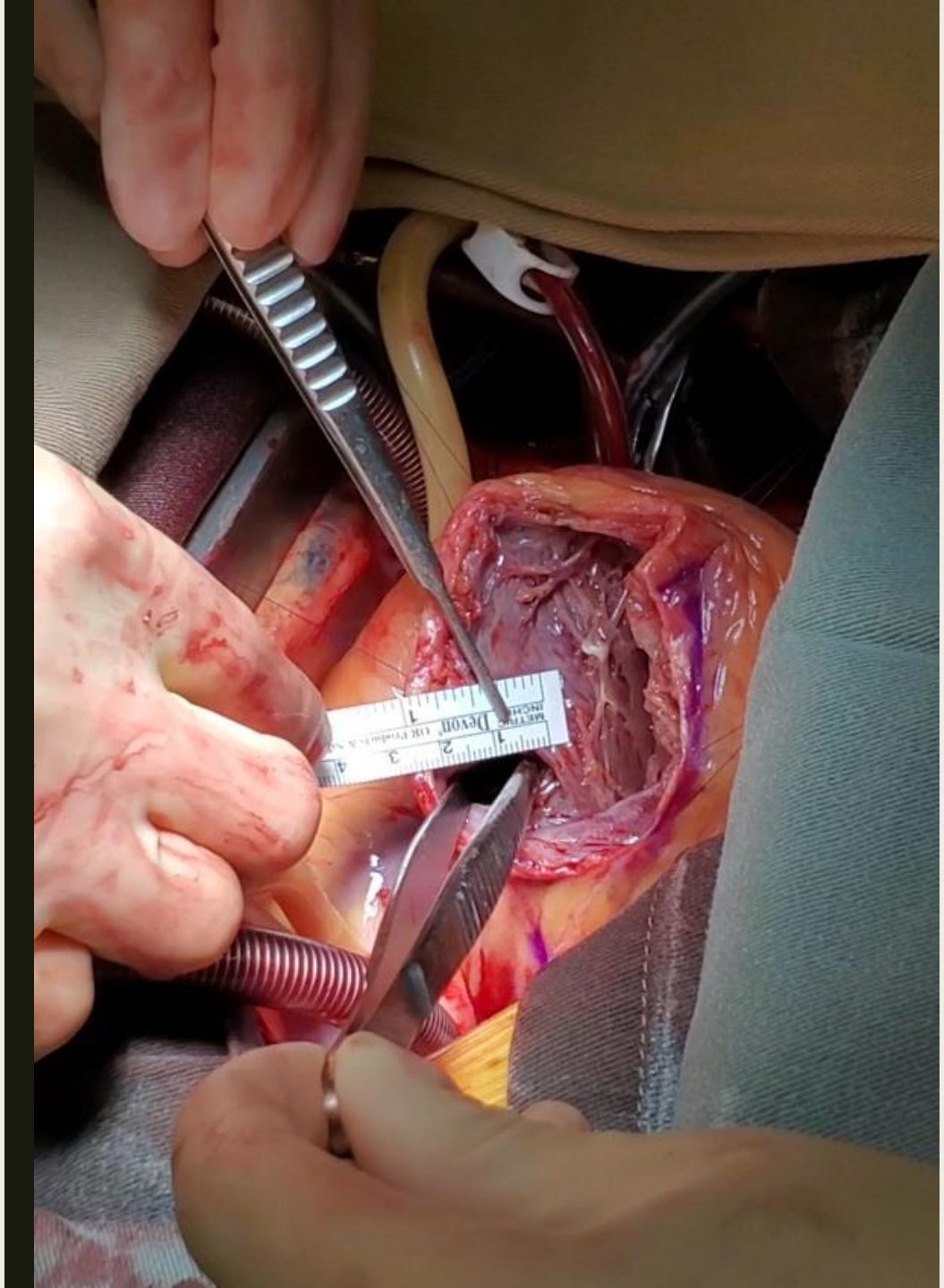
For our patient

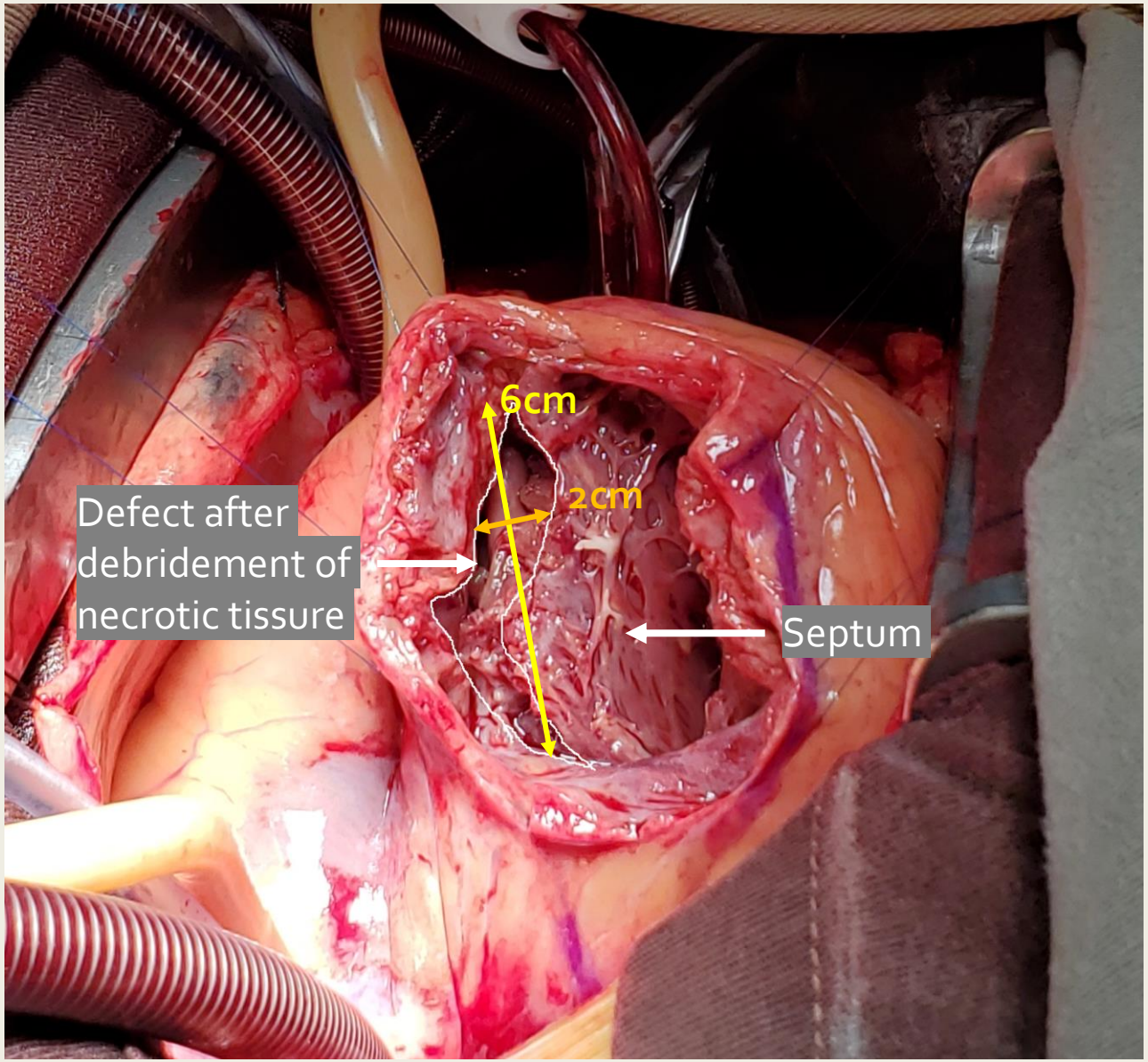
- **Double Patch + Infarct Exclusion**
- **Interrupted Sutures**
- **Principles of Successful VSR Repair**
  - *Expeditious cardiopulmonary bypass with moderate hypothermia*
  - *Meticulous attention to **myocardial protection***
  - ***Trans-infarct ventriculotomy***
  - ***Generous debridement** of LV infarcted tissue even if it involves enlarging the defect*
  - ***Avoid tension** by using appropriately sized patch (both septal defect and ventriculotomy)*
  - ***Large 1cm bites** of tissue*
  - ***Buttressing** of suture lines: pledgets/felts*

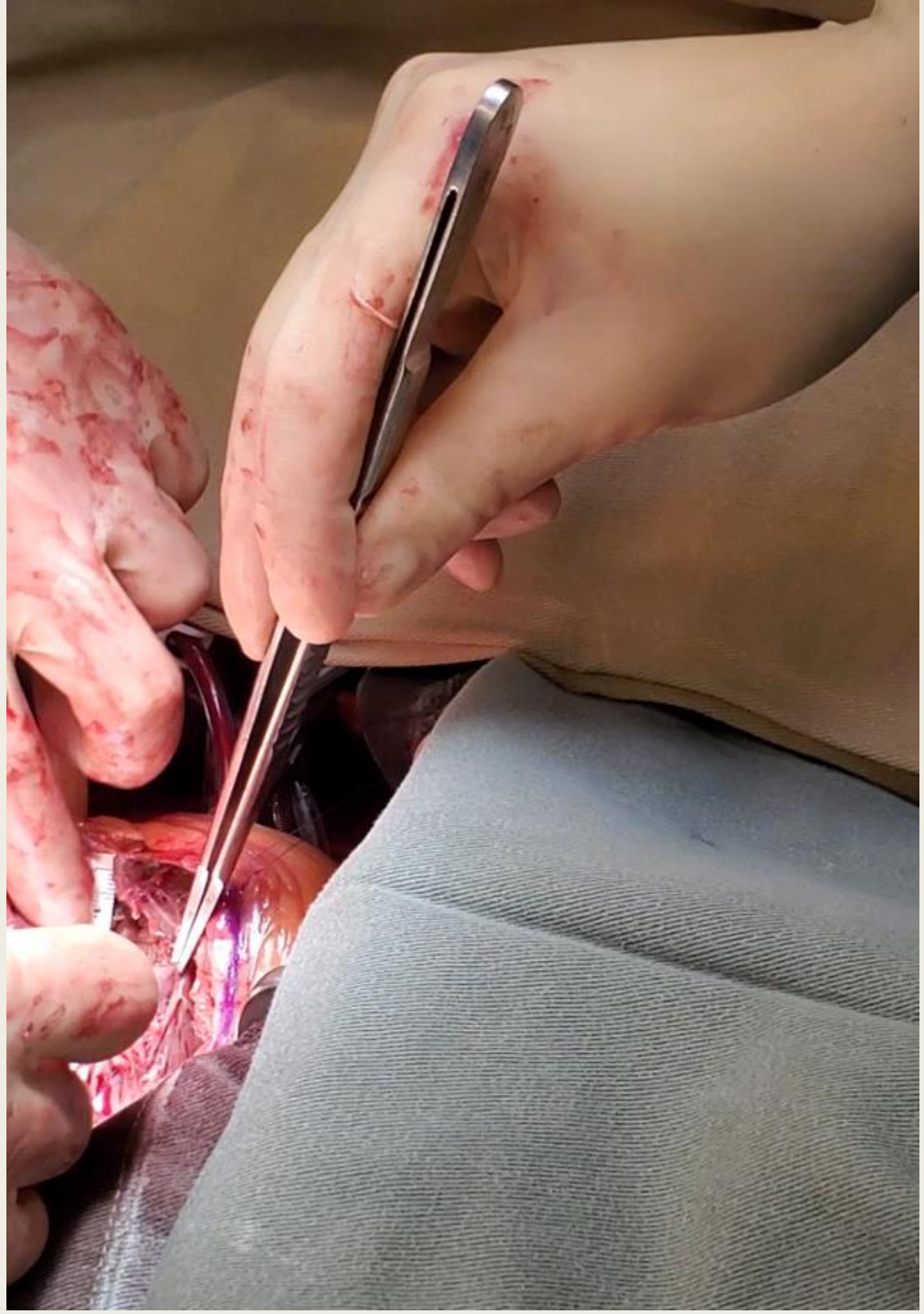


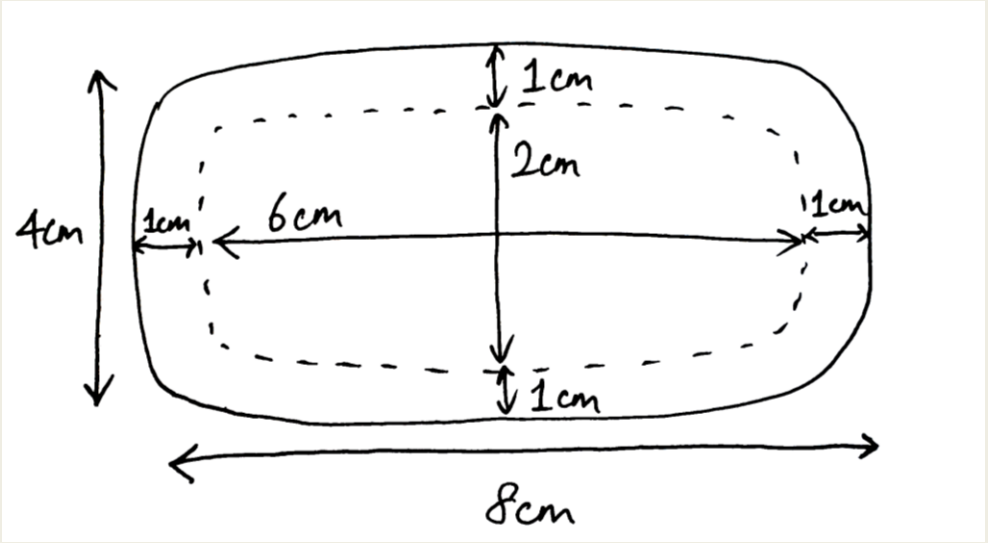


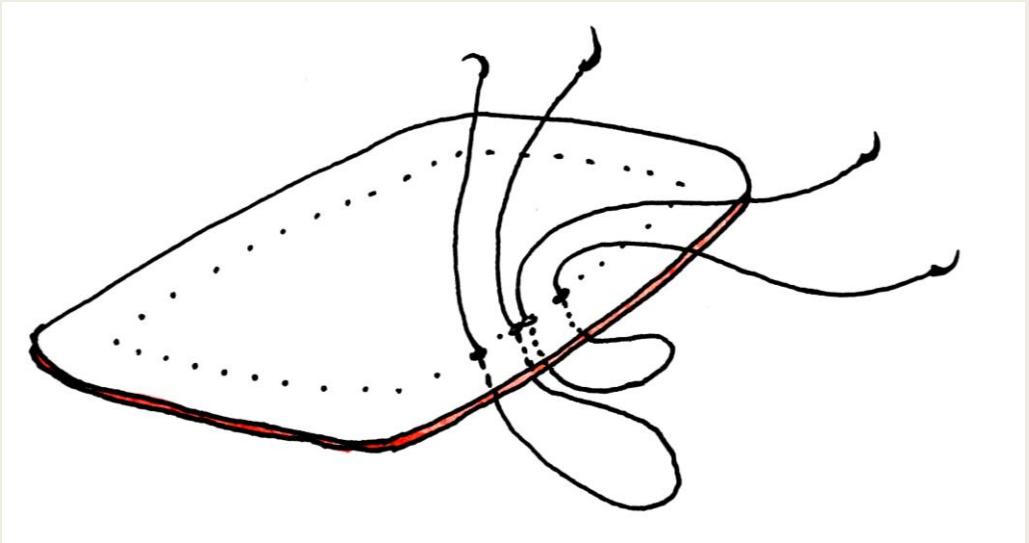

Patient's head
Right
Left
Cross clamp
& root vent
SVC venous
pipe
Apex lifted cranially
Septum
VSR
IVC venous pipe

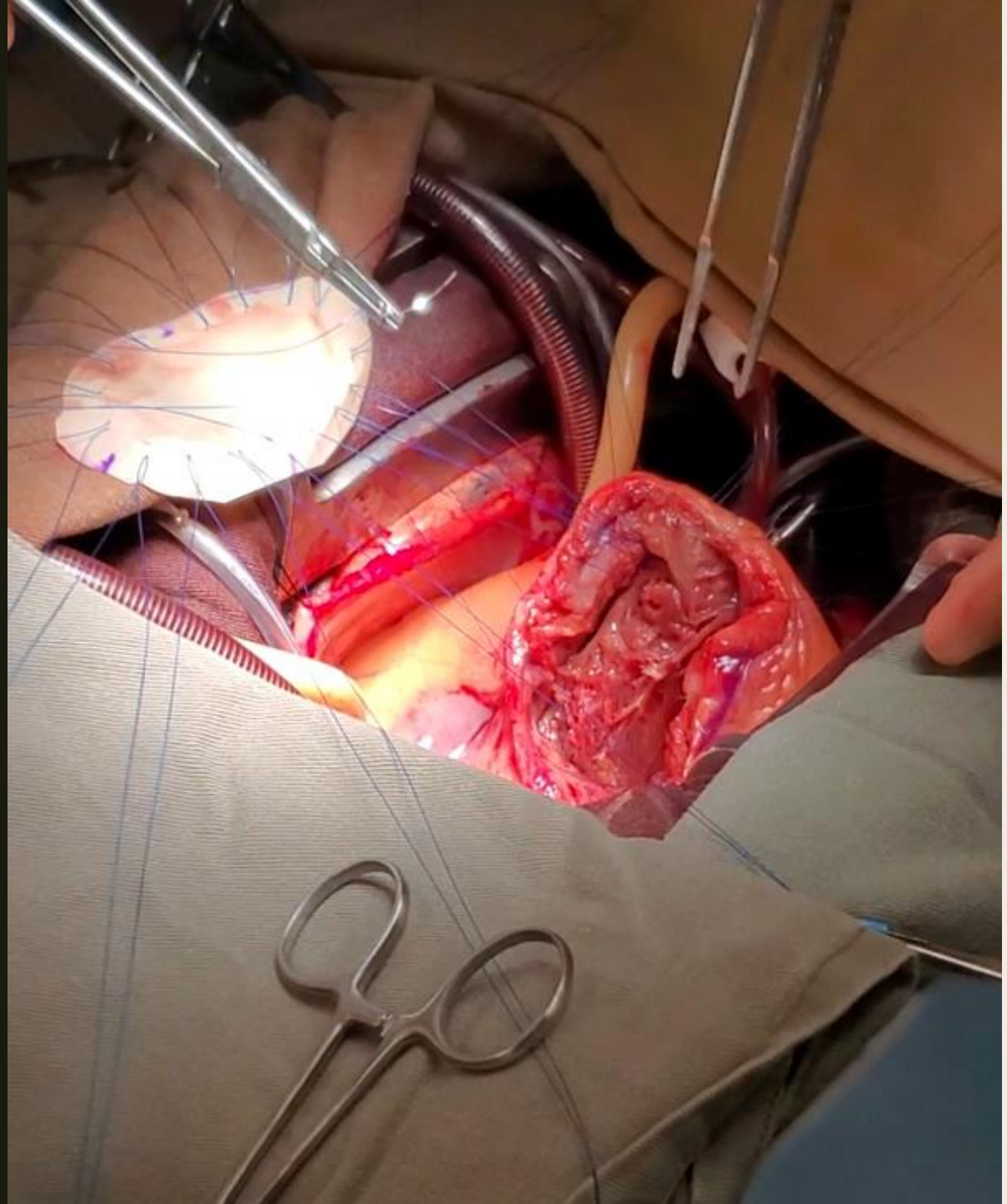


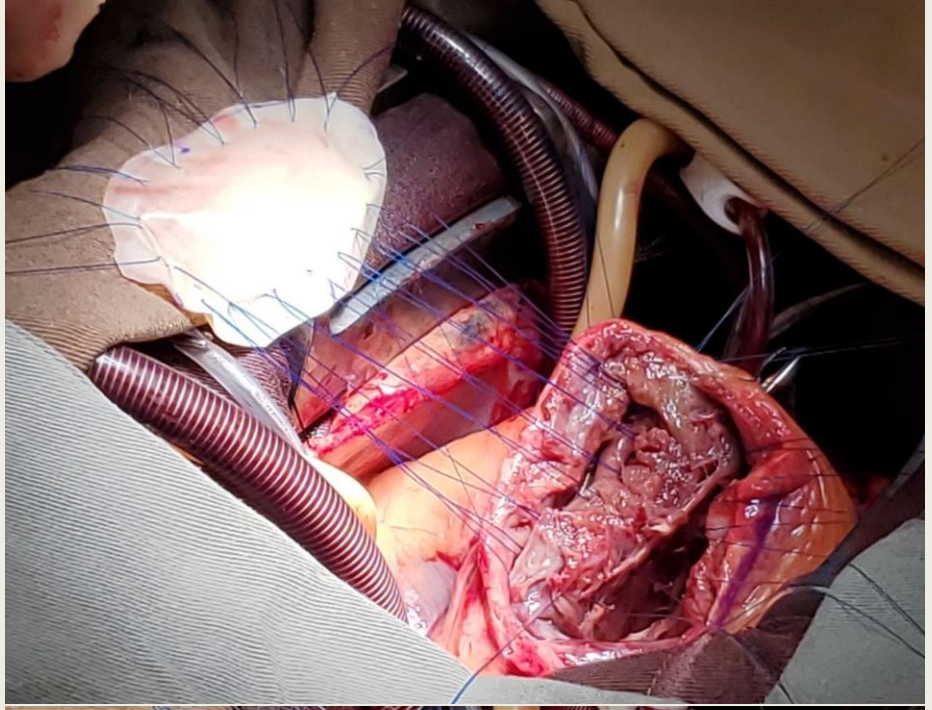

6cm
2cm
Defect after debridement of necrotic tissure
Septum

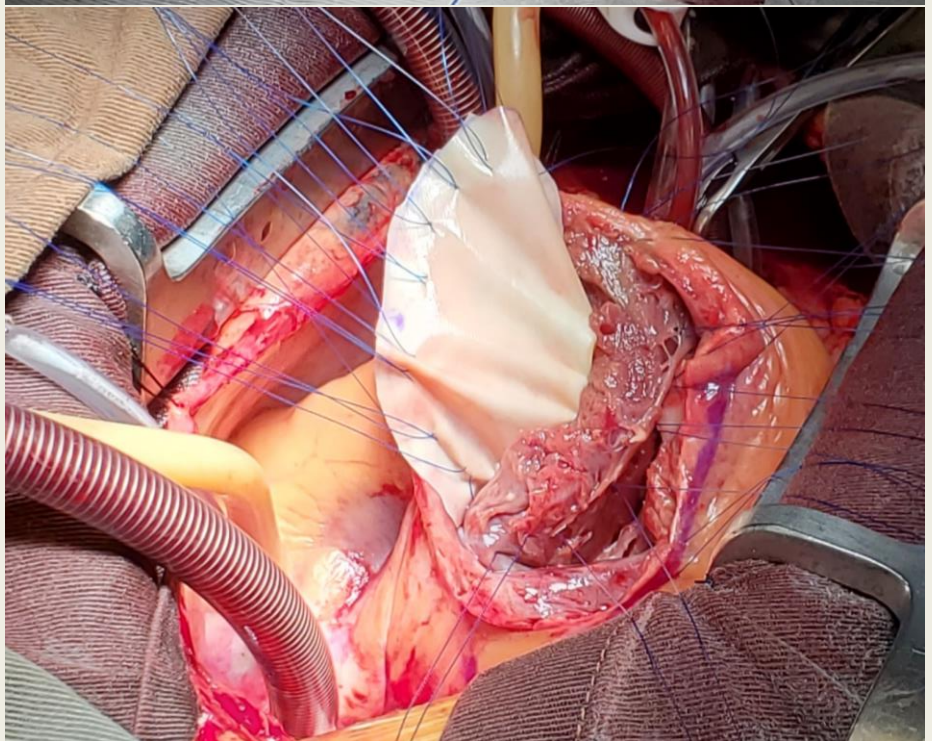


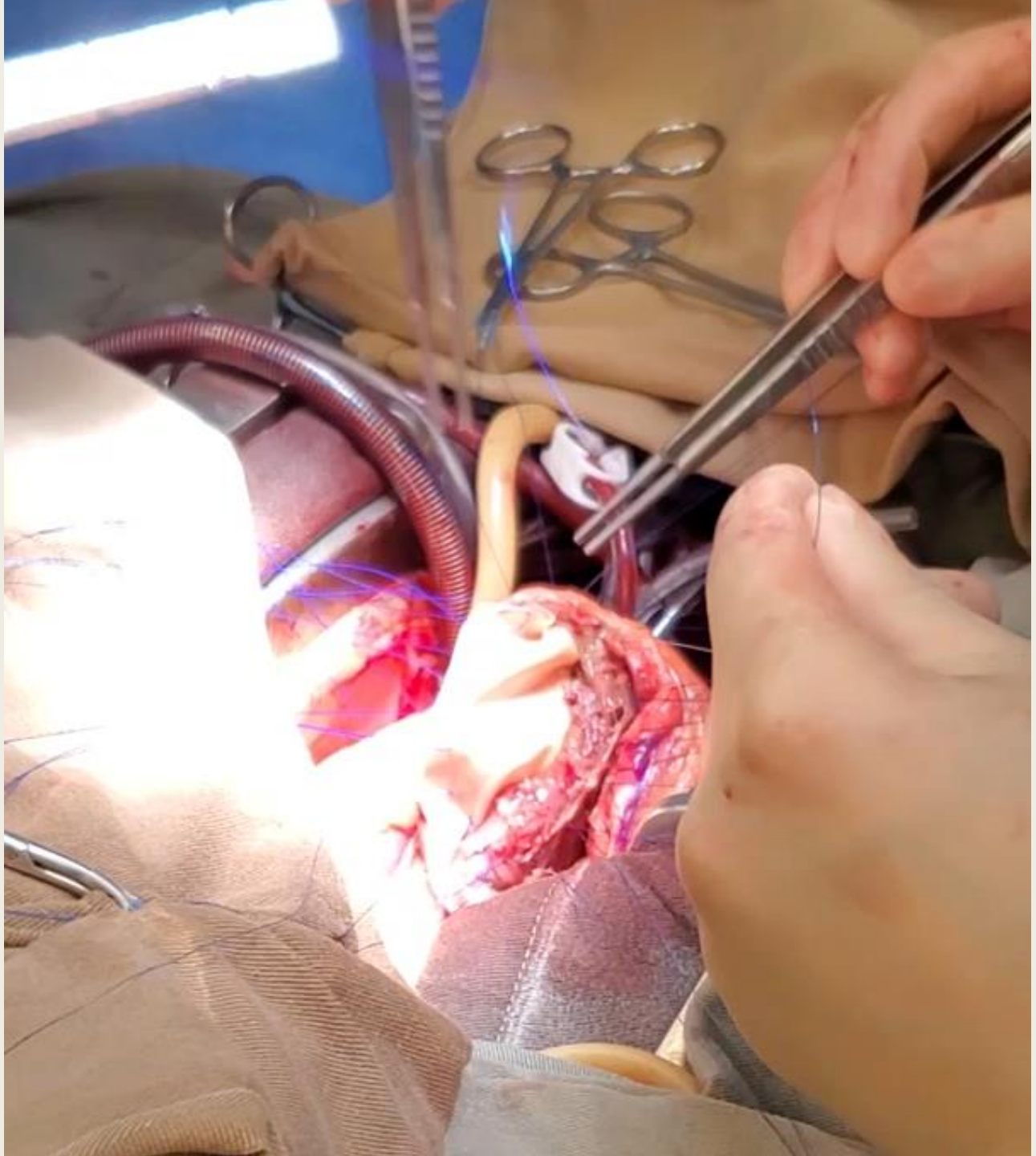

1cm
2cm
4cm
1cm
6cm
1cm
1cm
8cm

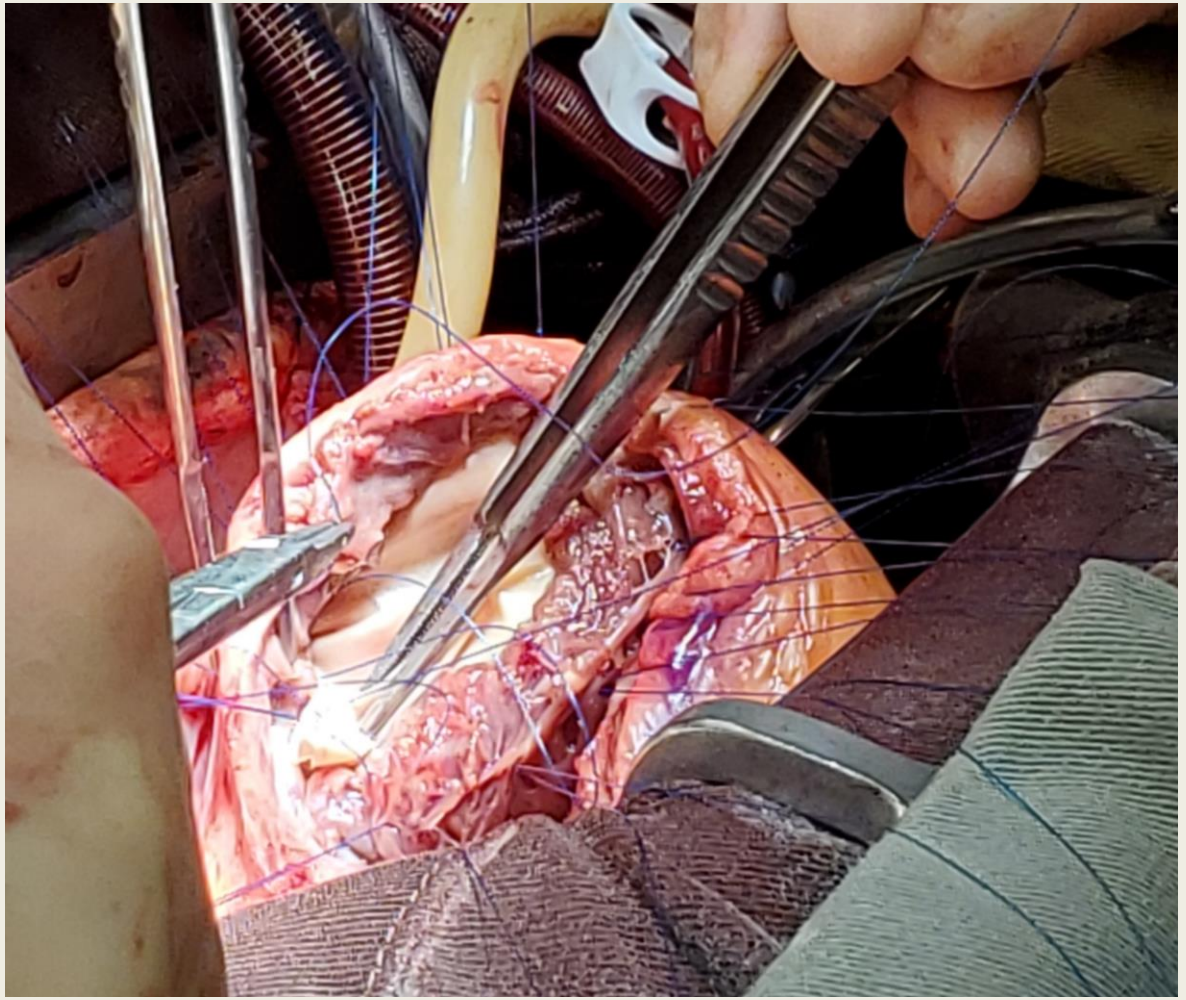


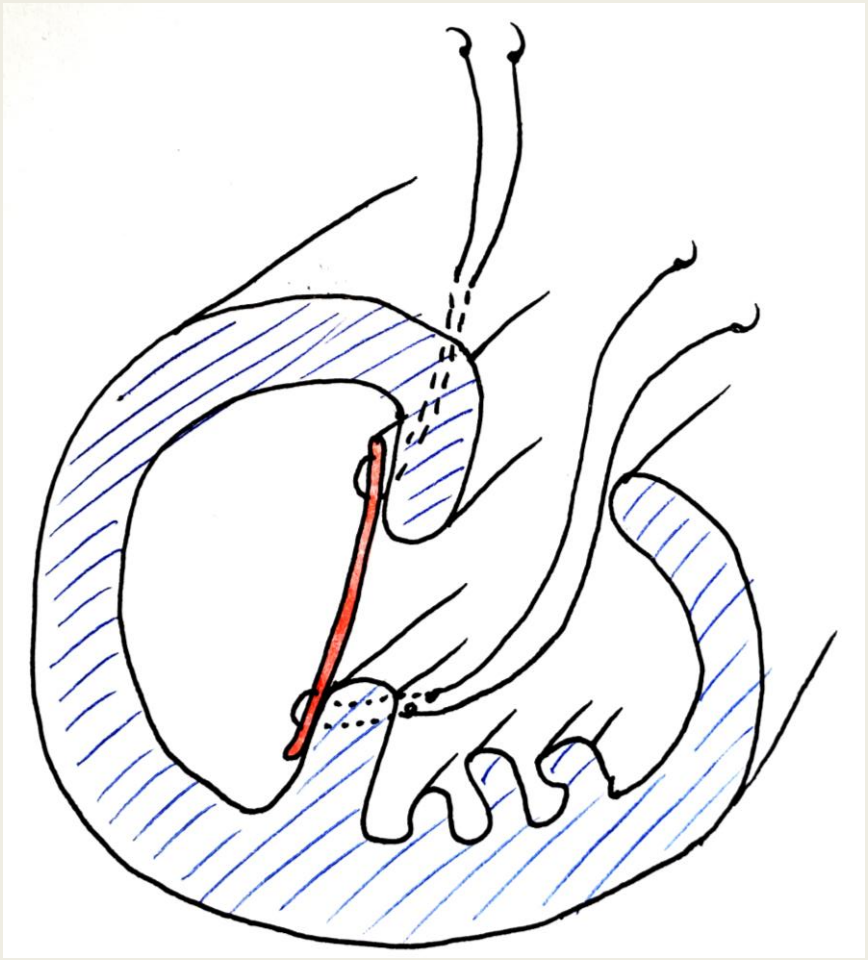


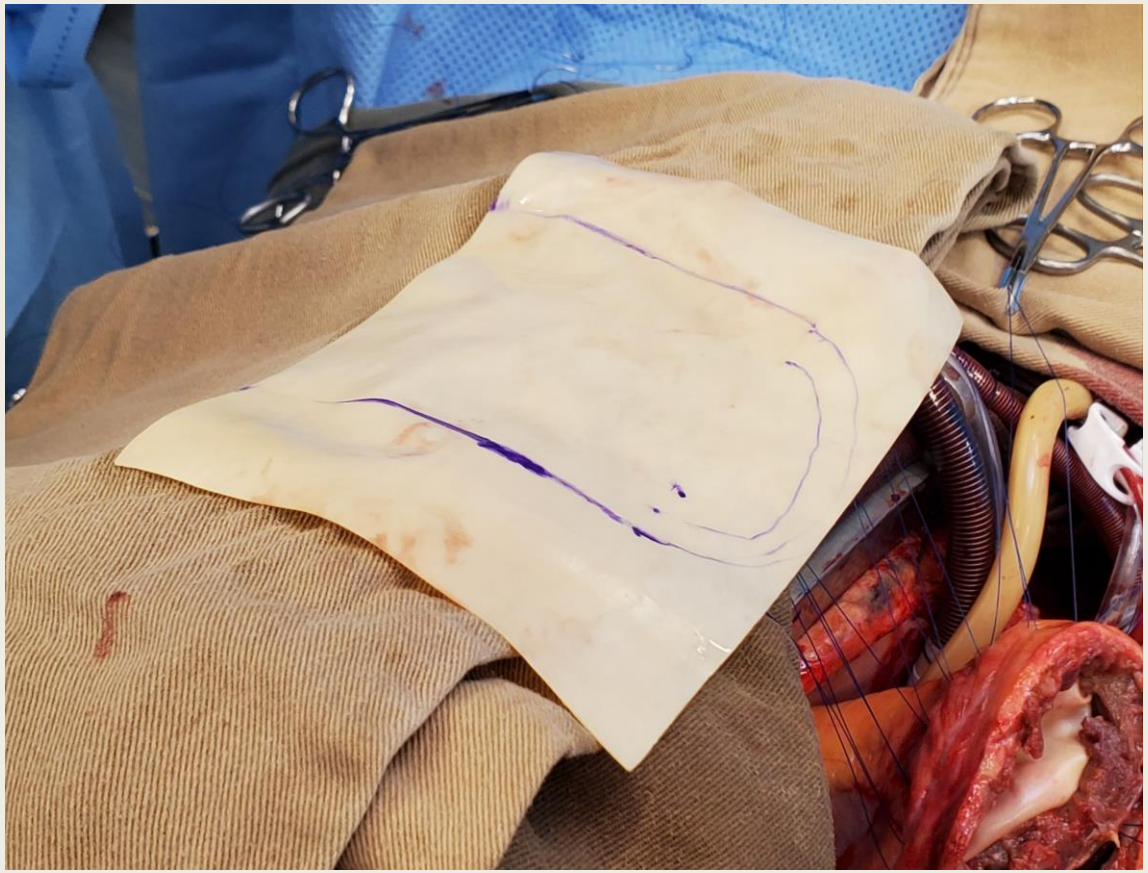


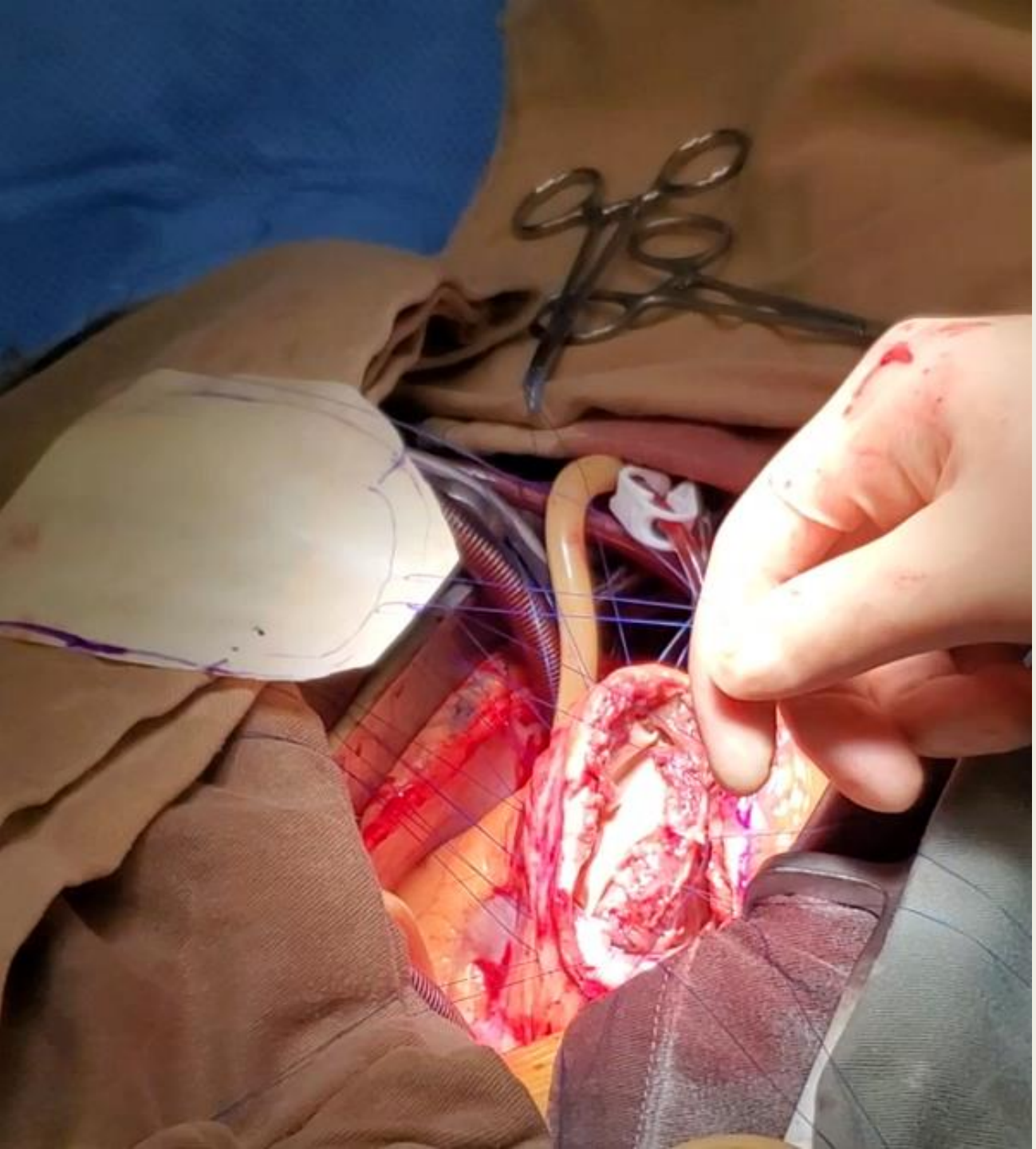


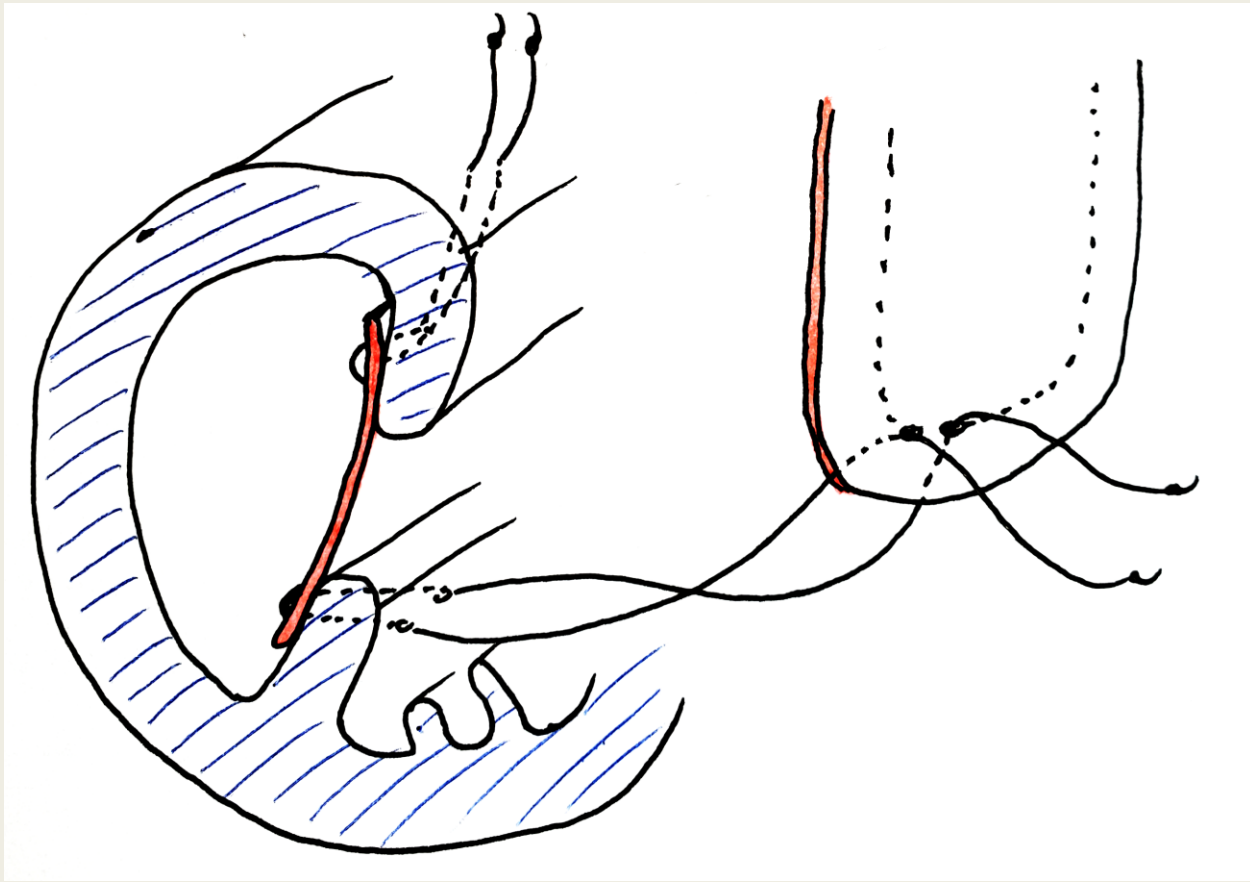


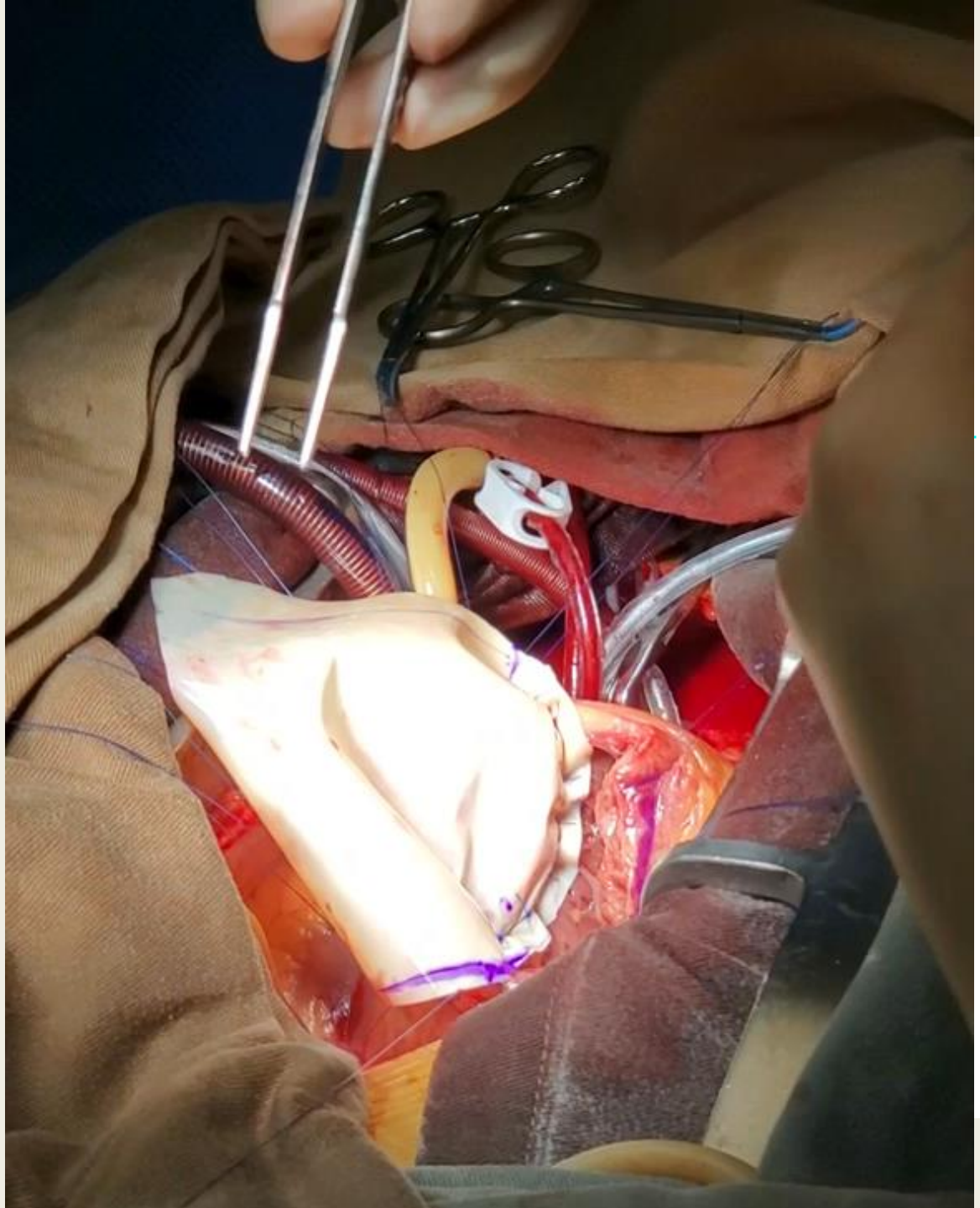


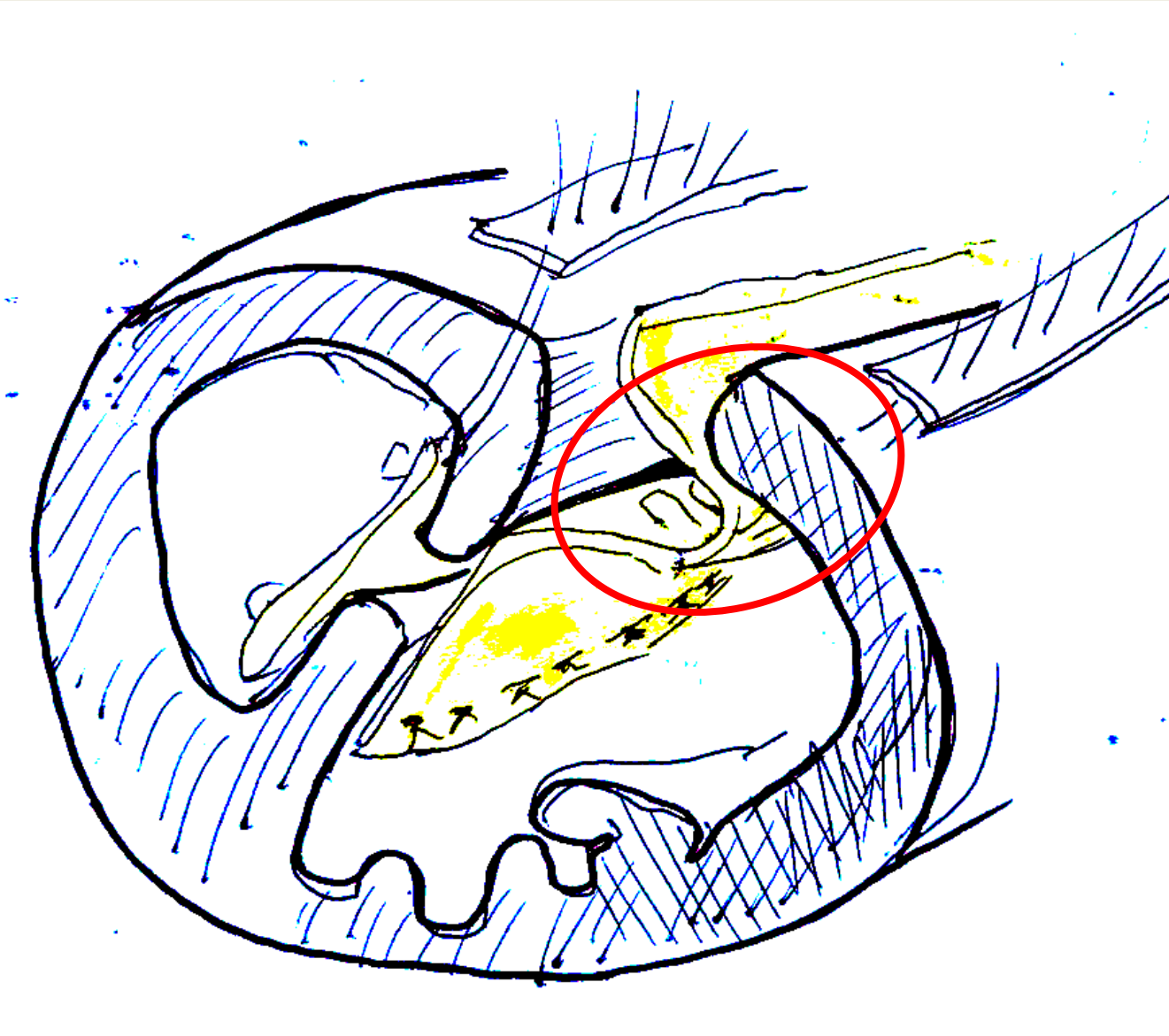


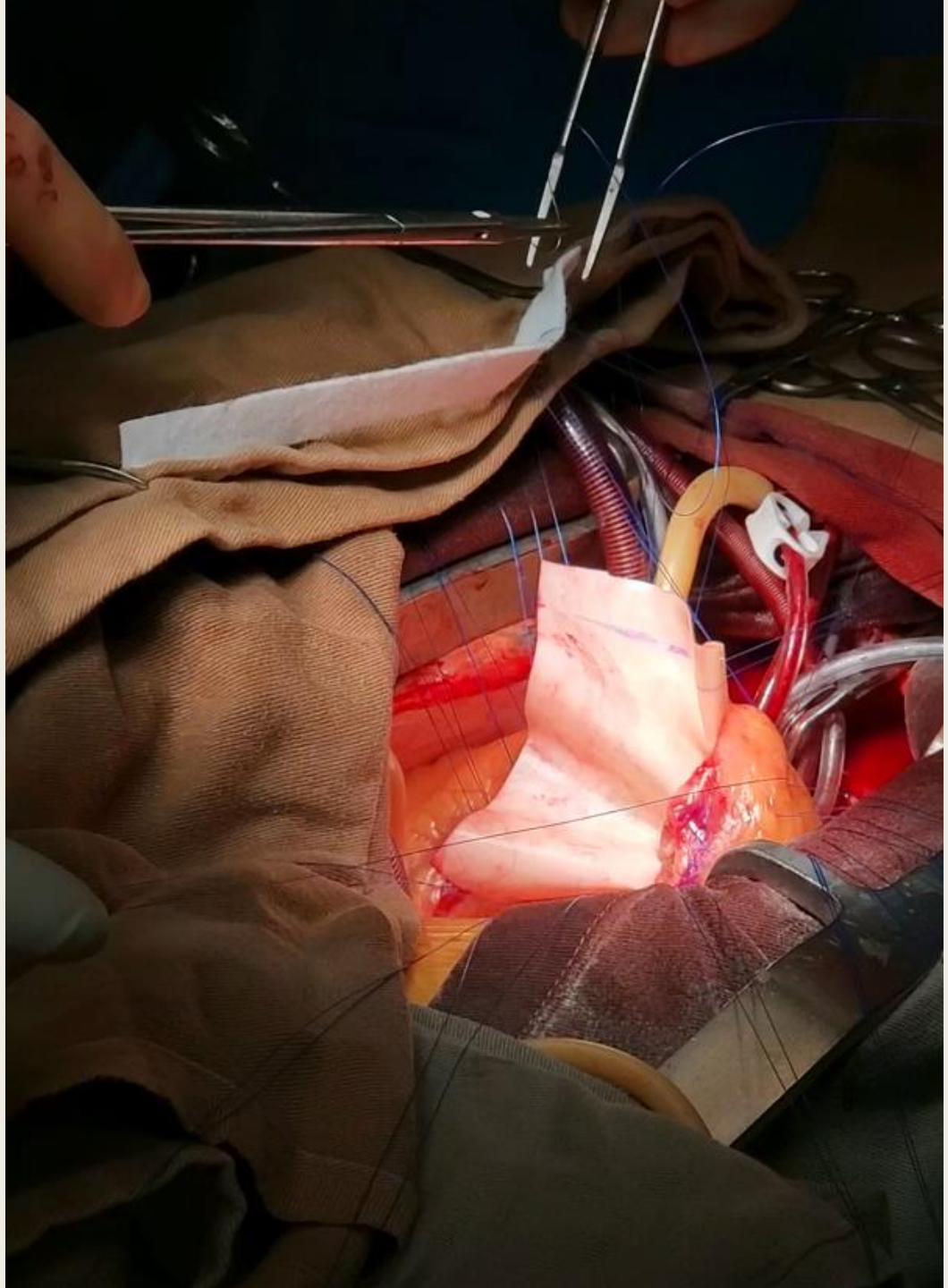


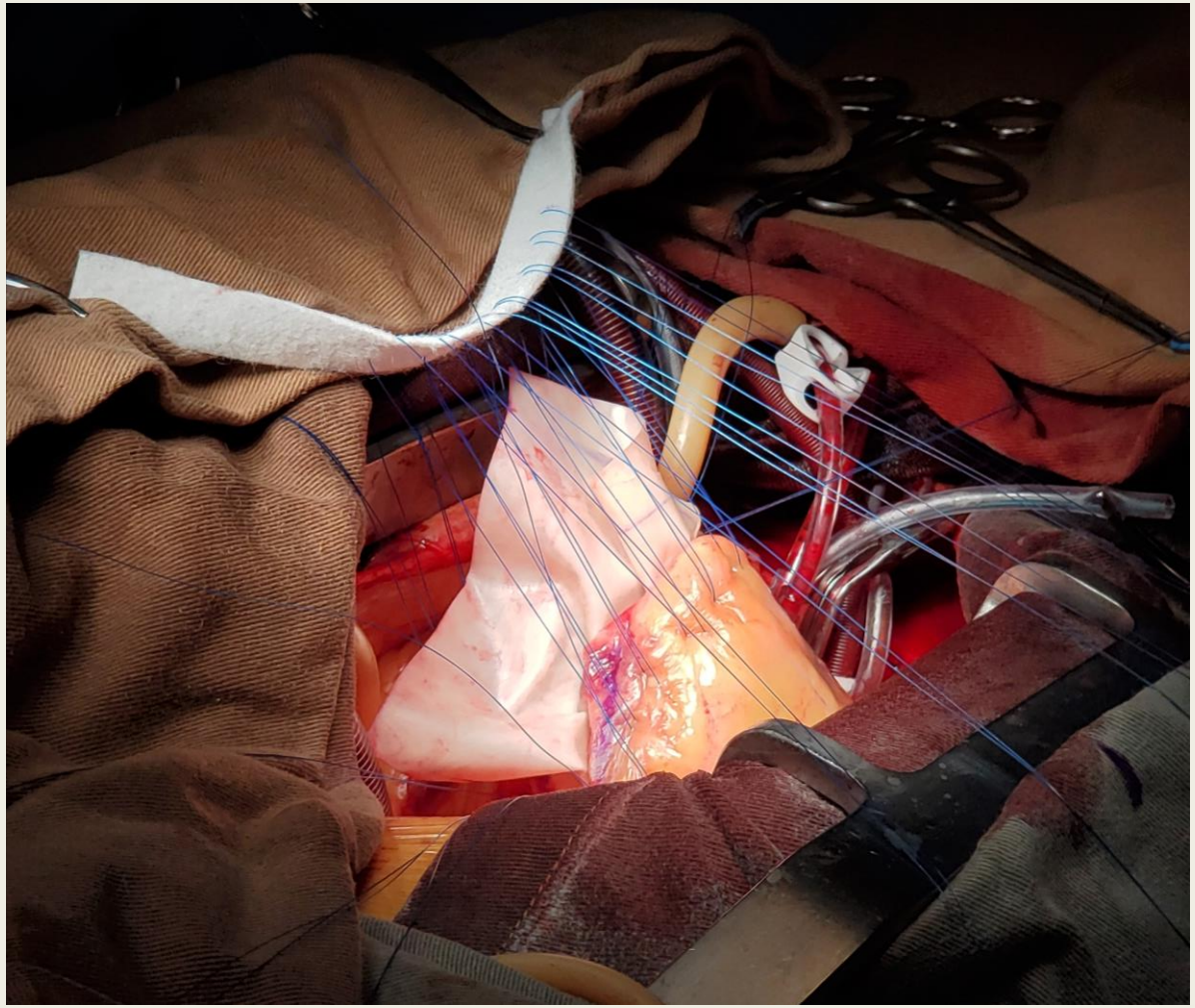


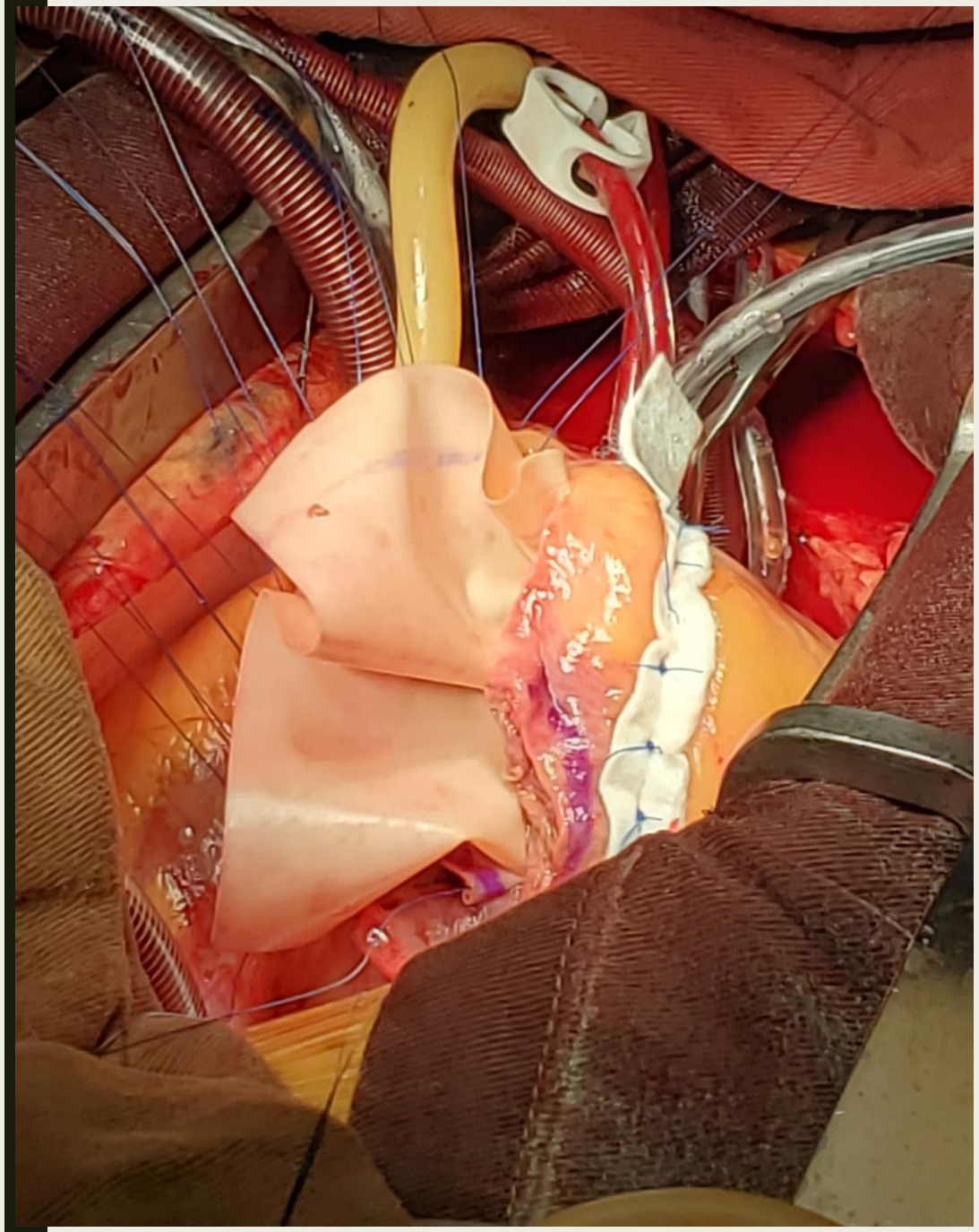


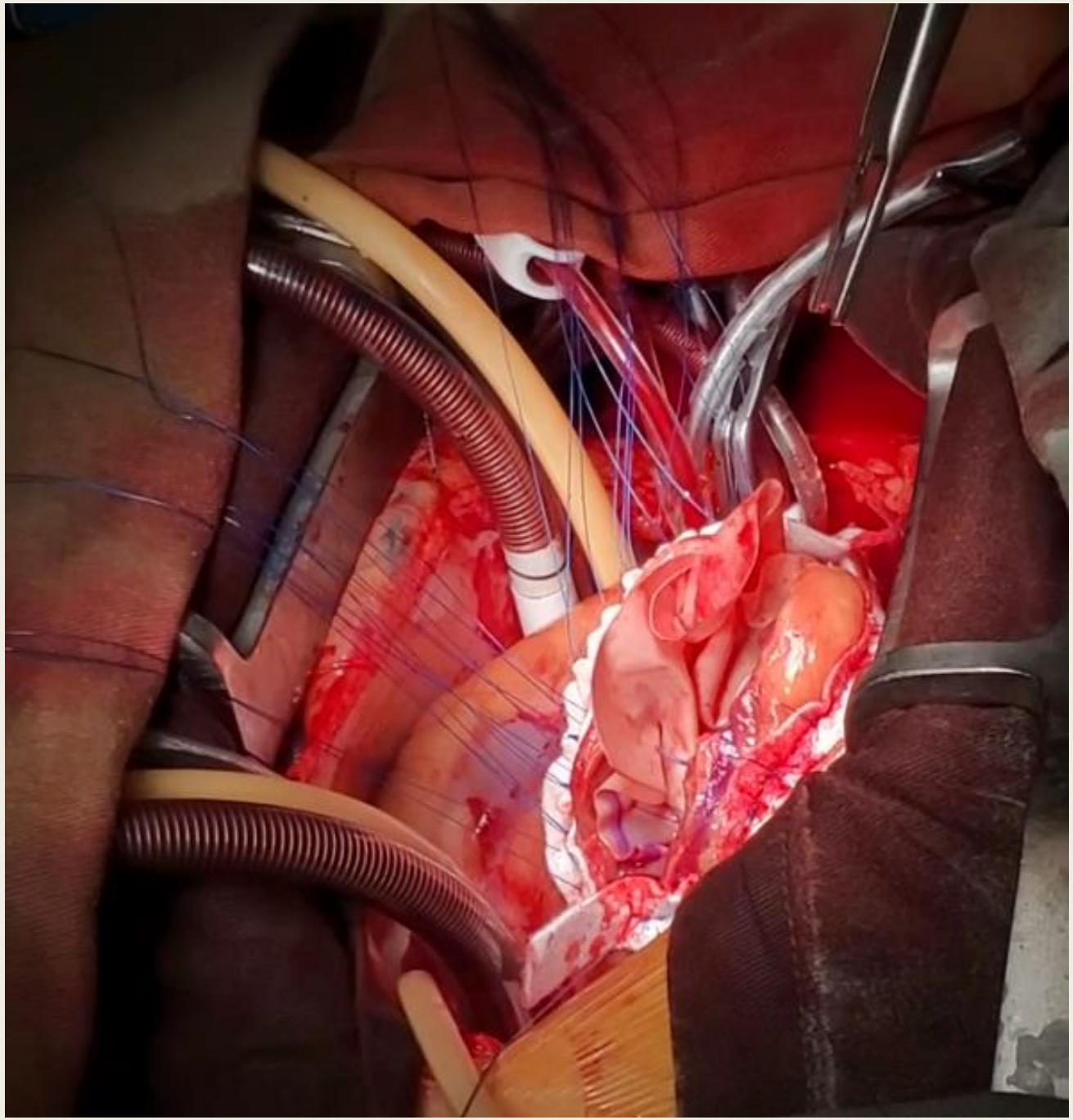


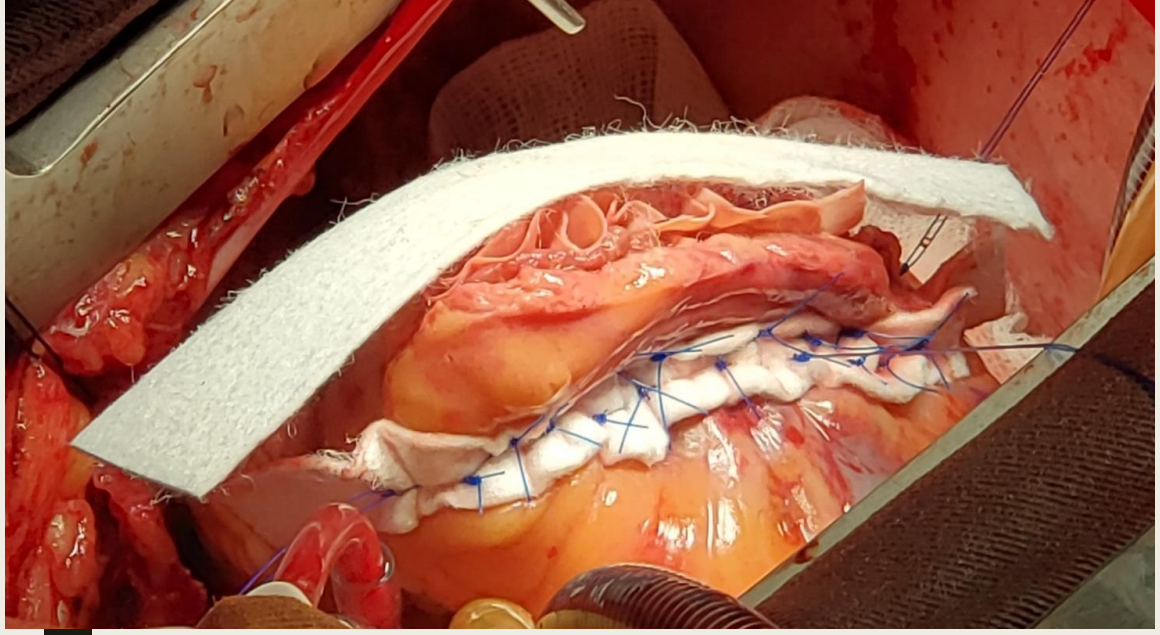


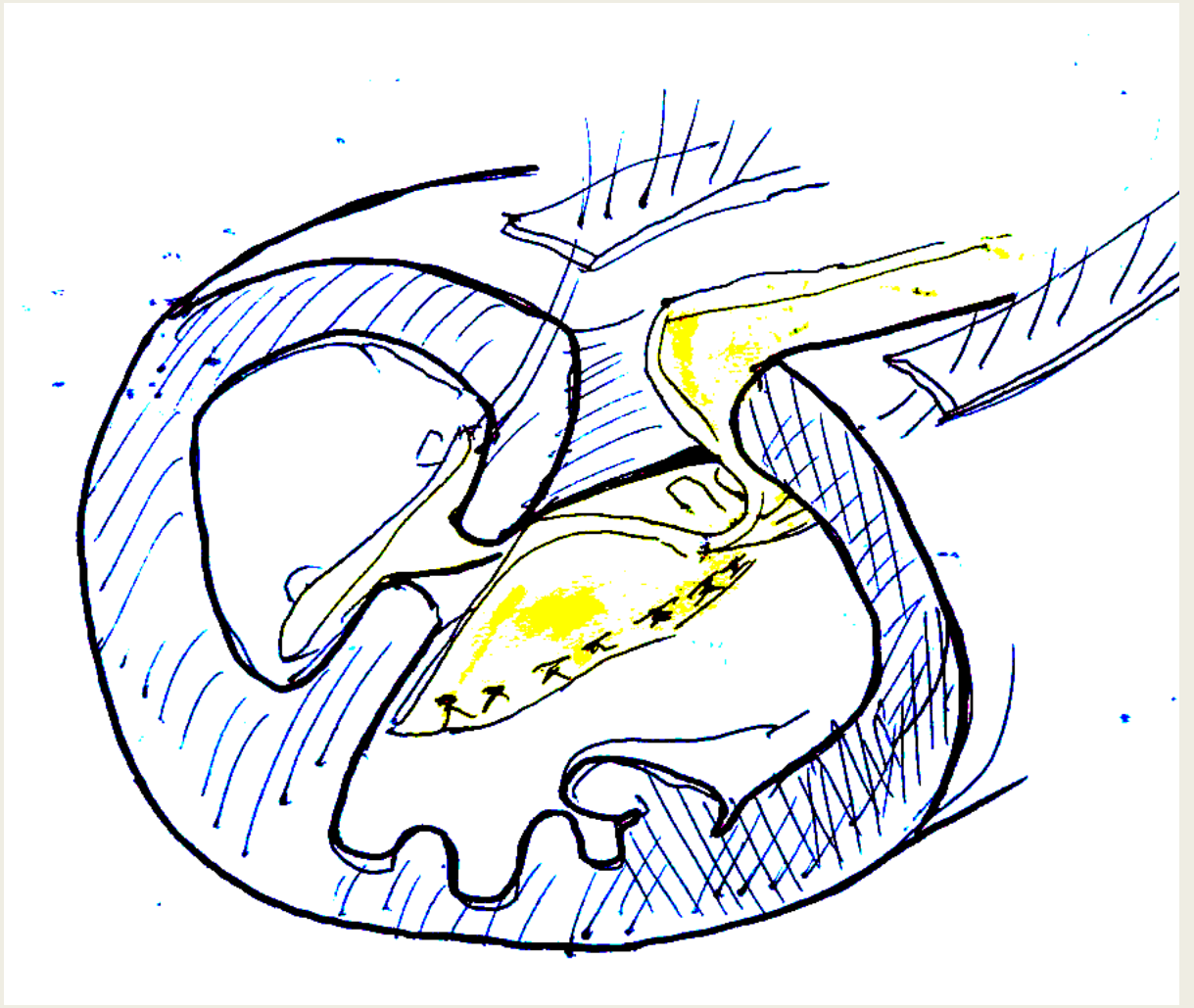












Post op course

- IABP weaned on day 3
- Echocardiogram on day 6:
  - *No residual VSR/pseudoaneurysm*
  - *LVEF 61%*
  - *Basal inferior akinesia*
- Discharged to rehab hospital on day 8

VSR REPAIR WITH DOUBLE PATCH REPAIR - PWH EXPERIENCE

Demographics and preop status

Patient	Age	Date of OT	Delayed presentation	Delayed days	Onset of MI	STEMI	Preop PCI	Coro	EF Preop	Position of VSR	Size of VSR
1	60	22/6/2018	Yes	10	14/5/2018	Yes	Yes	2VD: LAD+RCA	60%	Apical	1.98
2	75	2/8/2019	Yes	7	19/7/2019	Yes	No	TVD	40%	Apical	1
3	68	17/2/2020	Yes	7	3/2/2020	Yes	Yes	LAD aTO	20%	Apical	2
4	73	29/4/2020	Yes	10	26/4/2020	Yes	No	TVD	40%	Posterior	2

Patient	BiPAP	Intubation	IABP	ECMO	Log EuroSCORE	EuroSCORE II
1	yes	no	No	No	27	2.8
2	yes	no	Yes	no	71	34.25
3	yes	no	Yes	No	86	35
4	No	no	Yes	No	70	19

Operative Parameters

Patient	OT time	CBP Time	Ischemic Time	Intraop defect	Ventricular aneurysm	Ventriculectomy	Double patch	Approach	CABG	Other Concomitant
1	160	88	56	2cm	No	No	Yes	Right ventricular	No	No
2	265	148	104	1cm	Yes	Yes	Yes	Left ventricular	Yes	No
3	210	106	64	2	Yes	Yes	Yes	Left ventricular	No	No
4	290	163	115	2	Yes	Yes	Yes	Left ventricular	Yes	No
Mean	231.25	126.25	84.75							
SD	50.30	30.40	25.21							

- Consideration of LV or RV approach is dependent on the presence of ventricular aneurysm
- If LV aneurysmectomy is performed, LV approach is adopted to reduce ventricular insult
- So far all 4 survived and discharged

Take home message

- Post-infarct VSR is a rare but lethal complication of MI
- Surgical repair is definitive treatment
- Delaying surgical repair may be beneficial if patient can be stabilized
- Principles of successful VSR repair
- Double patch + Infarct exclusion technique improves success rate

Thank you!

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