SAM after Mitral Valve Repair

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Disclosures

• Consultant
  - Medtronic
  - Edwards
  - CryoLife
  - Abbott
  - ClearFlow
  - AtriCure

• Equity
  - ClearFlow

• Cleveland Clinic
  - Right to royalties from AtriCure
Case

- 58 year-old man
- Asymptomatic
- P2 prolapse
Triangular Resection
No trigger detected - defaulting to 1 second capture(s)
SAM!
SAM

• What happened?
• Predictors
• Prevention
• Treatment
  - Medical
  - Surgical
What Is SAM?
SAM

• Definition
  - Movement of anterior mitral leaflet into LVOT during systole

• Mechanisms
  - AML pulled into LVOT (Venturi effect)
  - AML pushed into LVOT (drag)

• Result
  - LVOT obstruction
  - MR
SAM Occurrence

5-8%

Repair for degenerative MR
Predictors
Echocardiographic Predictors of Left Ventricular Outflow Tract Obstruction and Systolic Anterior Motion of the Mitral Valve After Mitral Valve Reconstruction for Myxomatous Valve Disease

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OBJECTIVE To determine predictors of systolic anterior motion and left ventricular outflow tract obstruction (SAM/LVOTO) after mitral valve repair (MVRep) in patients with myxomatous mitral valve disease.

BACKGROUND Mechanisms for the development of SAM/LVOTO after MVRep have been described; however, predictors of this complication have not been explored. We hypothesize that pre-MVRep transesophageal echocardiography (TEE) can predict postrepair SAM/LVOTO.

METHODS Using TEE, the lengths of the coapted anterior (AL) and posterior (PL) leaflets and the distance from the coaptation point to the septum (C-Sept) were measured before and after MVRep in 33 patients, including 11 who developed SAM/LVOTO (Group 1) and 22 who did not (Group 2).

RESULTS Group 1 patients had smaller AL/PL ratios (0.99 vs. 1.95, p < 0.0001) and shorter distances (2.53 vs. 3.01 cm, p < 0.0001) than Group 2 patients post-MVRep than those in Group 2 patients.
SAM Predictors

- Coaptation-septum distance < 25 mm
- Aorto-mitral angle < 120 °
- Posterior leaflet height > 15 mm
- Ant/post leaflet height ≤ 1.3
- Basal septal diameter ≥ 15 mm
- EDD < 45 mm
- Hyperdynamic ventricle

Varghese et al. European J C-T Surg 2013
SAM Predictors

Too much leaflet tissue
SAM Predictors

Too much leaflet tissue

*Relative to the ventricle*
Prevention
Prevention

- General principles
  - Posterior leaflet height < 15 mm
  - Avoid small annuloplasty
Prevention

- Manage posterior leaflet
  - Sliding repair
  - Folding repair
  - Short neochordae
- Others
  - Large, open annuloplasty
  - Edge-to-edge repair
Left Ventricular Outflow Tract Obstruction
After Mitral Valve Repair
Results of the Sliding Leaflet Technique

Victor A. Jebara, MD; Serban Mihaileanu, MD; Christophe Acar, MD; Christian Brizard, MD; Philippe Grare, MD; Christian Latremouille, MD; Sylvain Chauvaud, MD; Jean Noël Fabiani, MD; Alain Deloche, MD; Alain Carpentier, MD, PhD

Background. Left ventricular outflow tract obstruction (LVOTO) occurs in 4% to 5% of patients after prosthetic ring mitral valve repair. Major anatomic factors incriminated in the genesis of LVOTO include degenerative mitral valve insufficiency with excess leaflet tissue, nondilated left ventricular cavity, and narrow mitro-aortic angle. We have previously reported a 14% incidence of LVOTO after prosthetic ring mitral valve repair in this high-risk group of patients. Serial echo Doppler studies demonstrated an overlapping and/or inversion of the left ventricular functional compartments generating systolic anterior motion of the posterior leaflet and paradoxical opening (eversion) of the anterior leaflet. In an attempt to eliminate LVOTO after mitral valve repair, a new surgical procedure was developed in 1988 by Carpentier: the sliding leaflet technique, which reduces the height of the posterior leaflet. The purpose of this study was to analyze the results of the new technique in terms of the occurrence of LVOTO.

Methods and Results. Eighty-two patients undergoing prosthetic ring mitral valve repair between 1988 and 1991 and identified as high risk for LVOTO were operated on using the sliding leaflet technique. There were 52 men and 30 women. Ages ranged from 28 to 75 years. The surgical techniques used included prosthetic ring annuloplasty (n=82), leaflet resection (n=82), chordal shortening or transposition (n=36), and other (n=19). Intraoperative and/or immediate postoperative echo Doppler studies were obtained in all cases. Two patients (2.4%) died, and 2 (2.4%) required reoperation. Nonsignificant LVOTO was identified in 2 cases (2.4%), in whom instantaneous maximal subaortic jet pressure were 20 and 18 mm Hg, respectively.

Conclusion. This study...
Sliding Repair
Folding Repair
Treatment
Systolic anterior motion after mitral valve repair: where do we stand in 2015?

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Keywords: Systolic anterior motion • Mitral repair • Mitral regurgitation

Systolic anterior motion (SAM) is a well-recognized complication of mitral reconstructive surgery [1]. SAM refers to the dynamic anterior movement of the mitral valve (MV) towards the interventricular septum during systole creating a left ventricular outflow tract (LVOT) obstruction almost invariably associated with residual mitral regurgitation (MR).

The degree of this complication can range from minor chordal protrusion with minimal LVOT obstruction and trivial MR to more severe obstruction with massive MR leading to haemodynamic instability, low cardiac output syndrome and intractable hypotension.

SAM can be transient and easily reversible or more resistant, necessitating to medical therapy and requiring new technique

Clearly, SAM is a multifactorial entity and the probability of this complication is higher when several anatomical and haemodynamic predisposing components co-exist.

HOW TO PREVENT SYSTOLIC ANTERIOR MOTION

When risk factors for SAM are identified, a tailored surgical strategy has to be adopted to prevent this complication [4].

Whenever excess leaflet tissue is present, leaflet resection with sliding plasty is applied in order to unburden the posterior leaflet more than 15 mm.
SAM Treatment Algorithm

**STEP 1**
- Avoid/discontinue inotropes
- Volume expansion

**STEP 2**
- β-blockers (esmolol) use
- Increase afterload (pharmacologically/partial digital occlusion of the ascending aorta)

**Repair revision**
- EE technique
- Posterior leaflet shortening
- Shortened neochord
- Sliding plasty if initially not done
- Upsized ring
- Ellipsoid excision of anterior leaflet
Pharmacologic Treatment

• Volume load
• Discontinue inotropes
• B-blockers
• Increase afterload (MAP > 80 mm Hg)
Pharmacologic Treatment

- Volume load
- Discontinue inotropes
- β-blockers
- Increase afterload (MAP > 80 mm Hg)

Successful in > 80%
Late clinical outcome of transient intraoperative systolic anterior motion post mitral valve repair

Rafael Kuperstein, MD, a Dan Spiegelstein, MD, a Gilad Rotem, BSc, b Michael Stein, BASc, b Alexander Kogan, MD, b Leonid Sternik, MD, b and Ehud Ramanani, MD b

ABSTRACT

Objective: Systolic anterior motion (SAM) after mitral valve repair with significant mitral regurgitation requires immediate reintervention. Transient SAM immediately after repair is usually managed by hemodynamic maneuvers. We investigated the late clinical and echocardiographic significance of postoperative transient SAM.

Methods: Between 2004 and 2013, mitral valve repair was performed on 549 consecutive patients with degenerative mitral valve disease. Of the 45 patients (8.2%) identified with postrepair SAM, 5 needed immediate reintervention. Hemodynamic maneuvers, such as preload and afterload augmentation and rate control, effectively abolished SAM in 40 patients (SAM). They were followed and compared with the remaining 509 patients (non-SAM).

Results: Mean clinical follow-up was 54 ± 28 and 31 ± 26 months and was available in 100% and 95% (SAM and non-SAM) patients, respectively. One hospital death occurred in each group (P = .14). At follow-up, 2 patients (0.3%) showed significant SAM with left ventricular outflow tract obstruction, which resolved in 1 patient after beta-blocker therapy. SAM patients underwent exercise stress echocardiography; 1 patient showed left ventricular outflow tract obstruction that worsened after exercise. At 5 years, freedom from moderate or severe mitral regurgitation and New York Heart Association functional class III/IV was 85% in SAM versus 92% in non-SAM (p = .27) and 81% versus 92% (p = .05), respectively.

Central Message
Conservative management of systolic anterior motion of the mitral valve immediately after repair was both successful and reliable.

Clinical Relevance
Transient systolic anterior motion of the mitral valve leaflet is a common finding after mitral repair surgery, and conservative management is highly reliable.
Systolic anterior motion after mitral valve repair: Is surgical intervention necessary?

Morgan L. Brown, MD, a Martin D. Abel, MD, b Roger L. Click, MD, c Ronald G. Morford, MD, d Joseph A. Dearani, MD, a Thoralf M. Sundt, MD, a Thomas A. Orszulak, MD, a and Harzell V. Schaff, MD a

Objective: The natural history and management of patients with systolic anterior motion after mitral valve repair are uncertain.

Methods: We performed a retrospective chart review and survey follow-up of all patients in whom systolic anterior motion developed intraoperatively after mitral valve repair.

Results: From January 1993 to December 2002, mitral valve repair was performed in 2076 patients, and in 174 cases (8.4%) systolic anterior motion was identified on intraoperative echocardiography. These patients form the study group. Initially, patients were managed with a combination of β-blockade, vasoconstriction with phenylephrine, and/or intravascular volume expansion. Four patients had revision of repair because of persistent systolic anterior motion, and 3 additional patients had revision of repair because of mitral regurgitation from other causes. The median follow-up of the remaining 167 patients was 5.4 years (range 0-13.2 years). There were 2 late reoperations, but none were caused by systolic anterior motion or left ventricular outflow tract obstruction. Ninety percent of patients were in New York Heart Association class I, 7% were in class II, and 3% were in class III. 

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Surgical Treatment

• After medical management
• LVOT gradient > 50 mm Hg
• MR ≥ 1+
Surgical Treatment

- Re-repair valve
  - Sliding repair
  - Folding repair
  - Edge-to-edge repair
  - Plicate posterior leaflet
  - Short posterior neochordae
- Replace valve
• Re-repair valve
  • Sliding repair
  • Folding repair
  • Edge-to-edge repair
  • Plicate posterior leaflet
  • Short posterior neochoordae
• Replace valve
SAM Strategy

- **Predict**
  - Echo measurements
  - Big leaflets/small ventricle
- **Prevent**
  - Reduce posterior leaflet height
  - Large band
Thank You
Left Ventricular Outflow Tract Obstruction
After Mitral Valve Repair
Results of the Sliding Leaflet Technique

Victor A. Jébara, MD; Serban Mihăileanu, MD; Christophe Acar, MD; Christian Brizard, MD; Philippe Grare, MD; Christian Latremouille, MD; Sylvain Chauvaud, MD; Jean Noël Fabiani, MD; Alain Deloche, MD; Alain Carpentier, MD, PhD

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Clinical Relevance
Transient systolic anterior motion of the mitral valve leaflet is a common finding after mitral repair surgery, and conservative management is highly reliable.
Systolic anterior motion after mitral valve repair: where do we stand in 2015?

Ottavio Alfieri* and Elisabetta Lapenna

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The degree of this complication can range from minor chordal protrusion with minimal LVOT obstruction and trivial MR to more severe obstruction with massive MR leading to haemodynamic instability, low cardiac output syndrome and intractable hypotension.

SAM can be transient and easily reversible or more resistant, requiring to medical therapy and requiring pacemaker in severe cases.

Clearly, SAM is a multifactorial entity and the probability of this complication is higher when several anatomical and haemodynamic predisposing components co-exist.

HOW TO PREVENT SYSTOLIC ANTERIOR MOTION

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Whenever excess leaflet tissue is present, leaflet resection with sliding plasty is applied to avoid the narrowing of the posterior leaflet to less than 15 mm.

**SAM during weaning from CPB**

**STEP 1**
- Avoid/discontinue inotropes
- Volume expansion

**STEP 2**
- β-blockers (esmolol) use
- Increase afterload (pharmacologically/partial digital occlusion of the ascending aorta)

**Repair revision**
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SAM can be transient and easily reversible or more resistant, requiring urgent to medical therapy and requiring possible surgical intervention.

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RESULTS Group 1 patients had smaller AL/PL ratios (0.99 vs. 1.95, p < 0.0001) and shorter distances (2.53 vs. 3.01 cm, p = 0.001) as compared to patients with no SAM/LVOTO (Group 2).
Systolic anterior motion after mitral valve repair: a predictive computational model

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Abstract

OBJECTIVES: Systolic anterior motion (SAM) can be an insidious complication after mitral repair. Predicting SAM represents a challenge, even for very experienced mitral valve surgeons. The goal of this pilot work was to illustrate for the first time, a computational software able to calculate and prevent SAM during mitral repair.

METHODS: Using MATLAB graphical user interface, a clinical software to predict SAM, we tested the performances of the software on 136 patients with degenerative mitral valves undergoing repair with standard techniques. A combination of 6 key echocardiographic parameters was used to calculate the SAM risk score. The discriminative performance of the model was assessed by the area under the receiver-operating characteristic curve. The receiver-operating characteristic was used to divide patients into low, medium and high risk for SAM. Simulation of virtual mitral repair (posterior leaflet resection and mitral ring annuloplasty) was also tested to reduce the risk of SAM.

RESULTS: The incidence of SAM was 8.1%; 73% were detected as high risk by the software. The area under the receiver-operating characteristic model discriminant performance was 0.87 (95% confidence interval: 0.78–0.95). Simulating a posterior leaflet resection with the annuloplasty width fixed at 15 mm, the estimated SAM risk was reduced to zero in all patients were then clinically followed up.

This software is the first system that allows calculation of the SAM risk score without any specific expertise.