A Surgical Armamentarium for Correcting Systolic Anterior Motion with Re-repair Rather than Replacement

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This study was reviewed and deemed exempt from informed consent by the University of Michigan Institutional Review Board (protocol number: HUM00148119, initial approval 8/7/2018, most recent amendment approval 4/20/2023).
Central Message: SAM is repairable with simple surgical techniques aimed at reducing posterior leaflet “height”. Correction of SAM should be attempted with re-repair rather than replacement. (174/200 characters)

Central Picture: Surgical techniques used for correction of intraoperatively identified SAM and re-repair. (89/90 characters)
Introduction

Systolic anterior motion (SAM) occurs in up to 10% of mitral valve repairs. Most cases resolve with medical intervention (volume expansion, discontinuation of inotropes, \( \beta \)-blockers), however some refractory cases with continued LVOT obstruction and residual MR require return to bypass and additional surgery. Unfortunately, refractory SAM is often reflexively treated with MV replacement (MVR) before attempts to re-repair have been made. We outline our armamentarium of surgical re-repair techniques used for the correction of intraoperatively identified SAM and the outcomes of these techniques. We aim to demonstrate that the correction of SAM can be achieved with these safe and relatively simple re-repair techniques.

Patients and Methods

Patients who underwent primary mitral valve surgery for degenerative MR from 2007-2022 at the University of Michigan and had intraoperatively identified SAM were included. Hypertrophic obstructive cardiomyopathy (HOCM) cases and concomitant valve operations were excluded. Primary outcomes were incidence of severe SAM (i.e., evidence of continued LVOT obstruction and any residual MR despite optimal medical management) identified intraoperatively, repair rate, operative mortality, and need for reoperation for either SAM or recurrent MR. Median length of follow-up was 2 years (IQR 3.1 years). The Institutional Review Board (IRB) of the University of Michigan approved the study protocol and publication of data with a waiver of consent (HUM00148119, initial approval 8/7/2018, most recent amendment approval 4/20/2023).

Results
The incidence of SAM requiring intraoperative re-repair was 0.7% (17/2217). Only three patients required a second repeat cross-clamp (i.e., three total cross-clamps) to repair SAM. The ultimate intraoperative repair rate was 100% with no patients requiring replacement for SAM. The median total bypass time was 212 minutes (IQR 150 minutes) and median cross-clamp time was 159 minutes (IQR 119 minutes). There was no operative mortality, and no clinically significant mitral stenosis identified during the follow-up period. Two patients (12%) required eventual reoperation for late recurrent SAM (<3 months postoperatively), but both were able to be re-repaired. One patient developed recurrent MR >2 years after the initial operation, unrelated to SAM, and underwent MVR. Long term survival in these re-repaired SAM patients matched non-SAM MV repair patients.

SAM is often related to posterior leaflet “height”. Primary techniques for the correction of SAM focus on reducing excessive posterior leaflet length (i.e., shortening the “height” of the posterior leaflet over the plane of the anterior leaflet) and moving the malpositioned zone of coaptation posteriorly.2-4 A “pull back” technique, performed by placing three total stitches with one through each posterior leaflet segment and anchored to the ring or just posterior to the ring on the left atrial wall, was used in three cases (Figure 1A). The placement of two additional sets of GoreTex Neochords through the posterior leaflet to mimic shortened posterior leaflet chordae was performed in three cases (Figure 1B). The intent of both of these techniques is to reduce the displacement of the anterior leaflet into the LVOT by a relatively “too tall” posterior leaflet. Additional P2 resection was performed in three cases to remove redundant leaflet tissue (Figure 1C). Upsizing of the ring was performed in nine cases (mean “upsize” difference 3.6 mm ± 1.3 mm)(Figure 1D) and a complete ring was exchanged for a partial ring in two cases to minimize potential bulging of the posterior leaflet and narrowing of the aortic-mitral angle (Figure 1E). A
central Alfieri stitch (edge-to-edge suture) coapting the tips of A2 and P2 was performed in two cases to limit the mobility of the anterior leaflet towards the LVOT (Figure 1F). This technique is appropriate when the anterior leaflet is observed to be long and redundant. It should be noted that a combination of these techniques may be required to achieve satisfactory re-repair.

For the two cases of late SAM requiring operative intervention, repeat P2 or P3 resection was undertaken with undermining of the remaining P2 and P3 segments from the annulus, followed by reattachment to the annulus. This achieves further reduction of posterior leaflet height.

Discussion:

The rate of intraoperatively identified SAM requiring repair was 0.7% in the study cohort of over 2000 patients undergoing mitral valve surgery. The re-repair rate for patients with either intraoperatively identified refractory SAM or recurrent SAM postoperatively was 100%. Other groups have discussed algorithms for the intraoperative medical management of SAM and reviewed operative approaches focusing on the anterior leaflet.\(^1,5\) We add to the existing body of SAM literature by outlining several relatively simple techniques aimed at reducing posterior leaflet “height” that have demonstrated safety and efficacy at our institution. With a well-developed armamentarium of surgical techniques, SAM can be re-repaired without the need for valve replacement.

References:


**Legends**

Figure 1: Schematic of the surgical techniques used successfully for re-repair in 17 cases of intraoperatively identified SAM. A) Three-stitch pull-back technique to reduce posterior leaflet height. B) Placement of supplemental posterior leaflet GoreTex Neochords. C) Alfieri stitch between the anterior and posterior leaflets. D) Additional P2 resection. E) Exchange of a complete annuloplasty ring for a partial ring. F) Upsizing of the annuloplasty ring.

SAM, systolic anterior motion; MR, mitral regurgitation; LVOT, left ventricular outflow tract.
Reduction of posterior leaflet height with "pull back" stitches (3 cases) or supplemental Gore-tex neochords (3 cases)

Affieri stitch (2 cases)

Intraoperative SAM with MRA/LVOT refractory to medical management

Additional P2 resection (3 cases)

Exchange of complete ring for partial ring (2 cases)

Upsizing of annuloplasty ring (9 cases)

Illustrations adapted from "Posterior Leaflet Shortening to Correct Systolic Anterior Motion Mitral Valve Repair" by George and Daffos, and "The 10 Commandments for Mitral Valve Repair" by Daffos, Burns, et al.
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