

Risk Assessment and Outcomes of Systolic Anterior Motion in Robotically Assisted Mitral Valve Repair

Yizhan Guo¹, Kei Kobayashi¹, John Yin², Martin Winter¹, Andrea Amabile¹, Christopher Lacomis², Irsa Hasan¹, Ezeldeen Abuelkasem², Michael Boisen², William Katz³, Matthew Suffoletto³, Johannes Bonatti¹

¹Department of Cardiothoracic Surgery; ²Department of Anesthesiology; Division of Cardiology, ³Department of Medicine



INTRODUCTION

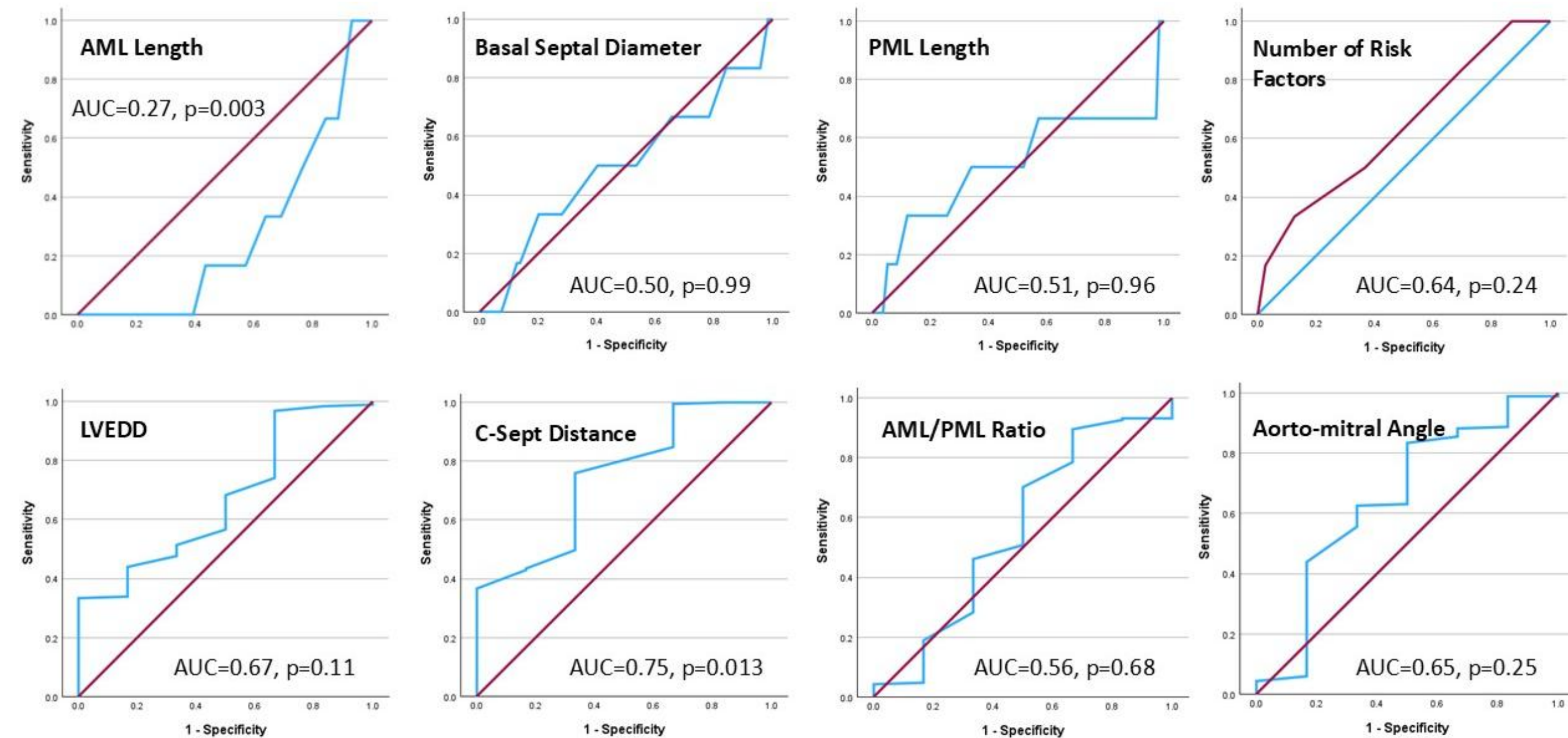
Systolic anterior motion (SAM) is a known complication of mitral valve repair characterized by displacement of the anterior leaflet to the left ventricle outflow tract (LVOT) during systole leading to mitral regurgitation (MR) and LVOT obstruction. Multiple risk factors have been reported to predict the occurrence of SAM. However, the value of these risk factors in robotically assisted mitral valve repair (RAMVR) is unknown.

METHODS

We retrospectively reviewed the peri-operative parameters of 197 consecutive isolated RAMVRs performed from January 2021 to August 2025. Patients were retrospectively stratified into low-risk (0-4) and high-risk (5-9) groups based on the total numbers of previously reported risks factors by pre-operative transesophageal echocardiography. Operative details and outcomes were compared between groups and the predictive value of the risk factors was analyzed.

RESULT

FIGURE 1



A total of nine risk factors of SAM were selected from previously published studies that had a sample size greater than 100. ROC analysis revealed that length of anterior mitral leaflet (AML) (AUC=0.27, 95% CI 0.12-0.42, p=0.003) and C-sept distance (AUC=0.75, 95% CI 0.55-0.94, p=0.013) were the only 2 risk factors that demonstrated statistically significant discriminatory power. Shorter AML length was associated the incidence of SAM (FIGURE 1).

TABLE 1. Comparison of Technical Details of RAMVR

Surgical Techniques	Low, N = 124	High, N = 73	p-value ¹
Repair Location			
Posterior Leaflet	98 (79.0)	55 (75.3)	0.2
Anterior Leaflet	7 (5.6)	1(1.4)	
Bileaflet Repair	12 (9.7)	14 (19.2)	
Annuloplasty Only	6(4.8)	3(4.1)	
Cleft Closure	67 (54.0)	37(50.7)	0.65
Posterior Leaflet Resection	79 (63.7)	46 (63)	0.92
Neochords	32 (25.8)	23 (31.5)	0.39
Sliding Valvuloplasty	4 (3.2)	4 (5.5)	0.33
Commissuroplasty	18 (15.5)	7 (9.5)	0.60
Annuloplasty			
Flexible Band	113 (91.1)	72 (98.6)	0.034*
Flexible Ring	11 (8.9)	1 (1.4)	
Implant Size (mm)	32 (30-34)	32 (30-34)	0.15
Concomitant Procedures			
LAA Closure	23 (18.5)	14 (19.2)	0.91
PFO Closure	13 (10.5)	11 (15.1)	0.34
Maze Procedure	13 (10.5)	9 (12.3)	0.69
Console Time	112 (88-132)	123 (94-139)	0.12
Re-CPB	11 (8.9)	9 (12.3)	0.44
Convert to Replacement	4 (3.2)	3 (4.1)	0.71

¹Mann-Whitney test; Pearson's Chi-squared test; Fisher's Exact test.
LAA: Left atrial appendage; PFO: Patent foramen ovale;

TABLE 2. Comparison of Post-operative Outcomes of RAMVR

Post-op Outcomes	Low, N = 124	High, N = 73	p-value ¹
Immediate			
SAM	3 (2.4)	3 (4.1)	0.79
Residual MR (%)			0.51
None	110 (88.7)	65 (89.0)	
Trace/Mild	11 (8.9)	7 (9.6)	
Moderate	4 (3.2)	3 (4.1)	
Mean Mitral Valve Gradient (mmHg)	2 (2-3)	2 (2-3)	0.39
Convert to Replacement (%)	4 (3.2)	3 (4.1)	0.71
Clinical ²			
Extubation in Operating Room (%)	71 (57.4)	40 (54.8)	0.74
Reoperation for Bleeding (%)	4 (3.2)	2 (2.7)	0.6
Total RBC Transfusion (Unit)	0 (0-0)	0 (0-0)	0.73
Leg Ischemia (%)	1 (0.8)	0 (0)	0.63
New Atrial Fibrillation (%)	35 (28.2)	14 (19.2)	0.11
Pacemaker (%)	0 (0)	0 (0)	n/a
Renal Failure (%)	0 (0)	0 (0)	n/a
ICU Time (Hour)	45 (25-72)	48 (25-71)	0.86
Hospital Stay (Day)	4 (4-6)	4 (3-5)	0.23
Short-term (30 days)			
Mortality (%)	0 (0)	0 (0)	n/a
SAM (%)	0 (0)	0 (0)	n/a
Residual MR (%)			0.37
None/Trace	99 (79.8)	59 (80.8)	
Mild	21 (16.9)	9 (12.3)	
Moderate	2 (1.6)	1 (1.4)	
Mean Mitral Valve Gradient (mmHg)	3 (2-4)	3 (2-4)	0.83
LVEF (%)	50 (49-60)	55 (45-60)	0.58

¹Mann-Whitney test; Pearson's Chi-squared test; Fisher's Exact test.

²All quantitative data is presented as Median (IQR)

RBC: Red Blood Cell; ICU: Intensive Care Unit; LVEF: Left Ventricular Ejection Fraction;

An annuloplasty device with the median size of 32mm was implanted in both risk groups. More flexible annuloplasty bands were placed in the high-risk group (98.6% vs. 91.1%, p=0.034) as opposed to a flexible closed annuloplasty ring. More bileaflet repairs (19.2% vs 9.7%) were carried out in the

high-risk group although it did not reach statistical significance. (TABLE 1).

The overall incidence rate of SAM after MVR on intra-operative TEE after weaning off CPB, was 3.0% (n=6). Post-operative course including complication rate, length of stay and mortality were comparable in between the 2 risk groups. At 4-week post-operative follow-up, none of the patients had SAM evident on transthoracic echocardiography (TTE). The grade of residual MR, mean mitral valve gradients and left ventricular ejection fraction (LVEF) were also similar (TABLE 2).

CONCLUSIONS

In summary, our data suggests that risk of SAM after robotically assisted mitral valve repair is relatively low. Pre-operative measurement of anterior mitral leaflet length and C-sept distance provides some predictive value for SAM in RAMVR and assisted in selection of repair techniques. The use of flexible annuloplasty bands is a reliable strategy in RAMVR. The combination of band annuloplasty and the robotic approach with excellent visualization and ergonomics probably contributed to a reasonably low SAM risks in our cohort.

REFERENCES

- Maslow AD, et al, Echocardiographic predictors of left ventricular outflow tract obstruction and systolic anterior motion of the mitral valve after mitral valve reconstruction for myxomatous valve disease. *J Am Coll Cardiol*.
- Loulmet DF et al. Systolic anterior motion of the mitral valve: A 30-year perspective. *Journal of Thoracic and Cardiovascular Surgery*.
- Varghese R et al. Predicting systolic anterior motion after mitral valve reconstruction: using intraoperative transoesophageal echocardiography to identify those at greatest risk. *Eur J Cardiothorac Surg*. 2014
- Ashikhmina E et al. Risk factors and progression of systolic anterior motion after mitral valve repair. *Journal of Thoracic and Cardiovascular Surgery*.