



Minimally Invasive Mitral Valve Repair with Artificial Chordae: Insights from a 6- Year Single-Center Study

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National training cooperation



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INTRODUCTION



- **MV Repair vs. Replacement**

- Superior Long-Term Results: MV repair is preferred over replacement for MR when repairable
- High success rate at centers with expertise in MV repair

- **Minimally Invasive Mitral Valve Repair (MIMVR)**

- Safety and Effectiveness
- Reduced Morbidity: Less incidence of stroke, atrial fibrillation, renal failure
- Shorter Hospital Stay: Beneficial for carefully selected patients





INTRODUCTION



- Carpentier's Techniques: annuloplasty rings and resection
 - Issues: Limited reproducibility and steep learning curve
- **Artificial Chordae**
 - Zussa and Frater
 - Widely adopted for its long-term effectiveness
- **MIMVR**
 - Need a simple, reproducible technique → artificial chordae
 - Technical Complexities: correct length of artificial chordae, placement accuracy
 - Variability in Outcomes: Learning curve, outcome variation, lack of standardized protocols



Etiology Trends in MV Disease and Repair in Vietnam

- Study by Cazaubiel and Iung
 - Analysis of 2734 MV surgery patients in Vietnam
 - From 1995-2010

0433

Evolution of mitral organic valve disease in Vietnam during last two decades

Inès Cazaubiel (1), Bernard Iung (2)

(1) CHU Hôpital Saint Antoine-APHP, Cardiologie, Paris, France –
(2) CHU Bichat-Claude Bernard-APHP, Cardiologie, Paris, France

- Findings
 - 15.4% increase in degenerative etiology
 - Significant rise in fibroelastic disease-related issues



Artificial chordae in Vietnam

ĐÁNH GIÁ KẾT QUẢ SỚM PHẪU THUẬT SỬA VAN HAI LÁ CÓ SỬ DỤNG DÂY CHẰNG NHÂN TẠO

Lý Hoàng Anh*, Trần Quyết Tiến*

TÓM TẮT

Mục tiêu: Đánh giá kết quả sớm phẫu thuật sửa van hai lá có sử dụng dây chằng nhân tạo bằng chỉ Polytetrafluoroethylene (PTFE) trên bệnh nhân hở van hai lá do sa lê van. **Phương pháp nghiên cứu:** Hồi cứu mô tả 21 bệnh nhân sửa van hai lá có sử dụng dây chằng nhân tạo từ tháng 1/2015 đến tháng 9/2015. Tuổi trung bình là 48.9 ± 10.3 , nam chiếm 57.1%. Suy tim theo phân độ NYHA độ II là 47.6%, độ III là 52.4%. Hở van hai lá nặng (3/4) là 23.8%, rất nặng (4/4) là 76.2%. Đường kính thất trái cuối tâm trương là 59 ± 10 mm. Thương tổn sa lê trước van hai lá là 47.6%, thương tổn sa lê sau van hai lá là 42.9%, thương tổn sa cả hai lá van là 9.5%. Số dây chằng nhân tạo được sử dụng cho mỗi trường hợp từ 1 đến

van hai lá đều được đặt vòng van. Siêu âm qua thành ngực được thực hiện trước, sau phẫu thuật và theo dõi trong 30 ngày. **Kết quả:** Không có tử vong sau 30 ngày phẫu thuật. Tỷ lệ rung nhĩ là 9.5%. Phân suất tổng máu là $53.6 \pm 10.7\%$. Van hai lá không hở là 81%, hở nhẹ van hai lá là 14.3%, hở trung bình 4.8%. Thời gian hồi sức trung bình là 3 ngày. Thời gian nằm viện trung bình sau phẫu thuật là 14 ± 9 ngày. **Kết luận:** Trong nghiên cứu của chúng tôi, suy tim nặng chiếm hơn 50%. Thương tổn van hai lá sử dụng dây chằng nhân tạo có thể thay thế những phẫu thuật kinh điển như cắt giảm lá van tam giác, cắt giảm lá van tứ giác, tạo hình trước lá van trong những trường hợp tổn thương nặng. Ngoài ra, dây chằng nhân tạo cho thấy

Lý Hoàng Anh (2011) 21 cases, artificial chordae, full sternotomy

TẠP CHÍ Y HỌC VIỆT NAM TẬP 524 - THÁNG 3 - SỐ 1B - 2023

KẾT QUẢ PHẪU THUẬT SỬA VAN HAI LÁ CÓ SỬ DỤNG DÂY CHẰNG NHÂN TẠO TẠI BỆNH VIỆN TIM HÀ NỘI

Lê Quang Thiện¹, Nguyễn Sinh Hiền¹, Nguyễn Hữu Phong¹, Nguyễn Hoàng Hà¹, Nguyễn Đăng Hùng¹, Đỗ Đức Trọng²

TÓM TẮT

Đặt vấn đề: Kỹ thuật sửa van hai lá sử dụng dây chằng nhân tạo đã được áp dụng từ năm 1960. Cùng với sự ra đời của loại chỉ Gore – Tex, phương pháp này ngày càng được phát triển đa dạng và cho thấy nhiều ưu điểm như tái sắp xếp lại mô van thay vì cắt bỏ, giữ được liên kết giữa các cấu trúc của hệ thống van hai lá, bảo tồn được điện áp. Tại Bệnh viện Tim Hà Nội, những năm gần đây chúng tôi đã áp dụng thường quy phương pháp sửa van hai lá có sử dụng dây chằng nhân tạo trên nhiều bệnh nhân hở van hai lá. Nghiên cứu này nhằm mục đích: nhận xét đặc điểm phẫu thuật và đánh giá kết quả phẫu thuật sửa van

research are analysing the characteristics and evaluating the result of mitral valve repair with artificial chordae in Hanoi Heart Hospital. **Methods:** A cross – sectional study. We retrospectively reviewed 42 patients undergoing mitral valve repair with artificial chordae in Hanoi Heart Hospital from 1/2017 to 4/2021. Data processing using SPSS 22 software. **Results:** The anterior leaflet prolapse counted for 61.9%, the posterior leaflet prolapse counted for 21.4% and the rest was combination. The main cause was degenerative mitral regurgitation (90.5%). 28.6% patients had the minimally invasive cardiac surgery. The loop technique could be seen in 24 patients (57.1%), the mitral repair with PTFE neochordae was

Lê Quang Thiện (2023) artificial chordae, 42 cases (28,6% mini-invasive)

VIETNAM MEDICAL JOURNAL N°1 - JULY - 2021

DÂY CHẰNG NHÂN TẠO TRONG SỬA VAN HAI LÁ Ở TRẺ EM

Đoàn Quốc Hưng**, Lê Quang Thiện*, Nguyễn Đăng Hùng*, Nguyễn Sinh Hiền*, Nguyễn Hoàng Hà*

TÓM TẮT

Kỹ thuật sửa van hai lá sử dụng dây chằng nhân tạo Gore-tex là một trong những kỹ thuật hiệu quả và ngày càng được áp dụng nhiều trong phẫu thuật sửa van hai lá (VHL) trên thế giới. Sau khi Zussa báo cáo công trình thành công đầu tiên sử dụng dây chằng Gore-tex, Tirone David đã phát triển và làm cho kỹ thuật này trở nên phổ biến nhất trong các kỹ thuật sửa van hai lá khi lá van bị sa do đứt, thiếu hoặc dài dây chằng. Nhiều nghiên cứu khác nhau đã báo cáo những kết quả tốt khi sử dụng dây chằng nhân tạo ở người lớn. Gần đây, sử dụng dây chằng nhân tạo trong

technique of using artificial chordae is a good solution to avoid as much as possible valve replacement in children. However, the long-term durability and biological adaptation of the PTFE suture when the patient grows are controversial. In Vietnam, the use of artificial chordae in mitral valve repair has been recently applied in some heart centers. The use of artificial chordae in children is limited and there has not been any reports. We report a clinical case of mitral valve repair using artificial chordae in children at Hanoi Heart Hospital in August 2020. **Keywords:** Mitral valve repair, mitral valve repair in children, artificial chordae.

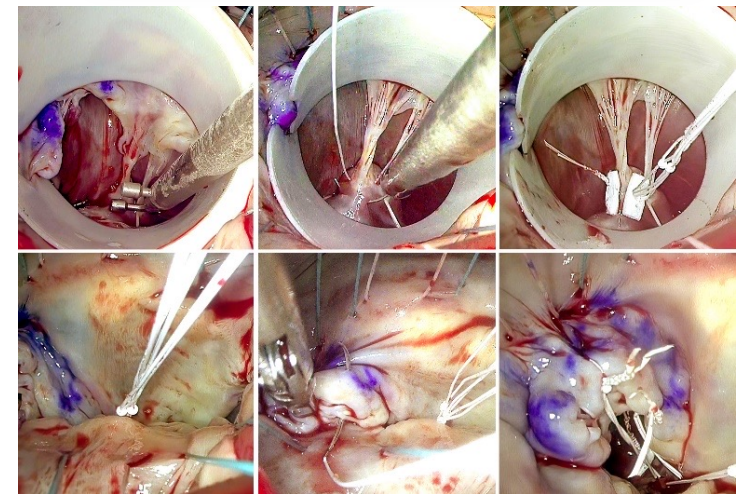
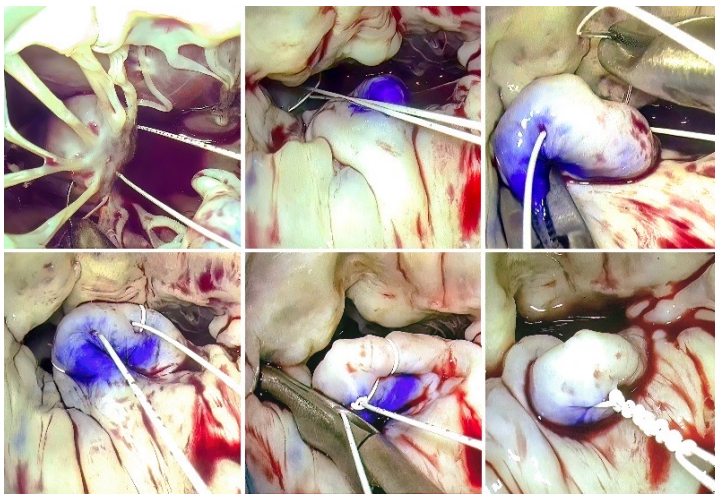
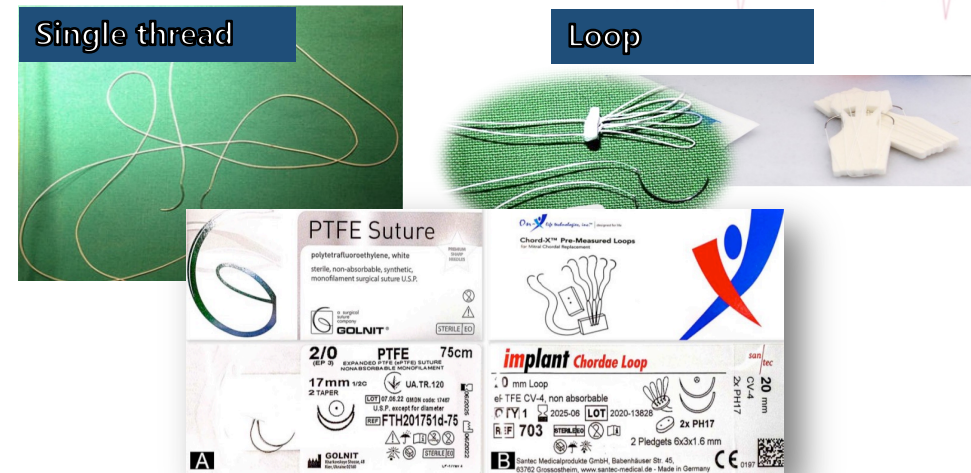
Đoàn Quốc Hưng (2021) artificial chordae in children, full sternotomy

- Our institute applied artificial chordae minimally since 2015
- **Aims at evaluating MIMVR artificial chordae through right mini-thoracotomy at our single center**

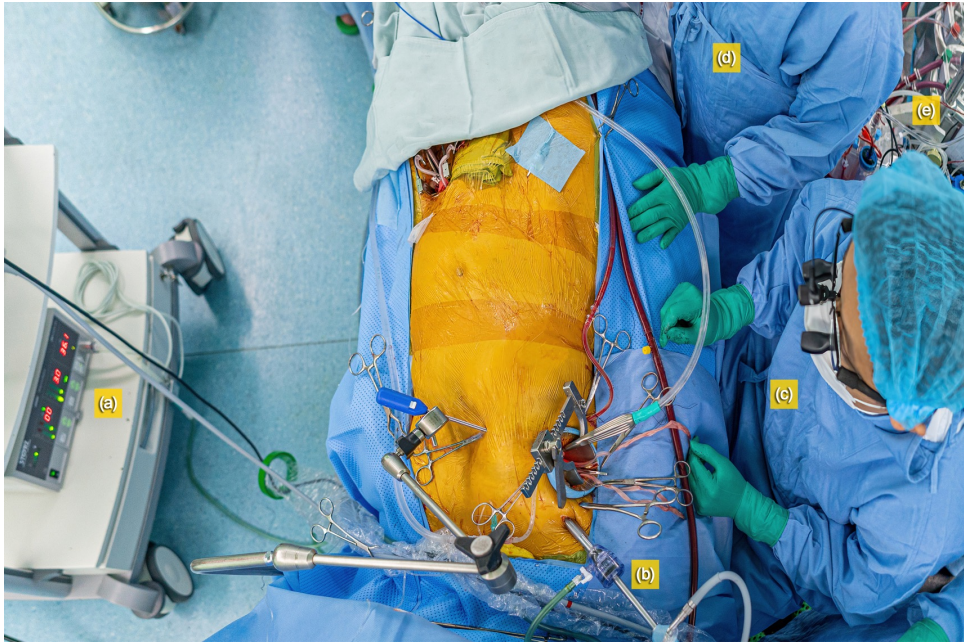


Material and Method

- Retrospective analysis at Ho Chi Minh UMC
- 3/2017 to 6/2023
- Severe DMR, single primary surgeon



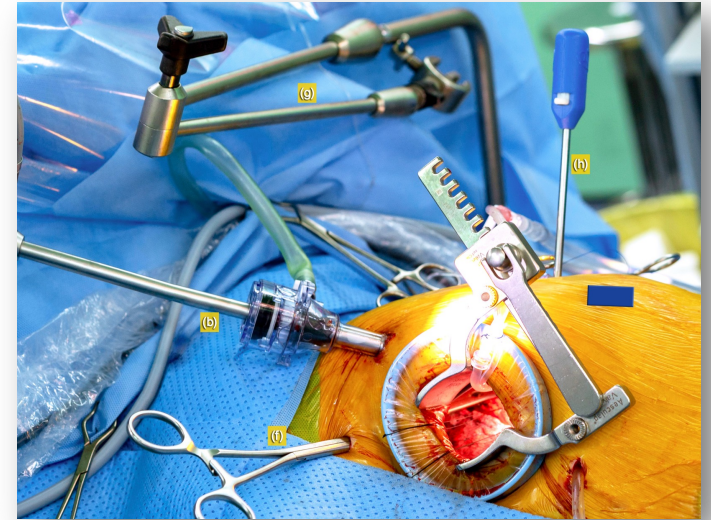
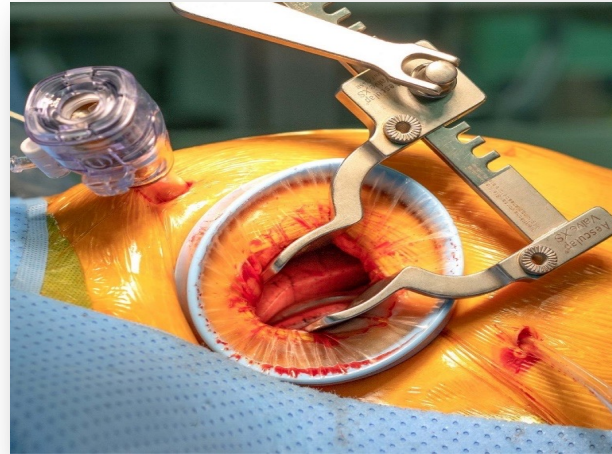
mini-invasive approach



- Peripheral bypass via femoral vessel cannulation
- Open Seldinger-guided technique used for cannulation



mini-invasive approach



- Supine position

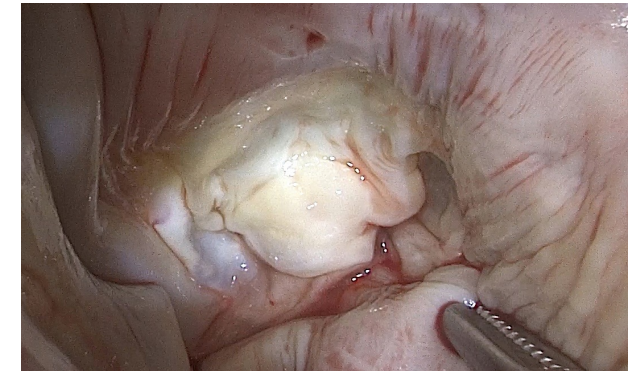
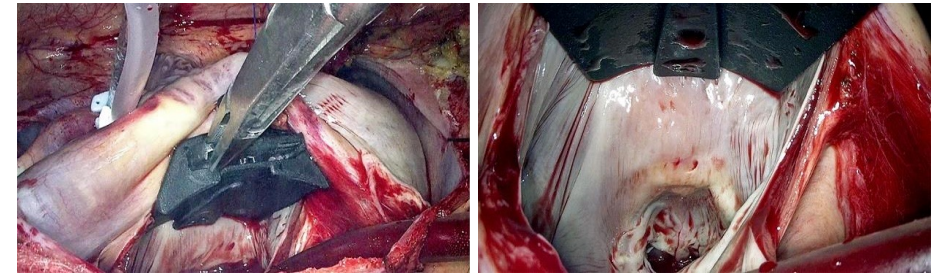
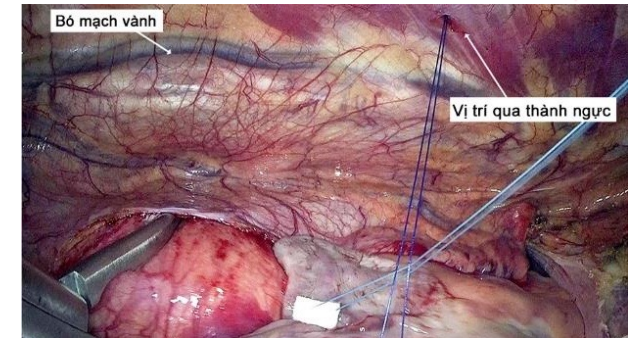
- A 4-cm incision parallel to the anterior axillary line
- Dissected into the 4th right intercostal space

- Insertion of video camera port in the 3rd space
- Chitwood cross-clamp
- Administration of Custodiol solution

MV exposure

Leipzig description

- Interatrial groove (Waterson) serves as the entry point to the left atrium
- Use of a left atrial retractor
- Additional thread at the diaphragmatic center



The 10 Commandments for Mitral Valve Repair

Innovations
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Marc Gillinov¹, MD, Daniel J. P. Burns¹, MD, MPhil , and Per Wierup¹, MD, PhD

- Place Annuloplasty Sutures First
- Valve Inspection
- Choose Repair Techniques That Work
- Use a Prosthetic Annuloplasty
- Avoid SAM
- Wait for Recovery of Ventricular Function
Before assessing the valve Repair
- **Do Not Accept a Bad Repair**

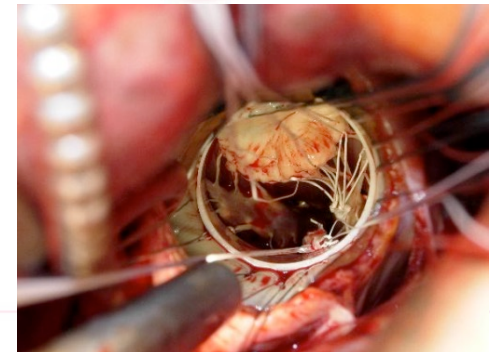
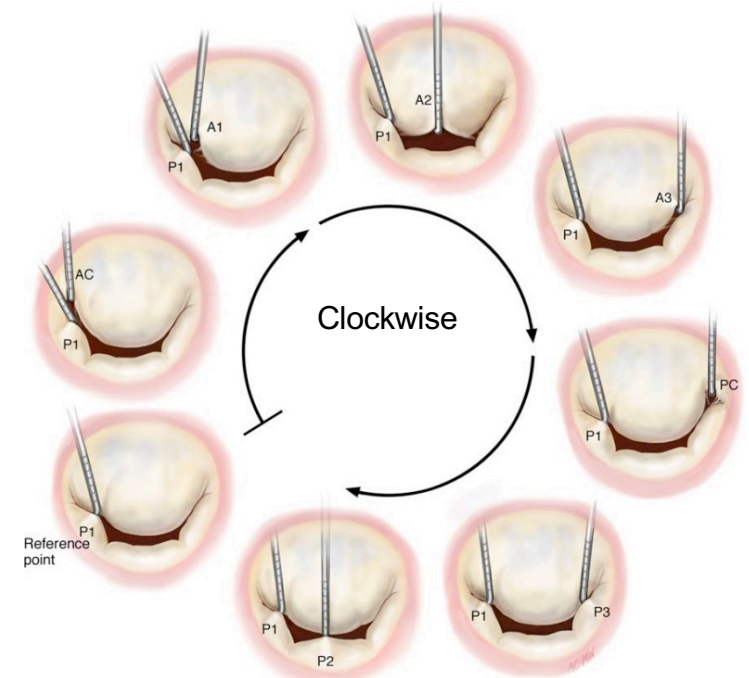


Valve Analysis: Carpenter's principles

Evaluation of each valve leaflet segment

- Clockwise
- Chordae height, tissue quality, potential areas of rupture
- Reference chord at P1
- Saline test: locate regurgitative sites and assess coaptation

zones ► distinguish any residual regurgitation due to **secondary lesions**



Our data

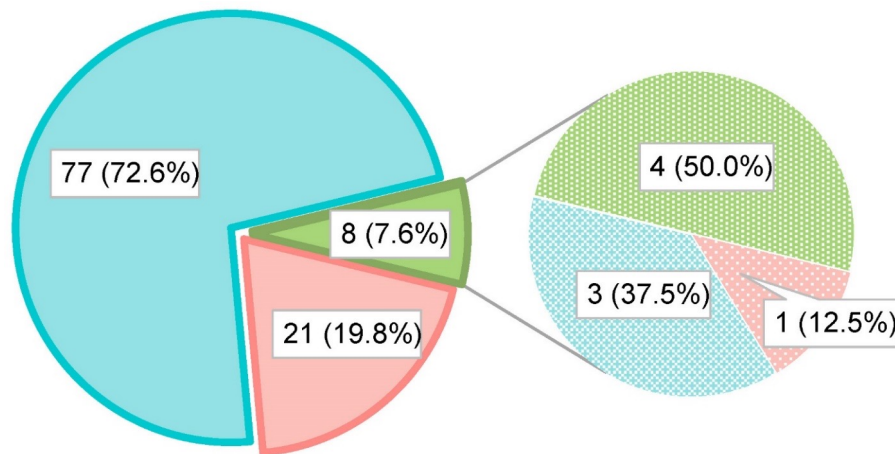
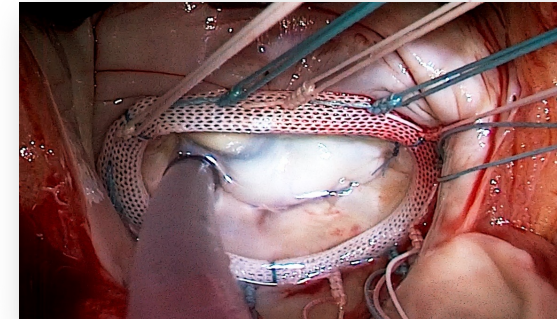
- Total of 106 cases
- Average age: 50.7 ± 12.4 years old
- Male 75.5%

Pre & Perioperative characteristics	N = 106
Type of degeneration	$58,3 \pm 6,6$
• FED	88 (83%)
• Barlow	4 (3,8%)
• Forme fruste	14 (13,2%)
Echocardiography	
LVEDD (mm)	$58,3 \pm 6,6$
LVESD (mm)	$36,7 \pm 5,1$
LVEF (%)	$63,3 \pm 6,2$
PAPS (mmHg)	$40,1 \pm 18,0$



Our data

- 100% artificial chordae + annular ring
- Average ring: $31,4 \pm 2,4$ mm



- Anterior prolapse: Anterior neochordae
- Posterior prolapse: Posterior neochordae
- Bileaflet prolapse:
- Anterior neochordae
- Posterior neochordae
- Bileaflet neochordae

- Correspondence between leaflet prolapse and artificial chordae placements
- Except In bileaflet: 7.6% of cases

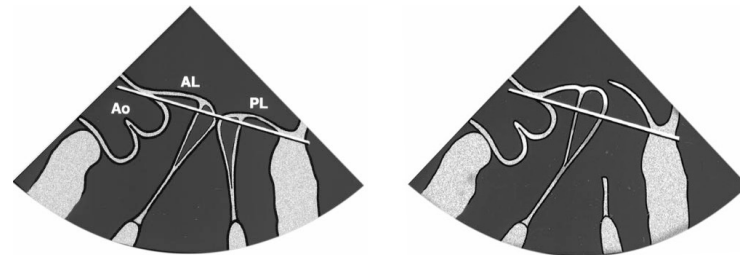
Our data: Bileaflet prolapse

Challenging

- First set annulus sutures
- Focus on the posterior leaf prolapse, then evaluate anterior prolapse
- Our data: 37.5% bileaflet using only posterior neochordae

Is Anterior Leaflet Repair Always Necessary in Repair of Bileaflet Mitral Valve Prolapse?

A. Marc Gillinov, MD, Delos M. Cosgrove III, MD, Sudhir Wahi, MD, William J. Stewart, MD, Bruce W. Lytle, MD, Nicholas G. Smedira, MD, Patrick M. McCarthy, MD, Per N. Wierup, MD, Joseph F. Sabik, MD, and Eugene H. Blackstone, MD



- *Many bileaflet prolapses might not show significant anterior chordae issues*
- *Even if echo evidence seems to indicate*
- *First repair of the posterior leaflet, any anterior prolapse is then considered*



Our data: Artificial chordae characteristics

Artificial chordae characteristics N = 106	
Type of artificial chordae	
• Single technique	43 (40,5%)
• Loop technique	52 (49,1%)
• Single & Loop technique	11 (10,4%)
Chordae per Patient	
• 1 pair	30 (28,3%)
• 2 pairs	38 (35,9%)
• 3 pairs	27 (25,5%)
• 4-5 pairs	10 (9,4%)
• 6 pairs	1 (0,9%)
Average 2.2 ± 1.1 pairs	

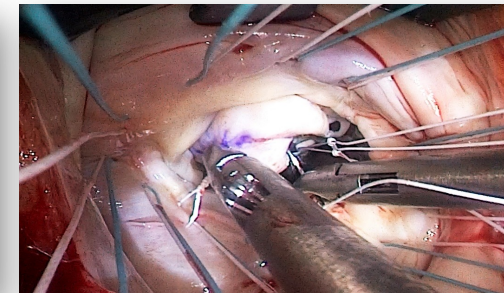
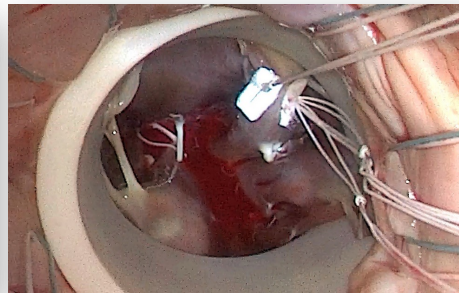
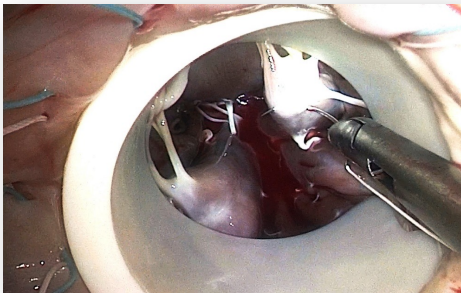
- We typically used ≥ 2 pairs
 - 2 pairs: 2 single PTFE threads
- Maximum 2 loops
 - 2 loops \rightarrow 6 – 8 pairs \rightarrow adequate for most MVr
- **Tirone David:** benefits of multi-chordal placement



Our data: papillary muscle (PM) implanted

Artificial chordae characteristics	N = 106
PM implanted	
• Anterolateral PM	22 (20,7%)
• Posteromedian PM	59 (55,7%)
• Both PM	25 (23,6%)

- Sutures 3-5mm below the PM apex
- Careful in leaner PM



Commisure or Indentation prolapse

Additional technique	N = 106
Indentation Closure	23 (21,7%)
Commisure Closure	21 (19,8%)
Edge-to-Edge Repair (Alfieri)	4 (3,8%)

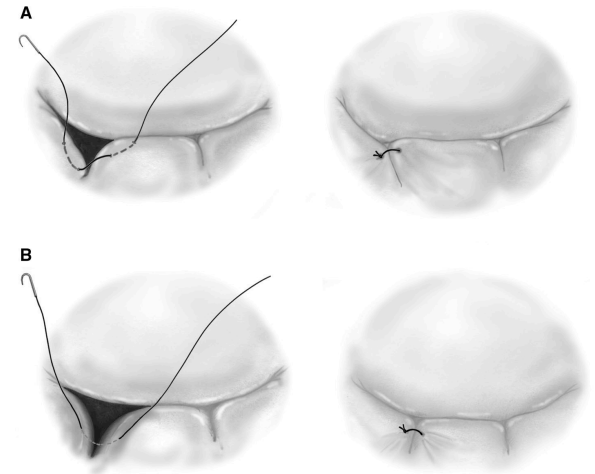
Secondary lesion

- Comissural prolapse is not uncommon → Residual lesions
- Indentation can develop as the leaflet volume expands (Myxomatous)

Challenging in diagnosis: may be missed and difficult to detect through echo

- overlap with regurgitation caused by the primary lesion
- easily identified through a saline test

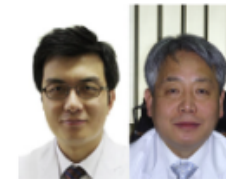
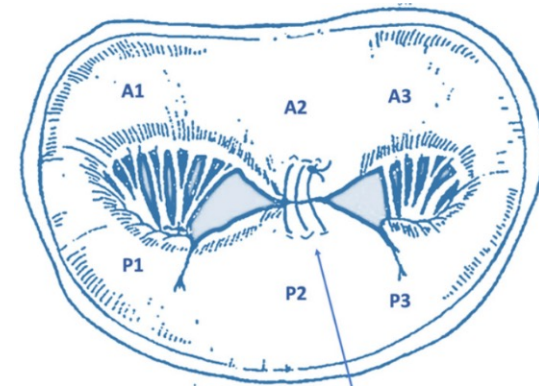
Repair method: 1 – 2 single stich(es), Magic stitches of Carpentier



Alfieri technique

4 cases

- 2 cases: due to observed moderate leakage during the saline test
- Rings ≥ 32 mm were used
- Caution when one of the two new orifices is less than 2 cm in diameter

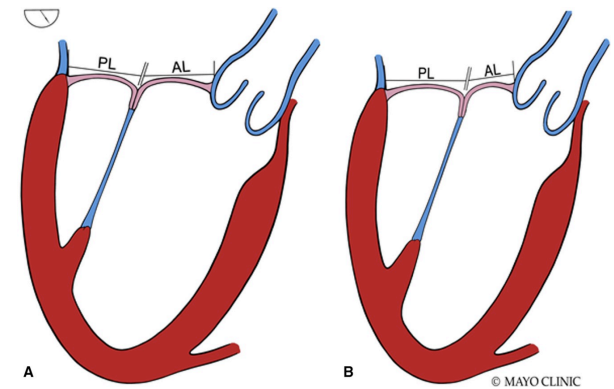


**SMALL RINGS AND
EDGE-TO-EDGE
TECHNIQUE ELEVATE
TRANSMITRAL
GRADIENTS IN MITRAL
VALVE REPAIR**



SAM

- Our approach: shorter chordae to position the posterior leaflet closer to the LV → shift the coapt zone posteriorly → reduce risk of SAM
- Alfieri technique: Particularly in Barlow with a P2 height $\geq 1.5 - 2$ cm identified during operation
- **Our data:** 11 (10.4%) showed mild SAM as TEE
 - Discharge: decreased to 2 (1.9%), not observed in follow-ups





Residual MR via TEE

- Restart CPB & re-clamp to adjust the repair or consider valve replacement
 - Secondary lesions → Addressable
- Our data: 2 (1.9%) re-clamp
- **Case 1:**
 - Primary neochordae A3, still regurgitate at A3 via TEE
 - Reclamp and assessment suggested: the A3 neochordae too long, perhaps due to the PTFE not extend completely during saline test → length adjustment (replace the neochord)
- **Case 2:**
 - P3 single pair neochordae not enough → reclamp → add an additional pair at P3



Our data: Discharge

Postoperative data	N = 106
Intubation time (hours)	9.0 [5.3; 16.8]
ICU time (days)	2.8 [1.9; 4.2]
Re-operation Due to Bleeding	3 (2,8%)
Pneumonia	9 (8,5%)
CRRT	1 (0,9%)
IABP	1 (0,9%)
Stroke	1 (0,9%)
Peripheral vessel complication	2 (1,9%)
Hospital death	0 (0,0%)

Predischarge MR	N = 106
Predischarge MR	
None/trivial MR	94 (88,7%)
Moderate MR	12 (11,3%)

No severe MR at discharge





Our data: Follow-up

- 104 pts were regularly monitored with an follow-up duration of 28.2 ± 17.5 months
- Longest: 63.9 months (5 years)

Follow-up	N = 104
Mortality	2 (1,9%)
Indication for Reoperation (Mitral Valve)	1 (1,0%)
Stroke	1 (1,0%)

- Re-surgery indicated pts: P3 prolapse, pulmonary hypertension (PAPS 75 mmHg), severe TR, LVEDD 64 mm
- Initial repair: artificial chordae at P3 + 28-mm annular ring + tricuspid valve repair
- 3 years post-surgery: exertional dyspnea, echo showed severe MR due to P3 prolapse



Our data: MV Repair Outcomes

Follow-up MV condition	N = 104
Mitral Regurgitation Severity	
None/Trivial	78 (75%)
Medium	20 (19,2%)
Severe	6 (5,8%)

- 6 (5.8%) severe MR:
 - 1 re-surgery indicated (1.0%) - symptomatic
 - 5 observation (4.8%) - asymptomatic

- **Reoperation rates:** lower than recurrence rates, factors: asymptomatic, refusal reop, advanced age, high risk of postop complications
- **David et al:** 20 years, 6% reoperation for MV-related issues, rate of severe MR was x 3 times higher
- Criteria for reoperations of late MR recurrence are different from initial MVr in asymptomatic pts:
 - The feasibility of another repair for the MV could be limited
 - If have to MVR → outcomes might be worse than no reoperation



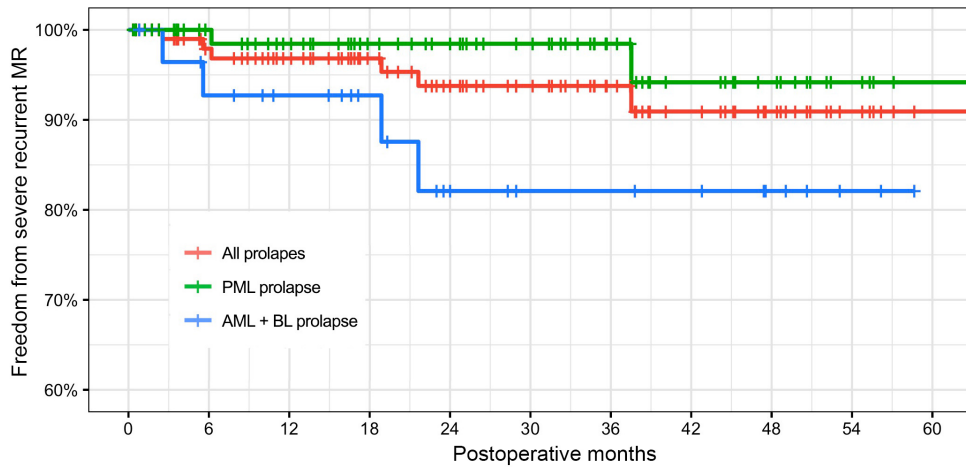


Our data: compare

- Postoperative mortality: 0.0%, stroke rate: 1.1%.
- Two-year mortality: 2.2% (cardiac deaths), severe MR rate: 8.9%
- No hemolytic anemia
- **Comparable to Mini-Mitral International Registry (mortality 1.7%, stroke 1.7%)**



Our data: Free from severe recurrent MR



KM curves to evaluate free from re-regurgitation rates at:

- 1, 2, and 4 years
- 97%, 94%, and 91%, respectively.

- Lang: 97%, 93%, and 87% for freedom from MR recurrence at intervals of 1, 5, and 10 years, respectively





Limitations

- Retrospective design may lead to biases and data limitations.
- Lack of control group hinders definitive conclusions.
- Small, single-center sample limits generalizability.
- Future larger, multi-center prospective studies needed for stronger evidence.



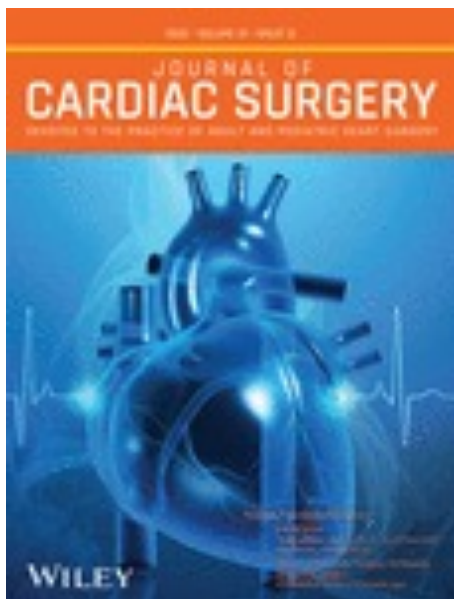


CONCLUSION

- Artificial chordae in MIMVR: Promising for various MV issues.
- Precision in chordae deployment critical for success.
- Initial experience: Right mini-thoracotomy with artificial chordae in MIMVR is viable, safe, effective



Accepted for publication



Dear Dr. Vinh D.A. Bui,

I am delighted to inform you that the review of your manuscript 5510950 titled "Minimally Invasive Mitral Valve Repair with Artificial Chordae: Insights from a 6-Year Single-Center Study" has been completed and your article has been accepted for publication in *Journal of Cardiac Surgery*.

If you have deposited your manuscript on a preprint server, now would be a good time to update it with the accepted version. If you have not deposited your manuscript on a preprint server, you are free to do so.





THANK YOU!

