Impact of Mitral Valve Repair on Regional and Global LV Remodeling in Barlow's Disease

Christian E. Berg-Hansen, Dana Cramariuc, Rune Haaverstad, Marina Kokorina, Robert M. Persson, Stig Urheim

Background

- Mitral valve prolapse
  - «Spectrum» from FED to Barlow's disease

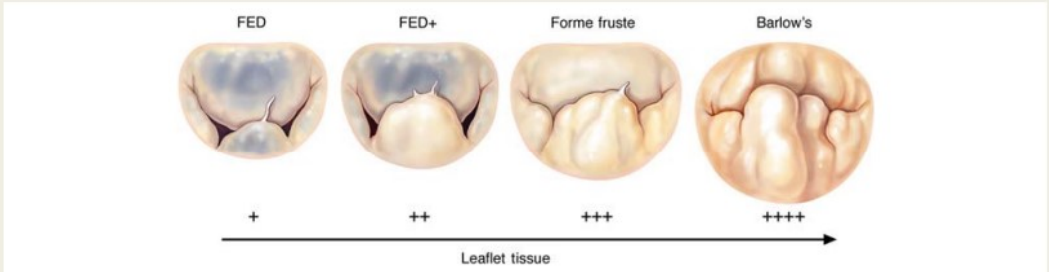
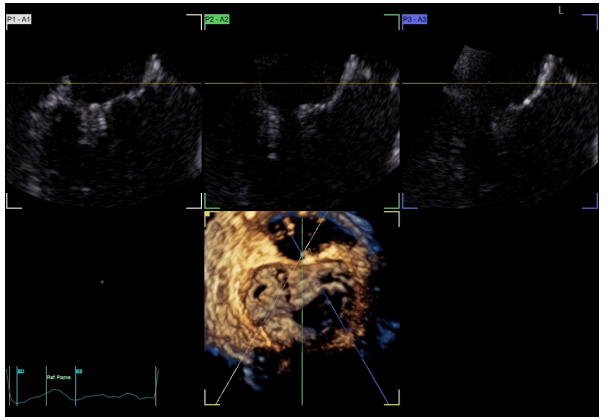


Figure 1 Spectrum of degenerative mitral disease. There is a spectrum of degenerative disease ranging from fibroelastic deficiency (FED) to Barlow's disease. In isolated FED there is a deficiency of collagen, with thin transparent leaflets and typically a ruptured thin chord. In long-standing prolapse, secondary myxomatous pathologic changes may occur in the prolapsing segment, resulting in leaflet thickening and expansion (FED+). Forme fruste designates degenerative disease with excess tissue with myxomatous changes in usually more than one leaflet segment, but usually does not involve a large valve size, distinguishing it from Barlow's disease. In the later, the hallmarks are large valve size, with diffuse myxomatous changes and excess leaflet tissue, with thickened, elongated, and often ruptured chordae.

Adams et al, 2010, EHJ



Background

- Role of GLS in degenerative MR

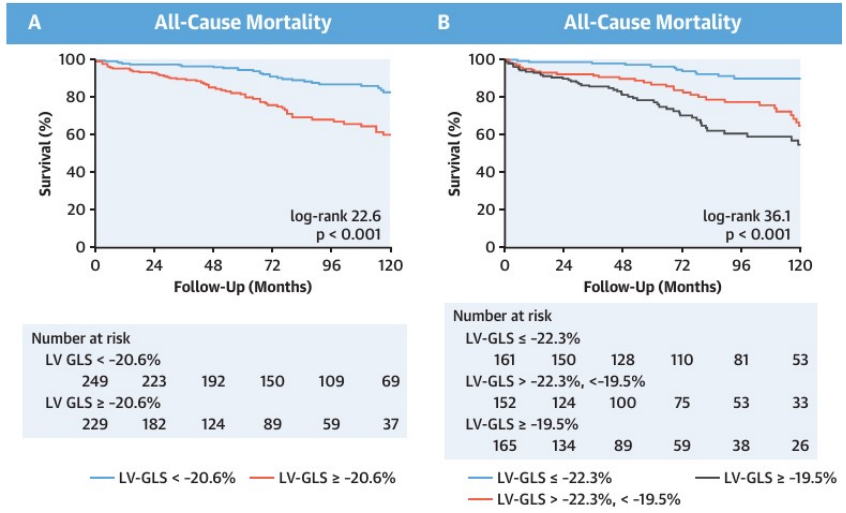
Hiemstra et al, 2020, JACC CVI

- **593 patients** with severe degenerative MR who underwent MV surgery
- **Outcome**: FU 6 years, 146 died, 46 HF-hosp, 13 cerebrovascular accidents
- **Impaired baseline GLS independently associated with all-cause mortality and CV-events**
  - Worse than -20.6 % predicted the outcome, HR 1.13, p<0.001
  - No difference between FED, Barlow and forme fruste

Prognostic Value of Global Longitudinal Strain and Etiology After Surgery for Primary Mitral Regurgitation

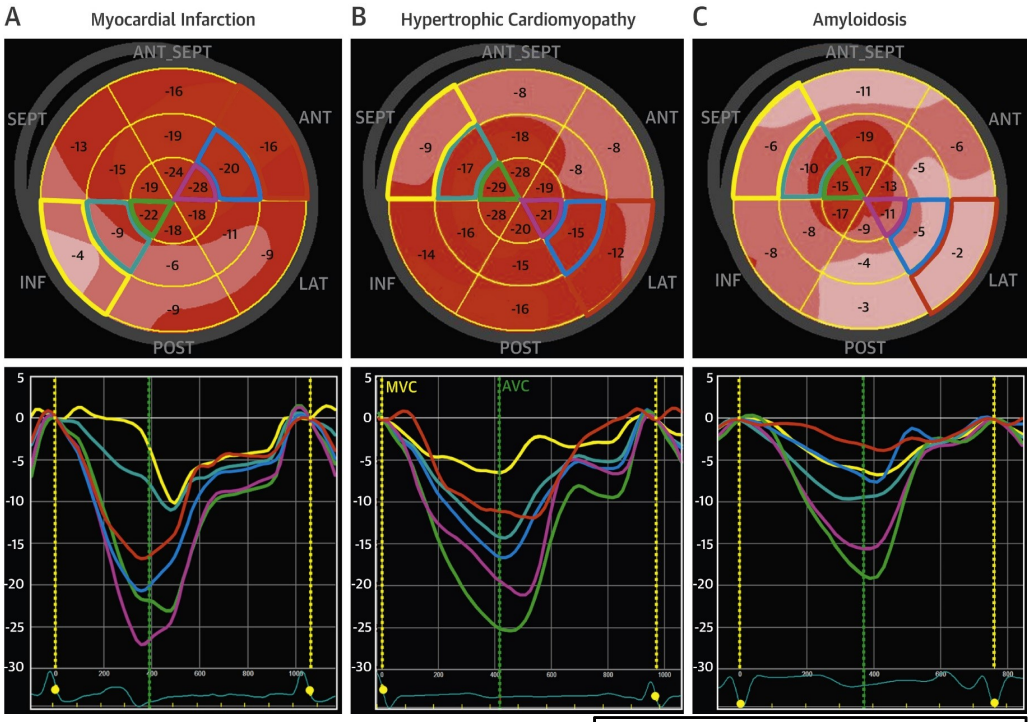
Yasmine L. Hiemstra, MD,[a] Anton Tomsic, MD,[b] Suzanne E. van Wijngaarden, MD,[a] Meindert Palmen, MD, PhD,[b] Robert J.M. Klautz, MD, PhD,[b] Jeroen J. Bax, MD, PhD,[a] Victoria Delgado, MD, PhD,[a] Nina Ajmone Marsan, MD, PhD[a]

CENTRAL ILLUSTRATION Kaplan-Meier Survival Curves According to LV-GLS



Background

- Regional strain pattern in other diseases



Voigt et al, 2019, JACC CVI

Background

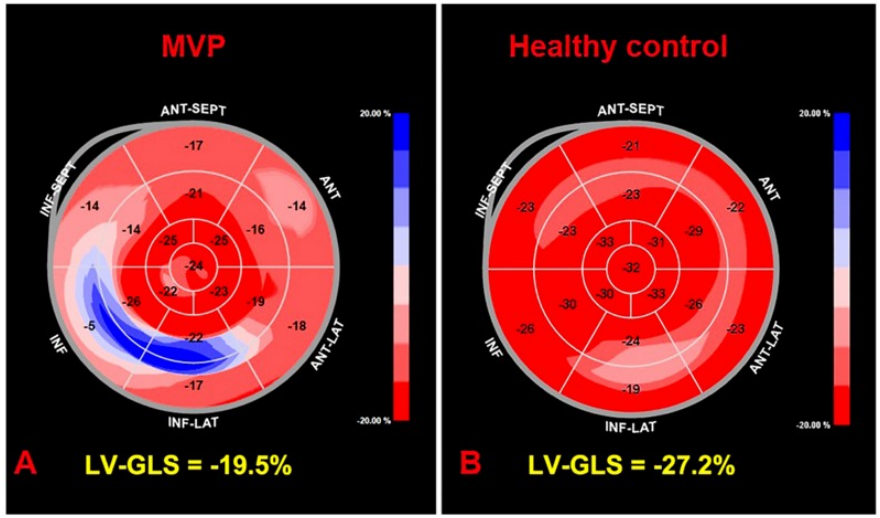
- Role of GLS in degenerative MR

Sonaglioni et al, 2024, Int J of CVI

- Metaanalysis of GLS in patients with MVP compared to healthy controls
- **1088 patients** and 591 controls
- Findings
  - **Worse GLS (-19.4 % vs -21.1 %)**
  - **Decreased regional strain in basal segments**
- Limitations
  - MR severity
  - MVP etiology

Echocardiographic assessment of left ventricular mechanics in individuals with mitral valve prolapse: a systematic review and meta-analysis

Andrea Sonaglioni[1] · Valeria Fagiani[2] · Gian Luigi Nicolosi[3] · Michele Lombardo[1]



Background

- Role of GLS in degenerative MR

Nagata et al, 2023, Circ CVI

- **113 patients** with MVP and 20 controls
- Echo and cMR
- Findings
  - Fibrosis (LGE+) in 43 patients
    - Basal-mid IL wall and PM
    - Despite only 33 % ≥ moderate MR
    - Associated with VA
    - Double peak strain pattern
      - 81 % vs. 26 %
  - **Similar GLS**, but worse than controls
  - **Impaired basal IL strain**
    - - 12.4 % in LGE+ vs. -18.9 % in LGE- vs. -26.9 % in controls
- Limitations
  - MR severity
  - MVP etiology
  - Endocardial strain

Abnormal Mechanics Relate to Myocardial Fibrosis and Ventricular Arrhythmias in Patients With Mitral Valve Prolapse

Yasufumi Nagata, MD, PhD*; Philippe B. Bertrand, MD, PhD*; Vinit Baliyan, MD; Jonathan Kochav, MD; Ruth D. Kagan, MD; Kristian Ujka, MD; Hassan Alfraidi, MD; Antonia, van Kampen MD; Jordan E. Morningstar, MS; Jacob P. Dal-Bianco, MD; Serguei Melnitchouk, MD; Godtfred Holmvang, MD; Michael A. Borger, MD, PhD; Reece Moore, BS; Lanqi Hua, RDCS; Razia Sultana, BA; Pablo Villar Calle, MD; Brian Yum, MD; J. Luis Guerrero, BS; Tomas G. Neilan, MD, MPH; Michael H. Picard, MD; Jiwon Kim, MD; Francesca N. Delling, MD, MPH; Judy Hung, MD; Russell A. Norris, PhD†; Jonathan W. Weinsaft, MD†; Robert A. Levine, MD†

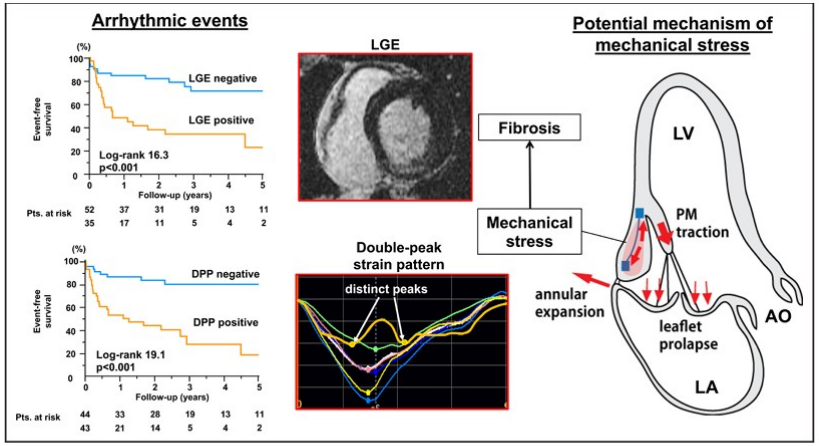


Figure 4. Abnormal valve-related mechanics relate to myocardial fibrosis and ventricular arrhythmia in mitral valve prolapse. Mitral valve prolapse potentially provokes mechanical stress on basal wall adjacent to papillary muscle (**right** schema), which relates to fibrosis and abnormal myocardial deformation (**middle**). Both fibrosis and the Double-peak strain pattern (DPP) were associated with ventricular arrhythmic events (**left**, Kaplan-Meier curves). AO indicates aorta; LA, left atrium; LGE, late gadolinium enhancement; LV, left ventricle; PM, papillary muscle.

Background

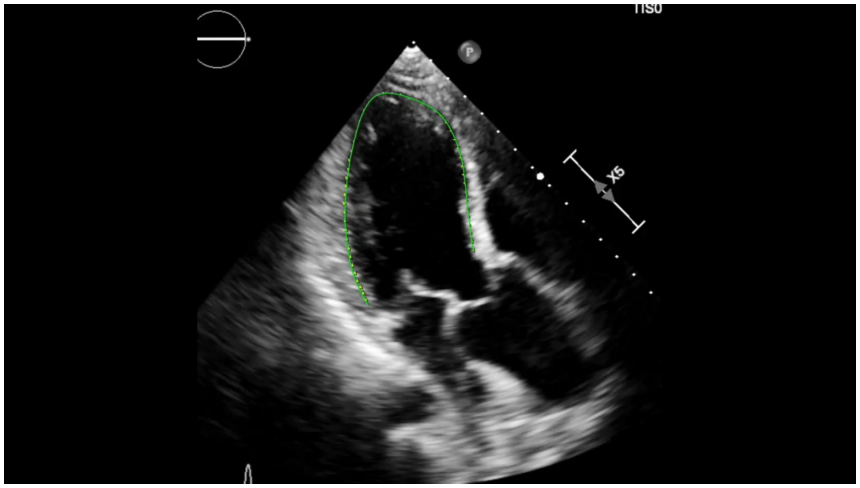
- Role of GLS in degenerative MR

Nagata et al, 2023, Circ CVI

- **113 patients** with MVP and 20 controls
- Echo and cMR
- Findings
  - Fibrosis (LGE+) in 43 patients
    - Basal-mid IL wall and PM
    - Despite only 33 % ≥ moderate MR
    - Associated with VA
    - Double peak strain pattern
      - 81 % vs. 26 %
  - **Similar GLS**, but worse than controls
  - **Impaired basal IL strain**
    - - 12.4 % in LGE+ vs. -18.9 % in LGE- vs. -26.9 % in controls
- Limitations
  - MR severity
  - MVP etiology
  - Endocardial strain

Abnormal Mechanics Relate to Myocardial Fibrosis and Ventricular Arrhythmias in Patients With Mitral Valve Prolapse

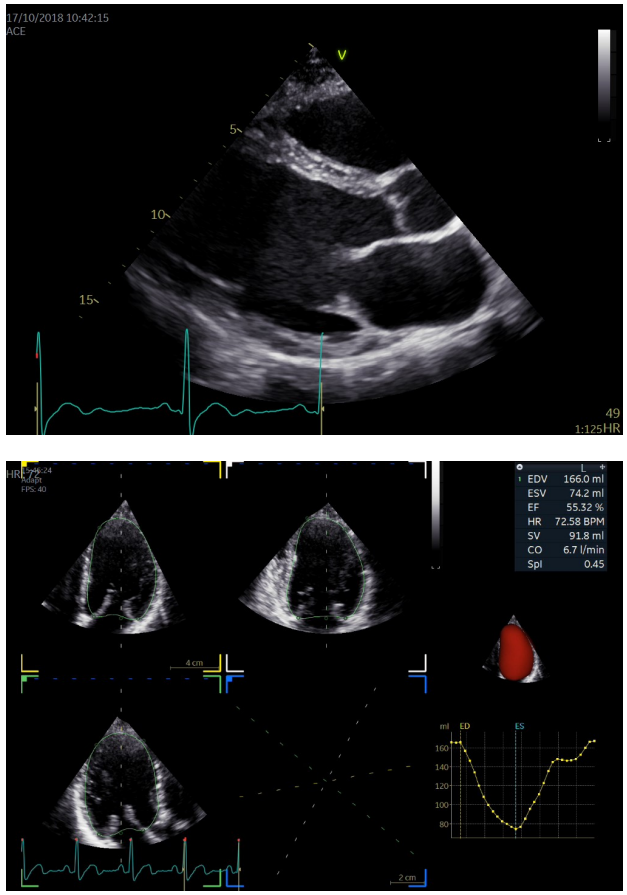
Yasufumi Nagata, MD, PhD*; Philippe B. Bertrand, MD, PhD*; Vinit Baliyan, MD; Jonathan Kochav, MD; Ruth D. Kagan, MD; Kristian Ujka, MD; Hassan Alfraidi, MD; Antonia, van Kampen MD; Jordan E. Morningstar, MS; Jacob P. Dal-Bianco, MD; Serguei Melnitchouk, MD; Godtfred Holmvang, MD; Michael A. Borger, MD, PhD; Reece Moore, BS; Lanqi Hua, RDCS; Razia Sultana, BA; Pablo Villar Calle, MD; Brian Yum, MD; J. Luis Guerrero, BS; Tomas G. Neilan, MD, MPH; Michael H. Picard, MD; Jiwon Kim, MD; Francesca N. Delling, MD, MPH; Judy Hung, MD; Russell A. Norris, PhD†; Jonathan W. Weinsaft, MD†; Robert A. Levine, MD†



Impact of mitral valve repair in Barlow's disease

Methods

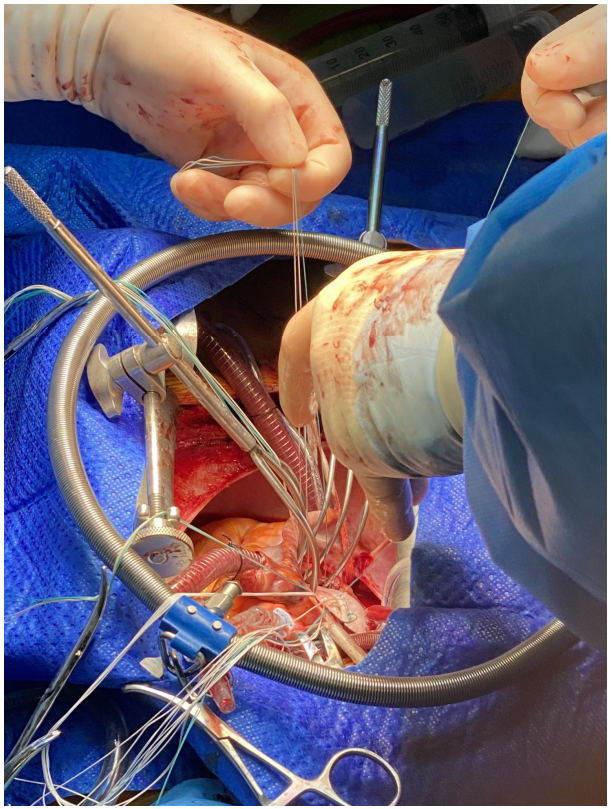
- 20 patients recruited prospectively 2017-2022
- Barlow's disease with severe MR referred for surgery
  - Mitral valve repair
- 2D/3D-echocardiography at baseline and 1-2 years after surgery



Impact of mitral valve repair in Barlow's disease

Methods

- Surgery - Mitral valve repair
- Annuloplasty (median ring size 36 mm [32-38 mm]) and implantation of neo-chordae in all patients
- Ventricularisation of disjunction in all patients with MAD
- Leaflet resection in 65 %



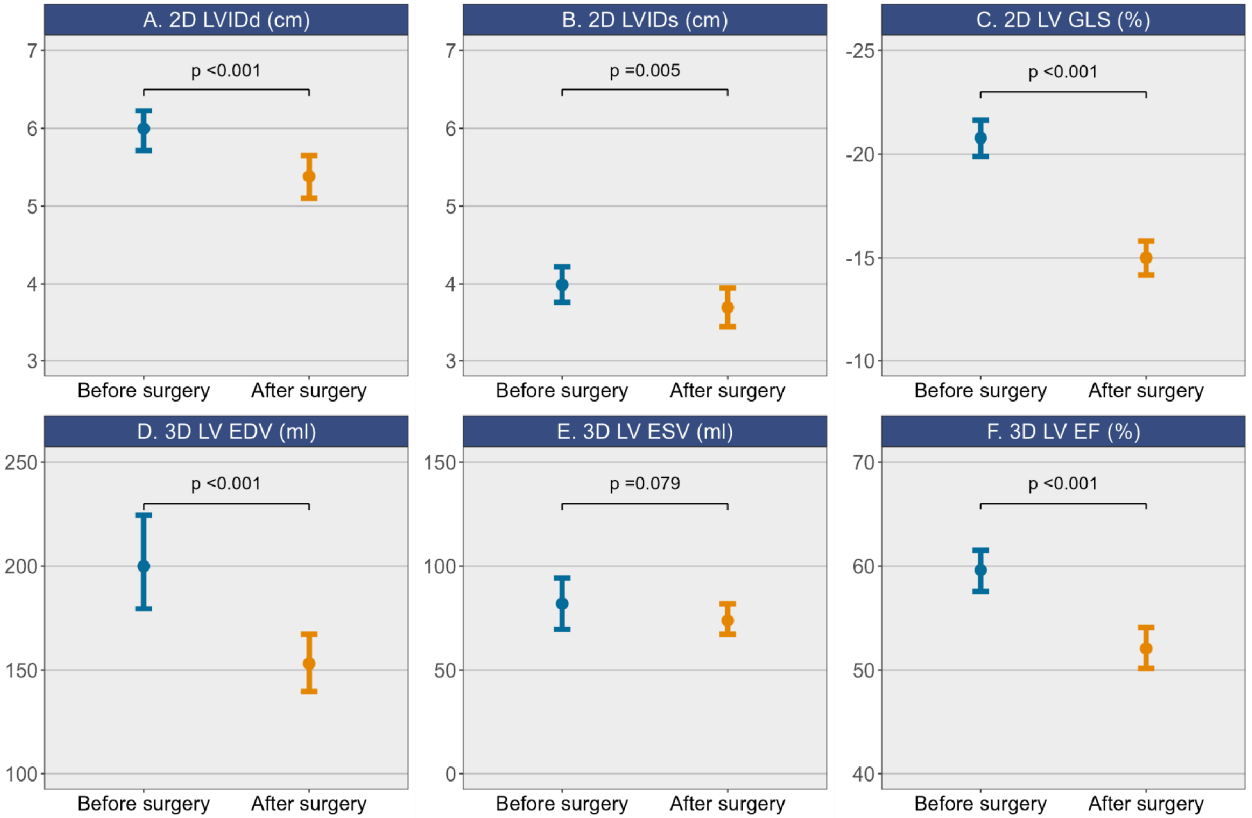
Impact of mitral valve repair in Barlow's disease

Baseline	n=20
Age (years)	56 ± 15 [23-83]
Women (%)	45
BMI (kg/m^2)	24 ± 2.0
Heart rate (bpm)	64 ± 10
Systolic BP (mmHg)	127 ± 15
Diastolic BP (mmHg)	77 ± 9.2
Paroxysmal Afib (%)	20
Hypertension (%)	15
Diabetes (%)	0
Coronary artery disease (%)	0

Impact of mitral valve repair in Barlow's disease

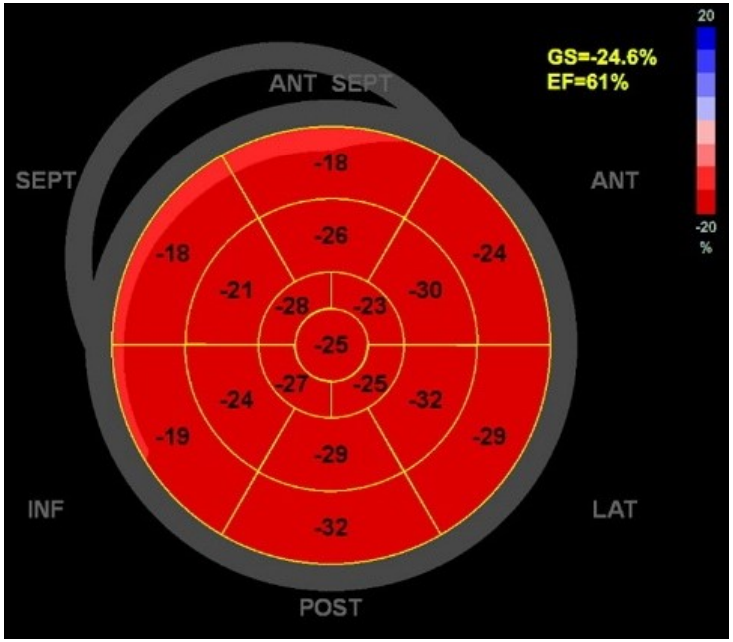
Echo parameters	Baseline	Follow-up	p-value
MR Rvol (ml)	49 ± 19	3.1 ± 11	**<0.001**
MR RF (%)	40 ± 10	3.6 ± 14	**<0.001**
3D LAVI (ml/m^2)	49 ± 12	36 ± 14	**<0.01**
2D LASr (%)	24.6 ± 7.5	20.1 ± 6.8	**<0.01**
TAPSE (cm)	28.4 ± 3.7	18.5 ± 3.6	**<0.001**
SPAP (mmHg)	29 ± 8.5	24 ± 3.0	**0.01**

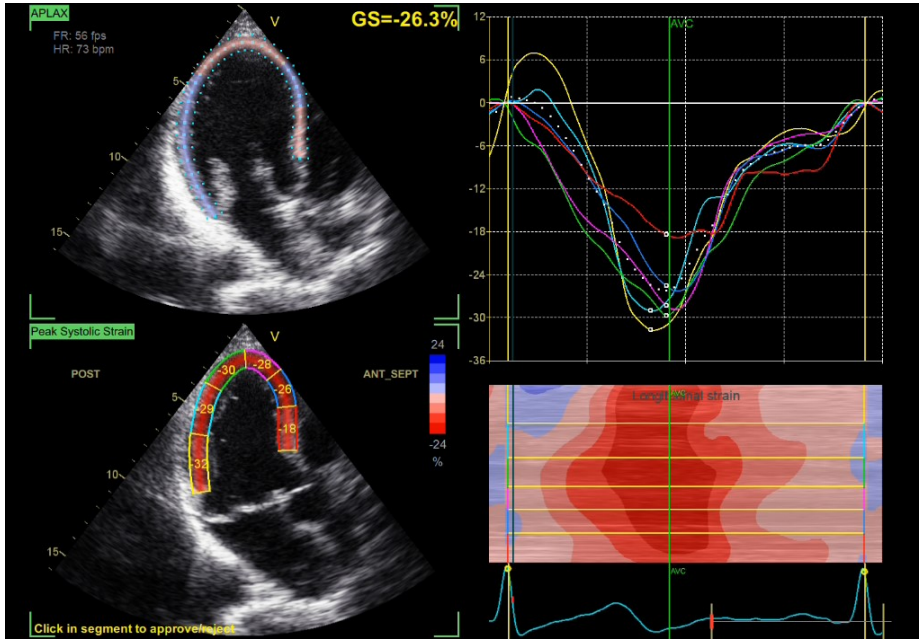
Impact of mitral valve repair in Barlow's disease



Regional strain patterns - an example

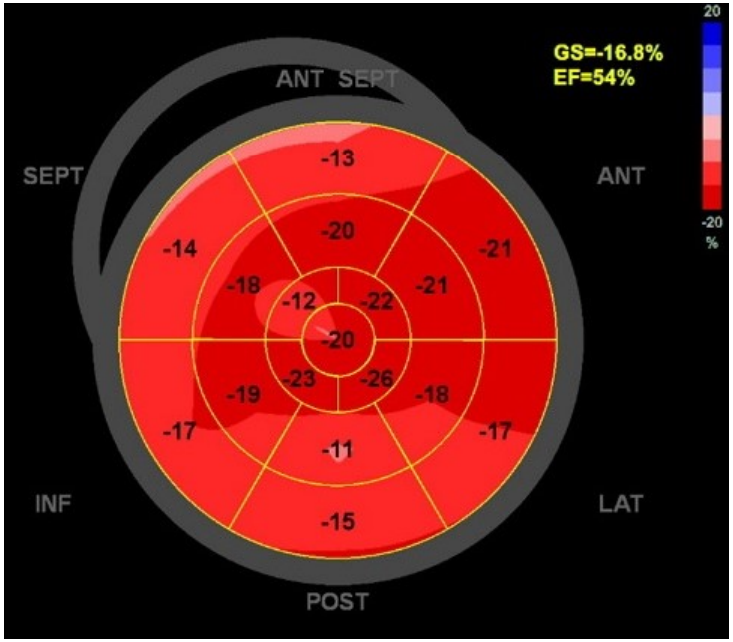
Before surgery

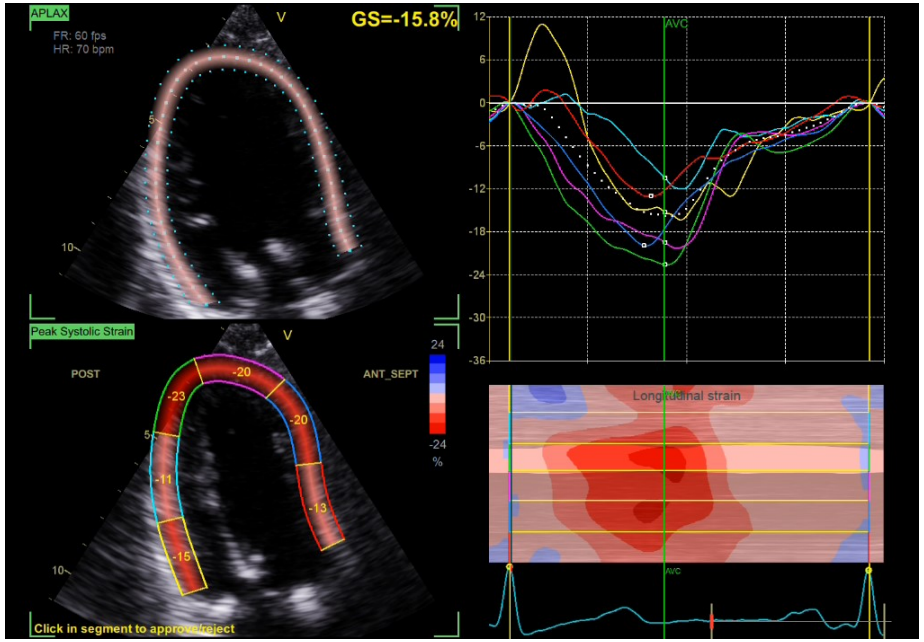




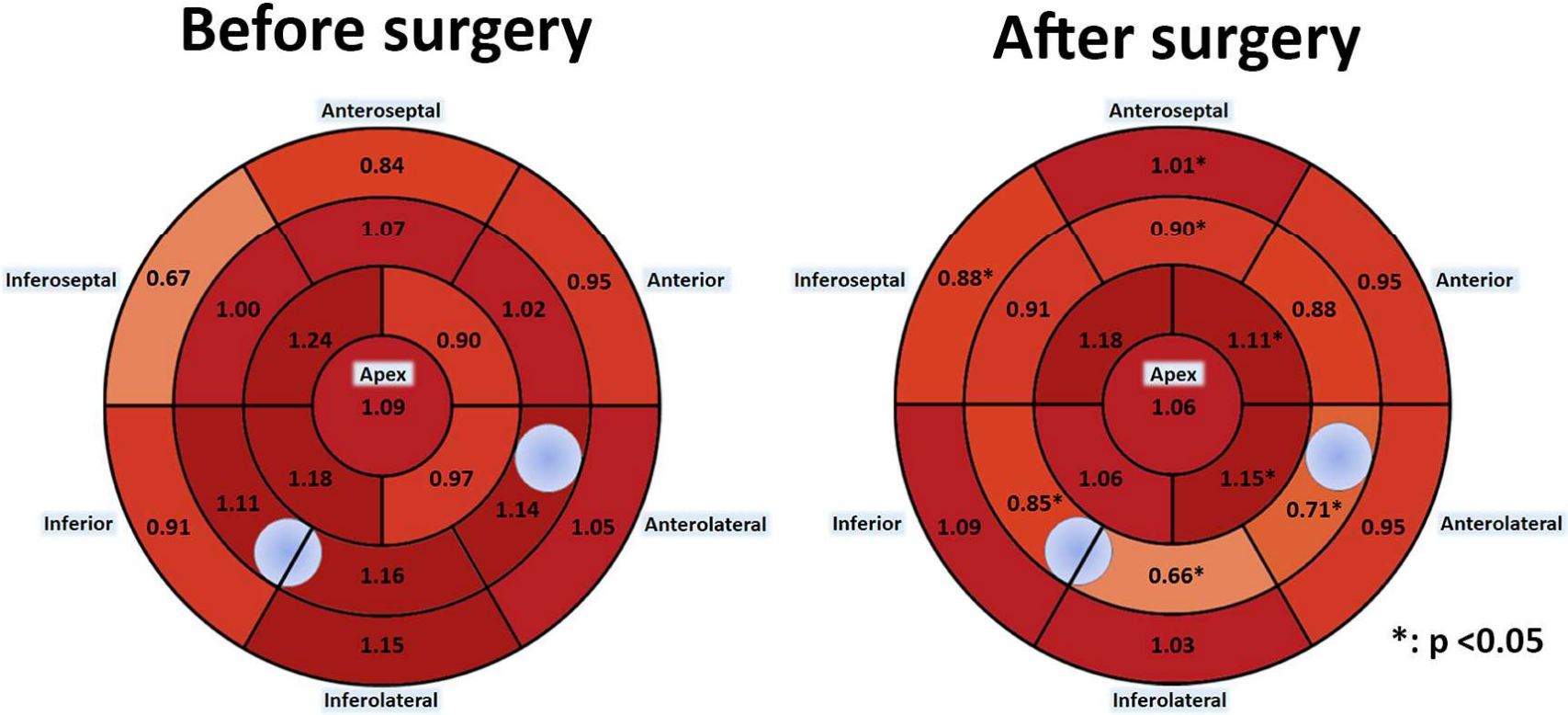
Regional strain patterns - an example

After surgery





Regional strain patterns
- ratio of segmental strain to GLS



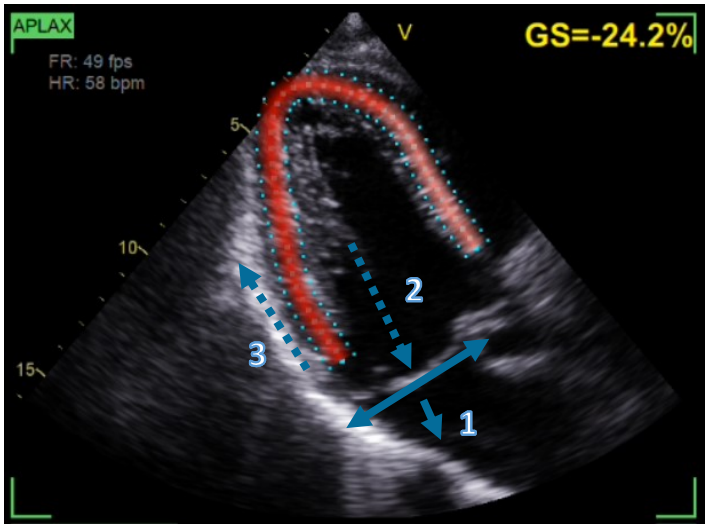
Proposed mechanical effects of mitral valve repair

1) **Stabilize mitral annular late-systolic dilation**
– annuloplasty

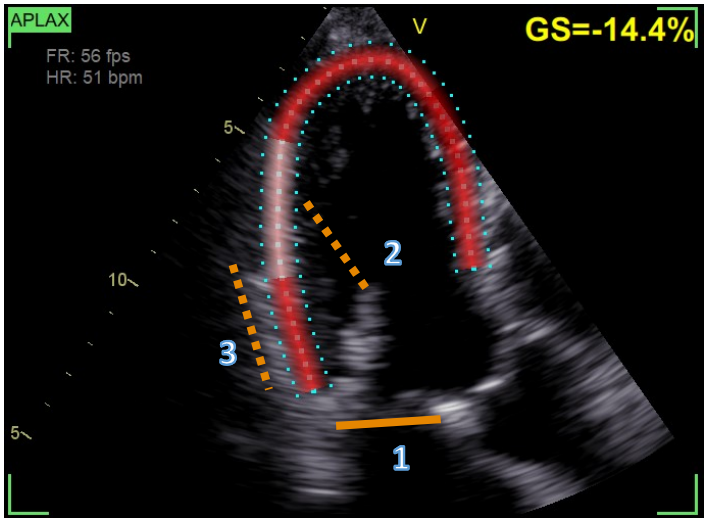
2) **Reduce papillary muscle traction**
– annuloplasty + neo-chordae

3) **Stabilize increased regional longitudinal strain**
– ventricularisation

Before



After



Conclusions

- In patients with Barlow's disease, mitral valve repair is associated with significant LV reverse remodeling and changed strain patterns in **regions neighboring the papillary muscles and MAD**.
- The observed changes probably reflect changed forces due to **reduced papillary muscle traction and MAD ventricularisation**.