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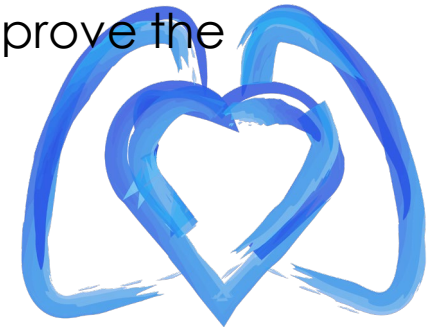
Improving the reproducibility of papillary muscle maneuvers in type IIIb MR: focus on papillary muscle geometry

Background / Study Objective

- **Type IIIb MR** results from geometric LV distortion → papillary muscle displacement → mitral leaflet tethering
- **Papillary muscle maneuvers** have been shown to improve the stability of MV repair in type IIIb MR.
- **REFORM-MR** registry confirmed the safety and efficacy of papillary muscle maneuvers in a multicenter setting
- The **reproducibility** remains an issue which limits broader implementation of such techniques
- We focused on papillary muscle geometry aiming to improve the reproducibility of papillary muscle maneuvers



Patients

Study cohort: 219 consecutive patients undergoing cardiac surgery at University Hospital (2021 – 2023)

Variable	**Cohort 1** (no MR) (n=141)	**Cohort 2** (MR) (n=78)	**Total cohort** (n=219)	p value
Age	63.4 (11)	62.8 (11.2)	63.2 (11.1)	0.68
Gender (m/f)	109/32	58/20	167/52	0.75
BSA	2 (0.2)	1.9 (0.2)	1.9 (0.2)	0.34
Arterial hypertension	99 (70.2)	34 (43.6)	133 (60.7)	<0.01
Diabetes	33 (23.4)	4 (5.1)	37 (16.9)	<0.01
LVEF (%)	47.1 ± 12.4	50.2 ± 9.9	48.2 ± 11.6	0.10
LVEDD (mm)	59.4 ± 9.1	63.3 ± 10.9	60.7 (9.9)	<0.01
LVEDV (ml)	112.6 (43.5)	123.9 (42.8)	116.7 (43.5)	0.06
LVESD (mm)	44 (9.9)	46.6 (9.8)	44.9 (9.9)	0.06
LVESV (ml)	64 (31.4)	68.4 (31.8)	65.6 (31.6)	0.33
Sphericity Index	1.5 (0.2)	1.3 (0.2)	1.4 (0.2)	<0.01
Interpapillary distance (mm)	20.4 (5.2)	21.2 (5.8)	20.7 (5.4)	0.25

Cohort 1 : CABG or SAVR (no MR)

Cohort 2 : MV repair (MR)

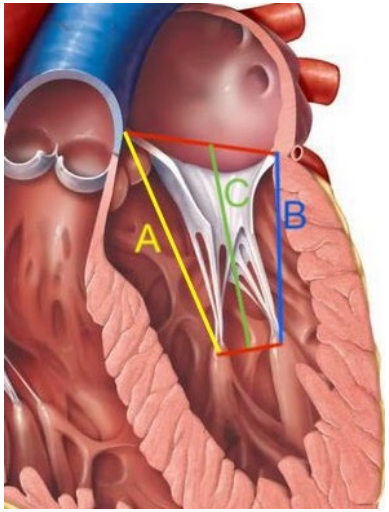
Methods 1

- TOE measurements (A,B,C) of echocardiographic distance between **papillary muscle (PM) tips and mitral valve annulus**

  A - posteromedial PM – posterior MV annulus (P3)

  B - anterolateral PM – posterior MV annulus (P1)

  C – PM tips plane – MV annulus plane



- Study endpoints:

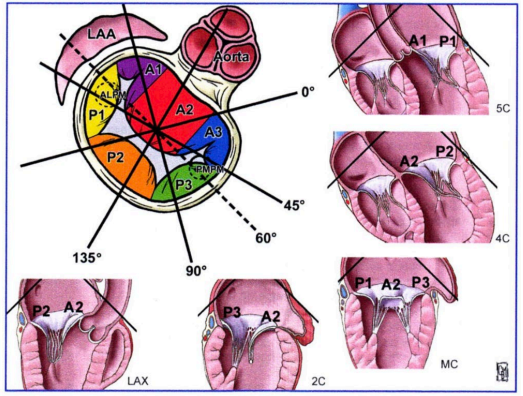
(1) Correlation between PM distance measurements

- intra-individual variation between A, B, and C
- inter-individual variation between A,B and C - Cohort I vs. Cohort II

(2) Correlation between PM distances and patients' characteristics

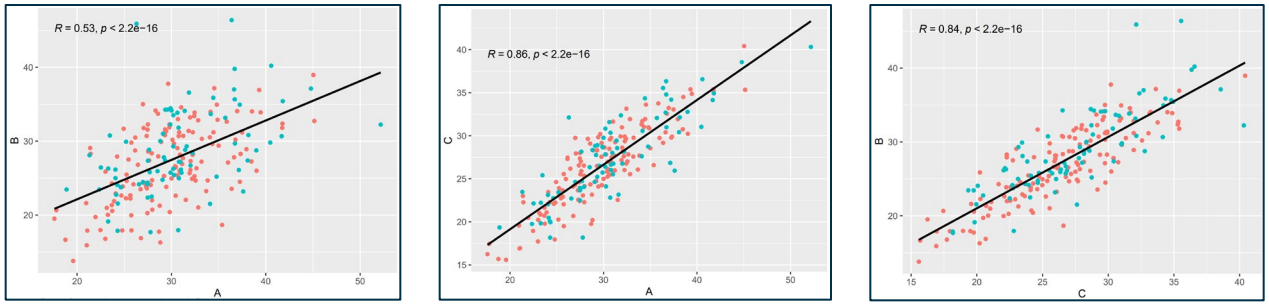
- Echocardiographic markers (LV size & geometry)
- Baseline characteristics (age, gender, BSA)

(3) Prediction model of optimal PM distance



(1) Correlation between PM distance measurements

- intra-individual variation between A, B, and C – ***strong correlation***



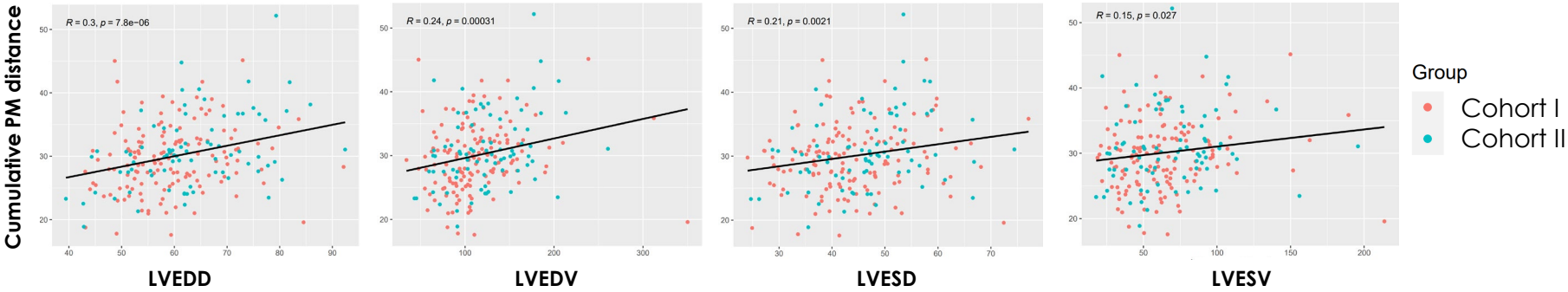
- inter-individual variation between A, B, and C in **Cohort I** vs. **Cohort II**

Variable	**Cohort 1** (no MR) (n=141)	**Cohort 2** (MR) (n=78)	**Total cohort** (n=219)	p value
A (mm)	29.7 ± 5.3	30.9 ± 5.9	30.1 ± 5.5	0.15
B (mm)	26.8 ± 5.3	28.8 ± 5.8	27.5 ± 5.5	0.01
C (mm)	26.4 ± 4.7	27.4 ± 4.9	26.7 ± 4.8	0.13
Cumulative distance*	28.3 ± 4.7	29.8 ± 5.0	28.8 ± 4.8	0.02

* i.e., mean of A and B

(2) Correlation between PM distance (cumulative) and patients' characteristics

- Echocardiographic markers (LV size & geometry) – ***better correlation for diastolic LV measures***



- Baseline characteristics
  - *Age*: ***no significant correlation*** (R = −0.054, p = 0.43)
  - *Gender, BSA*: ***significant correlation*** (R = 0.28, p = 3.4e−05)

(3) Prediction model of optimal PM distance

Among all considered linear prediction models, the best model included a single echocardiographic parameter (*LV length in end-diastole*)

Conclusion

- We present a thorough analysis of **papillary muscle geometry** based on standardized perioperative TOE-measurements in consecutive patients undergoing cardiac surgery

- The "normal" distance between **PM tips and posterior mitral valve annulus** is relatively stable and ranges between 27 – 30mm in patients without MR (A > B). The distance is increased by 1-2 mm in patients with MR

- The distance between **PM tips and posterior mitral valve annulus** correlates significantly with LV size and volume, while diastolic markers (in particular LVEDD) showed better correlation
- Mathematical models to predict the optimal PM distance based on echocardiographic and baseline parameters are desirable, however still suboptimal