



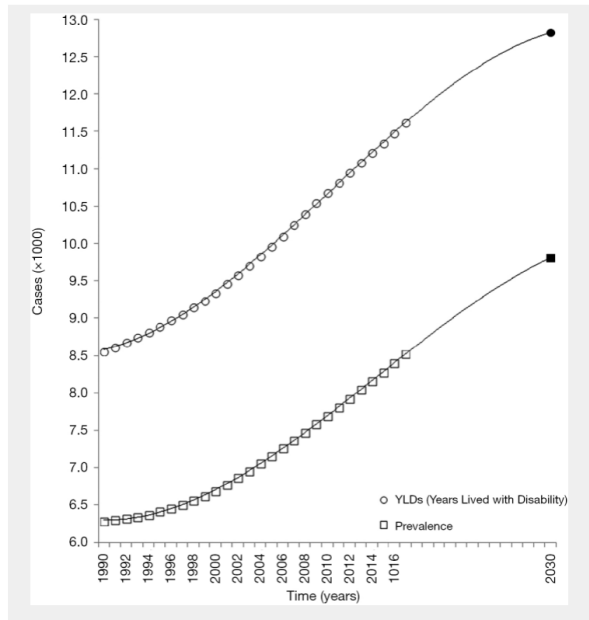
**PETROVSKY NATIONAL RESEARCH CENTRE OF SURGERY
(FSBSI «PETROVSKY NRCS»)
MOSCOW**



Solutions for Optimal Cardiac Resynchronization Therapy

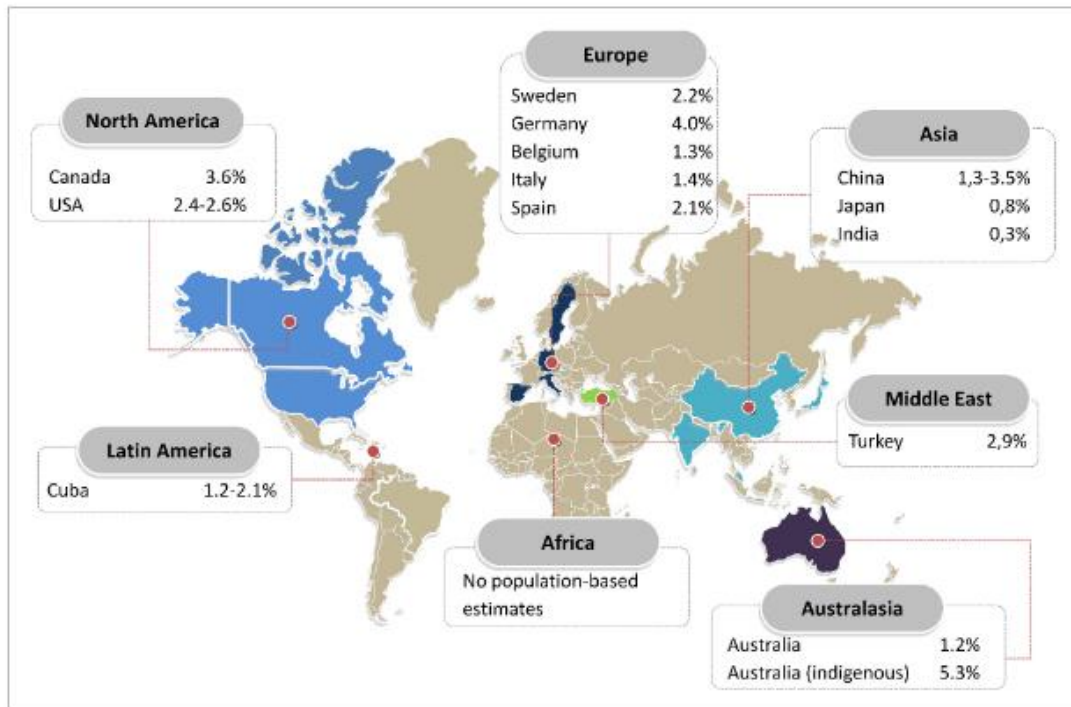
Dr. DMITRIY PODOLYAK





Heart Failure

This is a pathophysiological syndrome in which, as a result of one or another disease of the cardiovascular system, there is a decrease in the pumping function of the heart, which leads to an imbalance between the hemodynamic demand of the body and the capabilities of the heart.



Epidemiology Heart Failure

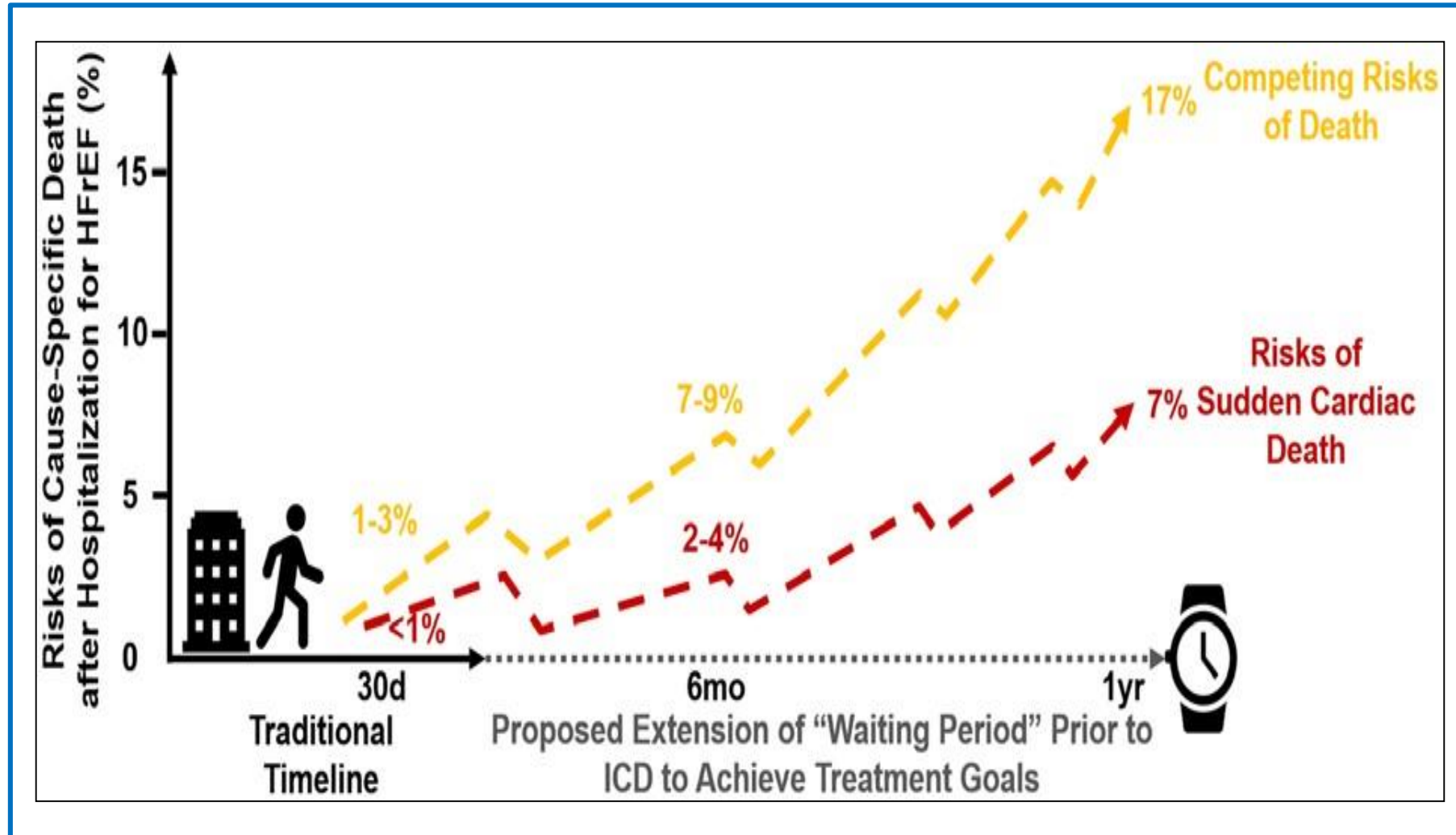
26- million people in the world. By 2030 y.- 30 mln. p.

In Russia, HF (I-IV) NYHA (2016 r) - 14,9 mln.p.

Among them, in severe form - 6,0 mln.p. ФК III-IV NYHA

One - year mortality is 880-980 thousand people.

Risks of Cause-Specific Death after Hospitalization patients with Heart Failure

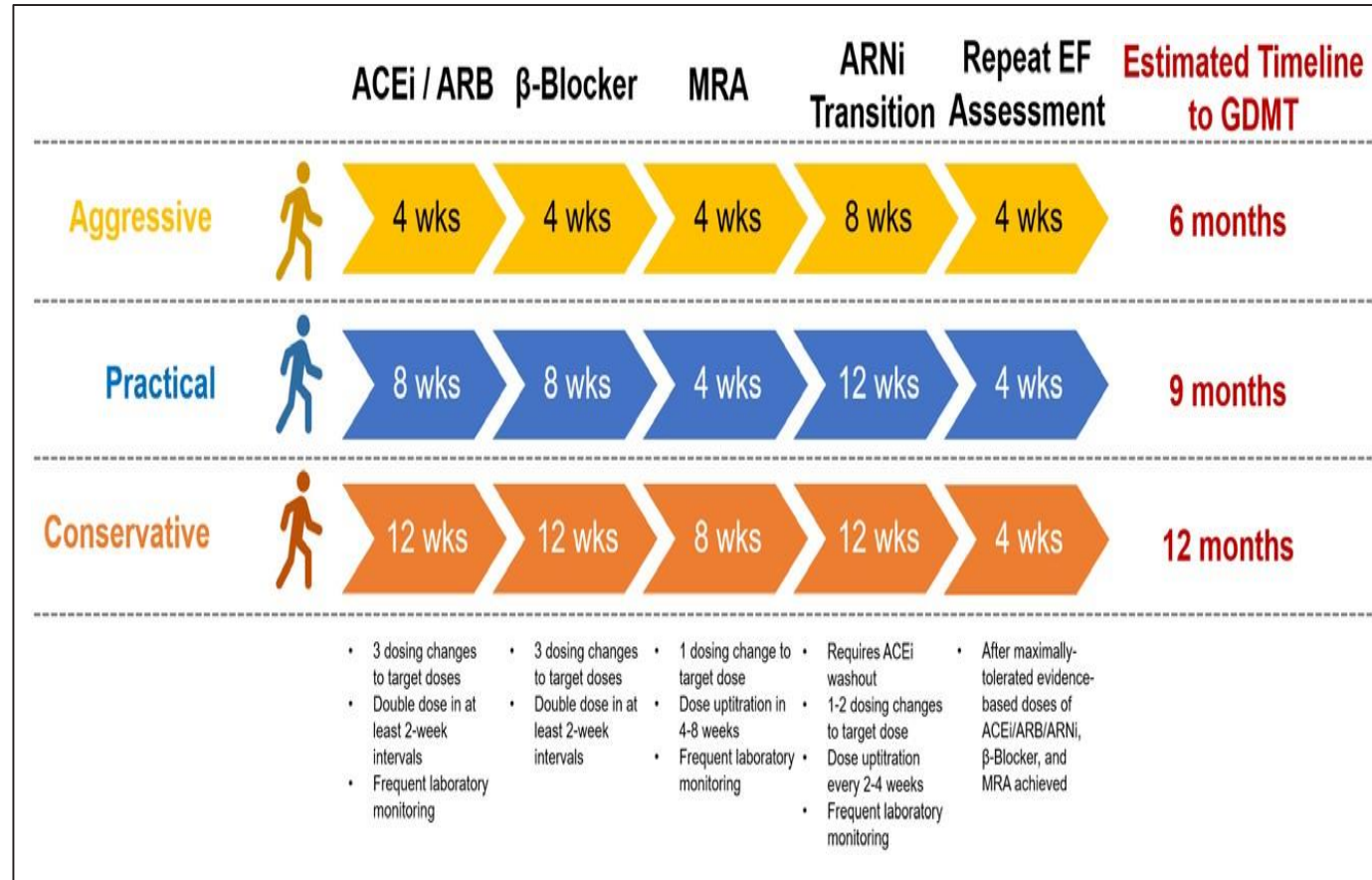




The main goals of treatment of patients with HF

1. Elimination of clinical symptoms
2. Prevention of target organ damage
3. Risk reduction SCD
4. Improving the quality and duration of life

Guideline-Directed Medical Therapy (GDMT)





Surgical methods of treatment HF

Cardiac Resynchronization Therapy (CRT)

Cardiac Contractility Modulation (CCM)

Left Ventricular Assist Device (LVAD)

Orthotopic heart transplantation

Cardiac Resynchronization Therapy

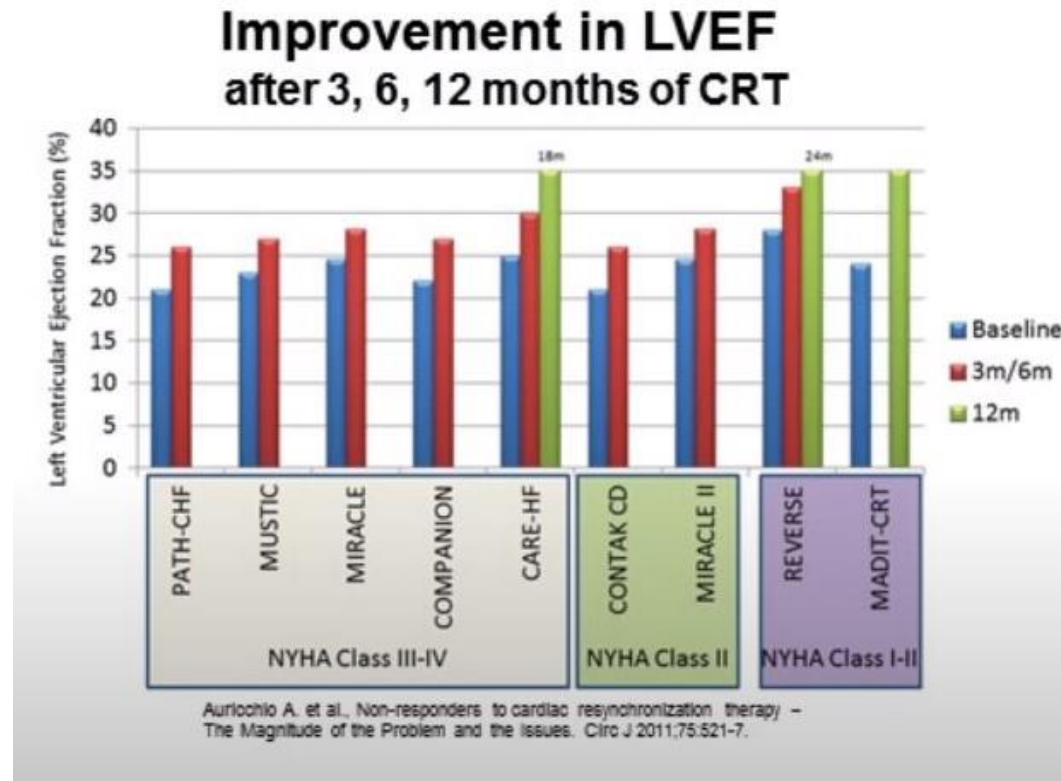
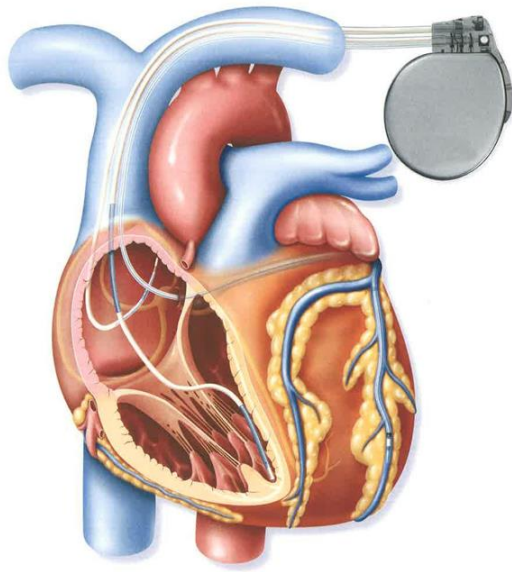


Table 1 2022 AHA/ACC/HFSA guidelines for the management of heart failure

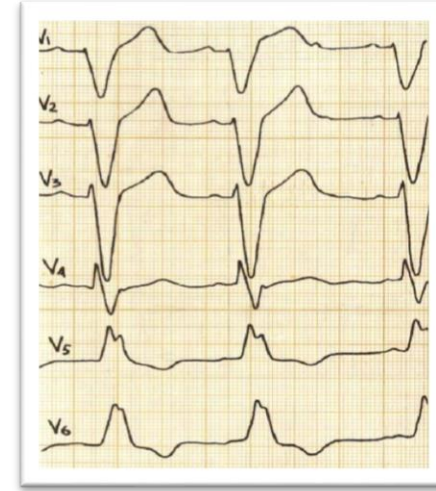
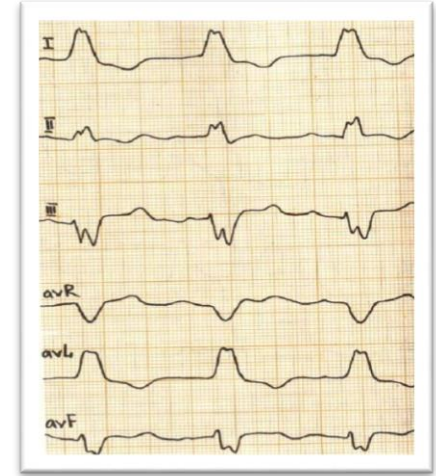
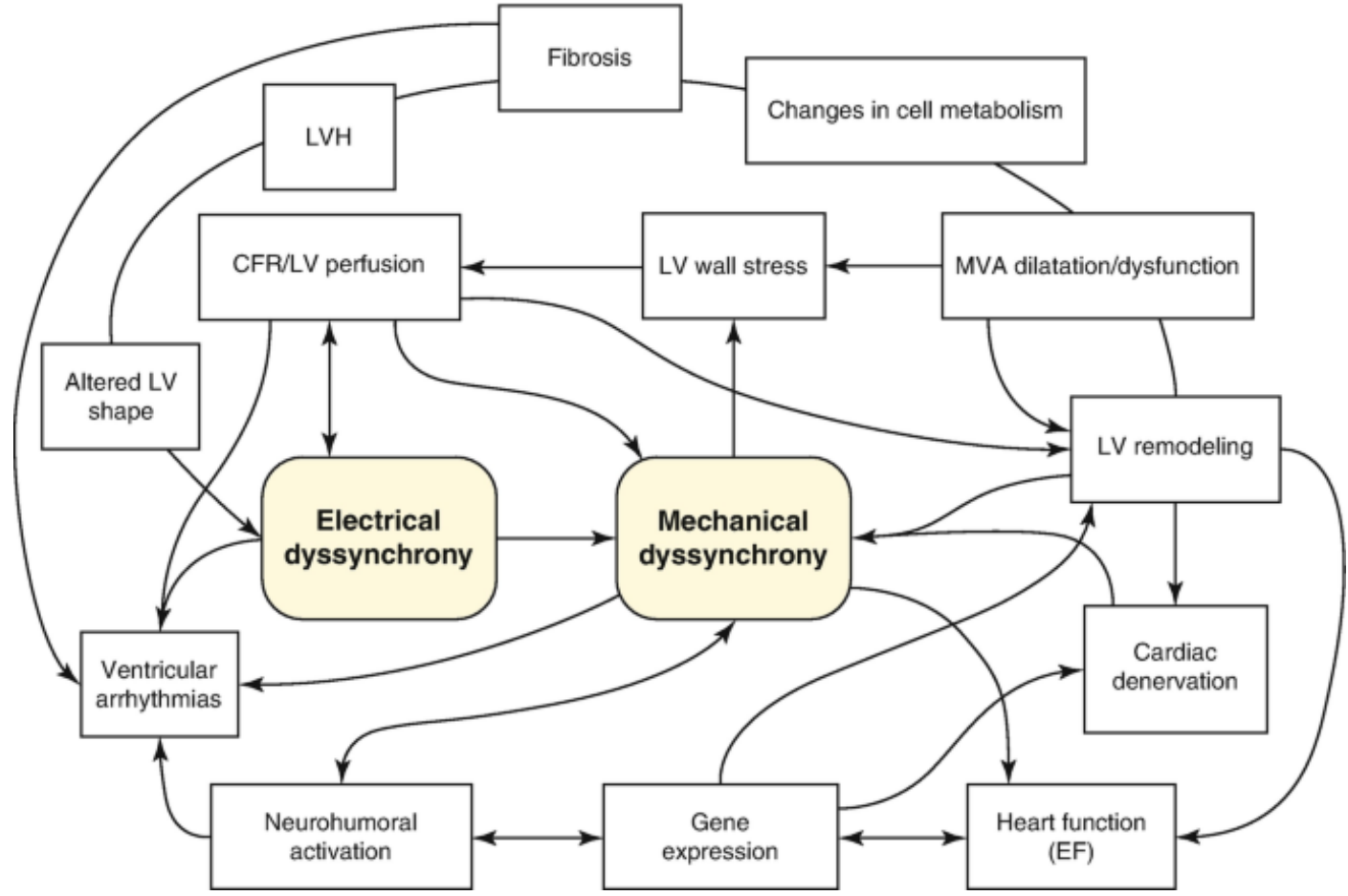
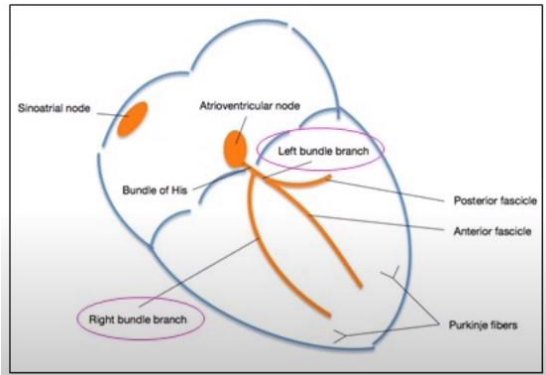
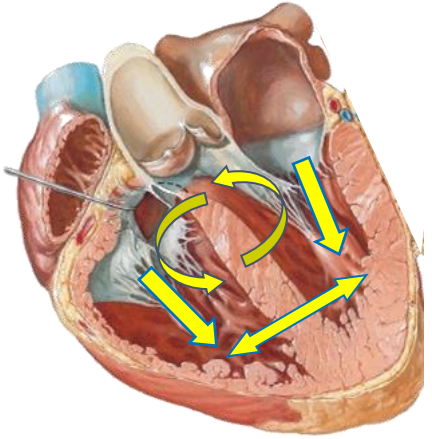
COR	RECOMMENDATIONS
I	For patients who have LVEF < 35%, sinus rhythm, left bundle branch block (LBBB) with a QRS duration ≥150 ms, and NYHA class II, III, or ambulatory IV symptoms on GDMT, CRT is indicated to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL. For patients who have LVEFs ≤35%, sinus rhythm, LBBB with a QRS duration of ≥150 ms, and NYHA class II, III, or ambulatory IV symptoms on GDMT, CRT implantation provides high economic value.
2A	For patients who have LVEF ≤35%, sinus rhythm, a non-LBBB pattern with a QRS duration ≥150 ms, and NYHA class II, III, or ambulatory class IV symptoms on GDMT, CRT can be useful to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL.
2A	In patients with high-degree or complete heart block and LVEF of 36% to 50%, CRT is reasonable to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL.
2A	For patients who have LVEF ≤35%, sinus rhythm, LBBB with a QRS duration of 120 to 149 ms, and NYHA class II, III, or ambulatory IV symptoms on GDMT, CRT can be useful to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL.
2A	In patients with AF and LVEF ≤35% on GDMT, CRT can be useful to reduce total mortality, improve symptoms and QOL, and increase LVEF, if: a) the patient requires ventricular pacing or otherwise meets CRT criteria and b) atrioventricular nodal ablation or pharmacological rate control will allow near 100% ventricular pacing with CRT.
2A	For patients on GDMT who have LVEF ≤35% and are undergoing placement of a new or replacement device implantation with anticipated requirement for significant (>40%) ventricular pacing, CRT can be useful to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL.
2B	For patients who have LVEF ≤35%, sinus rhythm, a non-LBBB pattern with QRS duration of 120 to 149 ms, and NYHA class III or ambulatory class IV on GDMT, CRT may be considered to reduce total mortality, reduce hospitalizations, and improve symptoms and QOL.
2B	For patients who have LVEF ≤30%, ischemic cause of HF, sinus rhythm, LBBB with a QRS duration ≥150 ms, and NYHA class I symptoms on GDMT, CRT may be considered to reduce hospitalizations and improve symptoms and QOL.
3	In patients with QRS duration <120 ms, CRT is not recommended.
3	For patients with NYHA class I or II symptoms and non-LBBB pattern with QRS duration < 150 ms, CRT is not recommended.
3	For patients whose comorbidities or frailty limit survival with good functional capacity to < 1 year, ICD and cardiac resynchronization therapy with defibrillation (CRT-D) are not indicated.

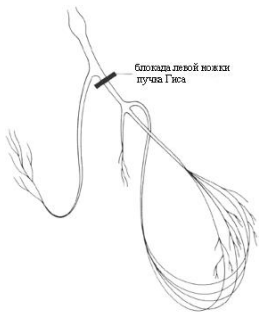
Reduction in overall mortality by 29%

Reduction in mortality due to progressive HF by 38%

MIRACLE, COMPANION, CARE-HF, REVERSE, MADIT-CRT, RAFT.

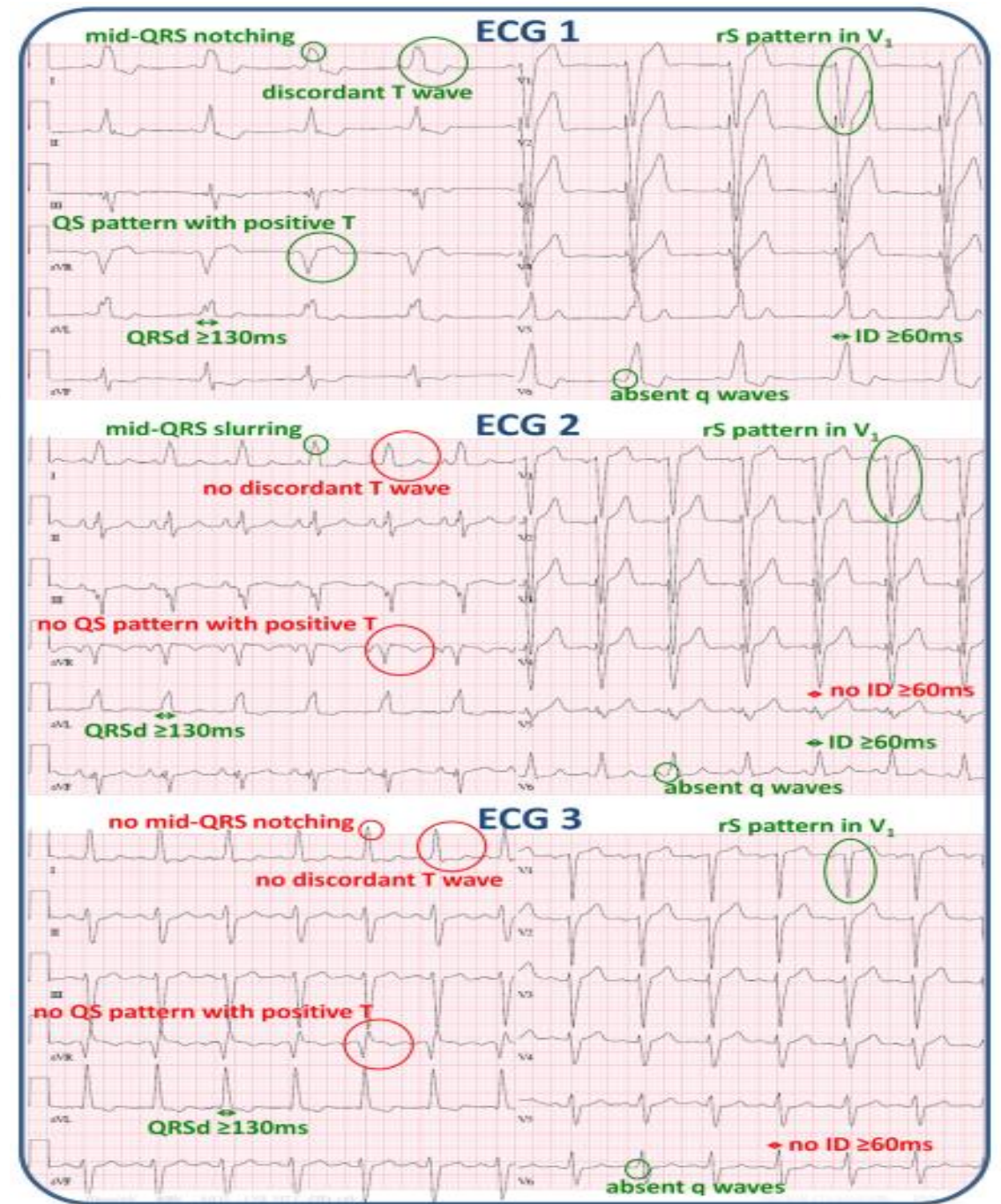
Dyssynchrony is a pathological dissociation of contraction or relaxation of individual chambers of the heart and segments of the myocardium as a result of disturbances in impulse conduction, which leads to a violation of the contractility of the heart and an increase in energy consumption by the myocardium.





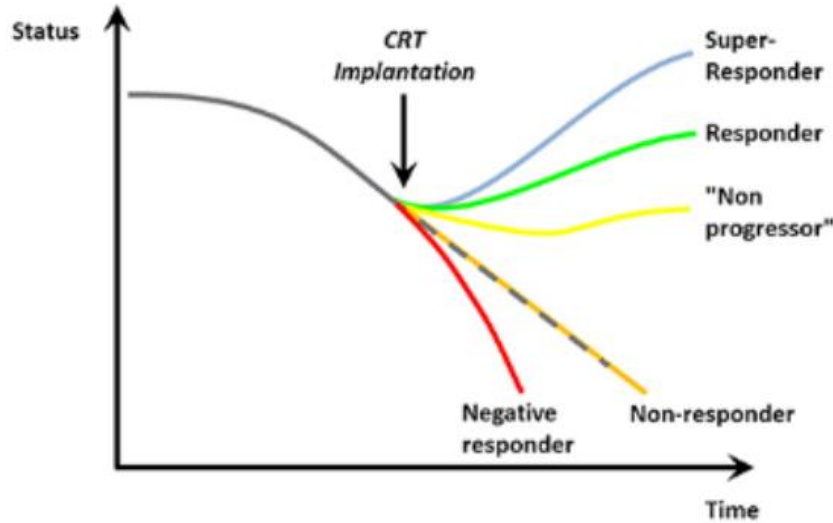
ECG – parameters LBBB. (QRS duration and morphology)

ECG parameter for complete LBBB	ESC	AHA	Strauss	MADIT	REVERSE
QRS duration (ms) \geq	120	120	♀130 ♂140	130	120
QS or rS in V ₁	Yes	Yes	Yes	Yes	Yes
Positive T in V ₁	Yes	No	No	No	No
Normal ID R in V ₁ -V ₃	No	Yes	No	No	No
ID R in V ₅ \geq 60 ms	No	Yes	No	No	No
ID R in V ₆ \geq 60 ms	Yes	Yes	No	No	No
ID R in I \geq 60 ms	Yes	No	No	No	No
Notch/slurred R in I, aVL and V ₅ -V ₆	No	Yes	No	No	No
Mid-QRS notch/slurring in \geq 2 leads of V ₁ -V ₂ , V ₅ -V ₆ , I, aVL	No	No	Yes	No	No
RS pattern allowed in V ₅ -V ₆	No	Yes	Yes	Yes	Yes
Absent q in V ₅ -V ₆	No	Yes	No	Yes	Yes
Absent q in I	No	Yes	No	No	No
QS with positive T in aVR	Yes	No	No	No	No
Usually discordant T	Yes	Yes	No	No	No



Who Responds to CRT?

Overall response rate 70%



- **Significant dyssynchrony**

LBBB, QRSD > 150 msec.
3D ECHO IVD >40 msec.

- **Minimal lateral LV scar**

MPI/SPECT/MRI ≤ 13-15%

- **Adequate CS anatomy**

Lead placement
Pace site of latest activation

Likelihood to Respond to CRT

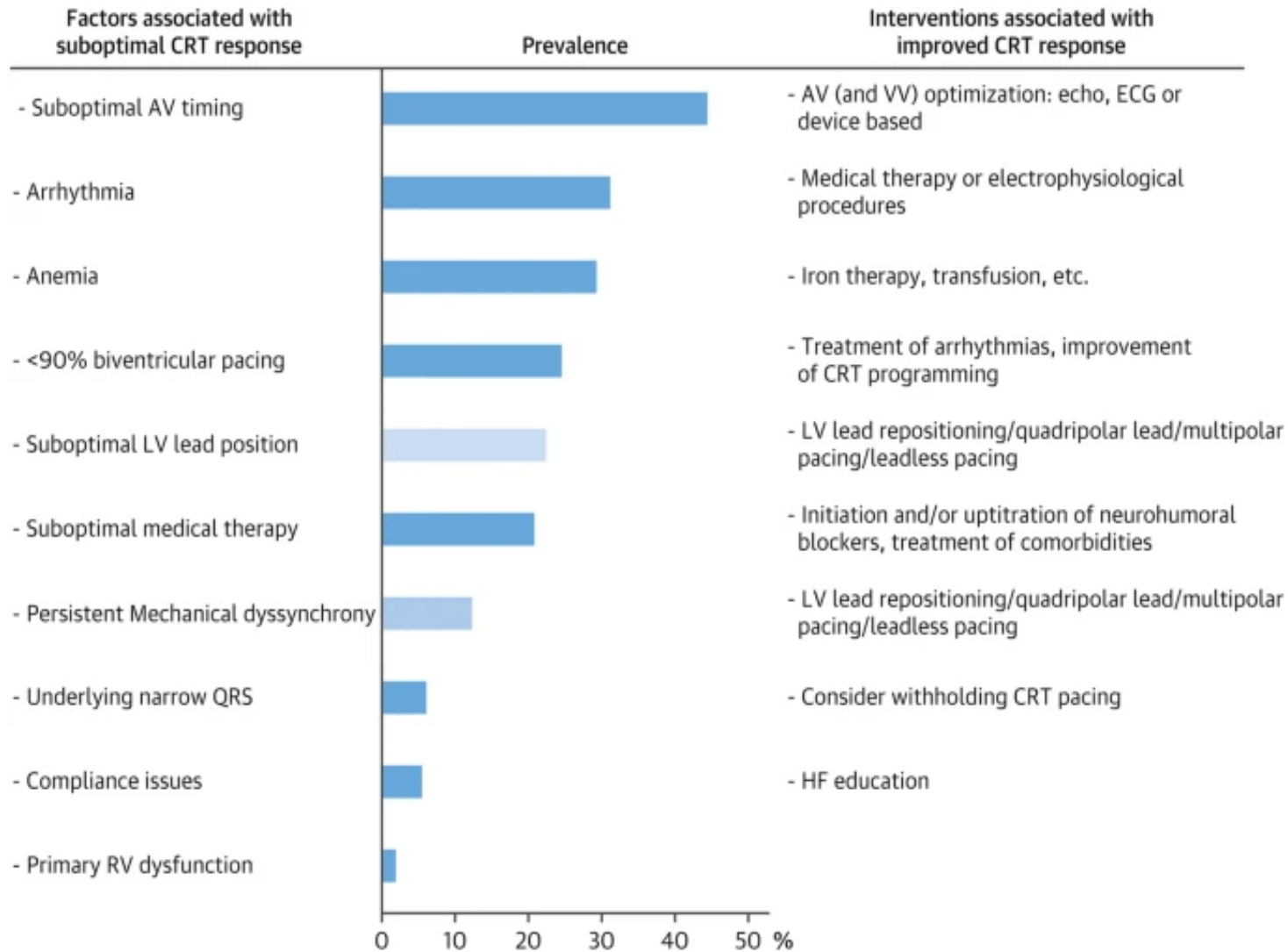


Parameters

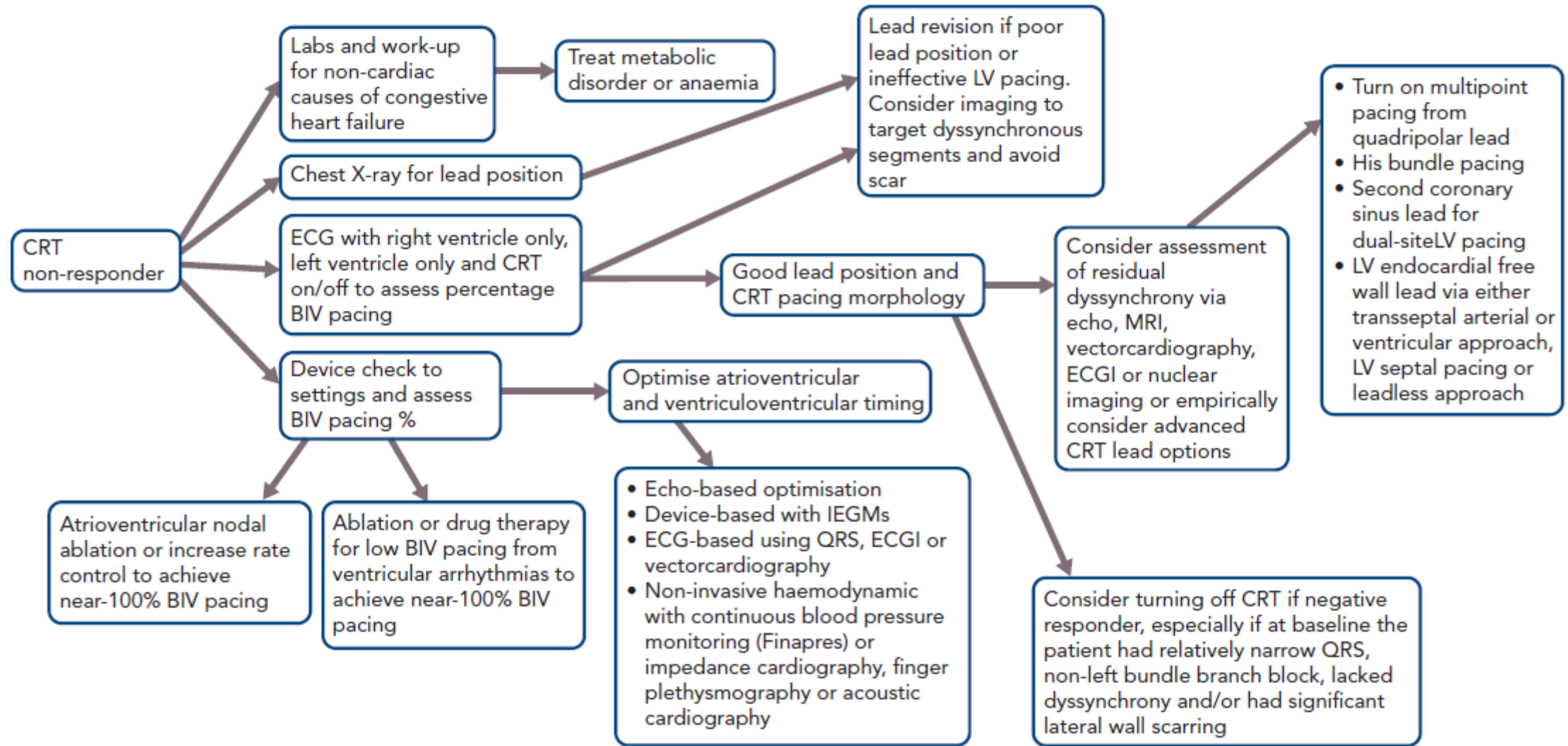
		≥150 ms	120-150 ms	<120 ms	Estimated relative importance
Reported in Prospective Randomized Controlled Trials	QRS Duration	≥150 ms	120-150 ms	<120 ms	Very High
	QRS Morphology	LBBB	RBBB	IVCD	
	Etiology	DCM	CAD		High
Reported in Observational Studies	Septal Rebound Stretch	Present	Absent	Absent	High
	Posterolateral Scar	Absent or minimal	Present	Present	
	Dyssynchrony	Present	Minimal	Absent	Moderate

Auricchio A. et al., Non-responders to cardiac resynchronization therapy – The Magnitude of the Problem and the Issues. *Circ J* 2011;75:521-7.

Understanding non-response to cardiac resynchronization therapy

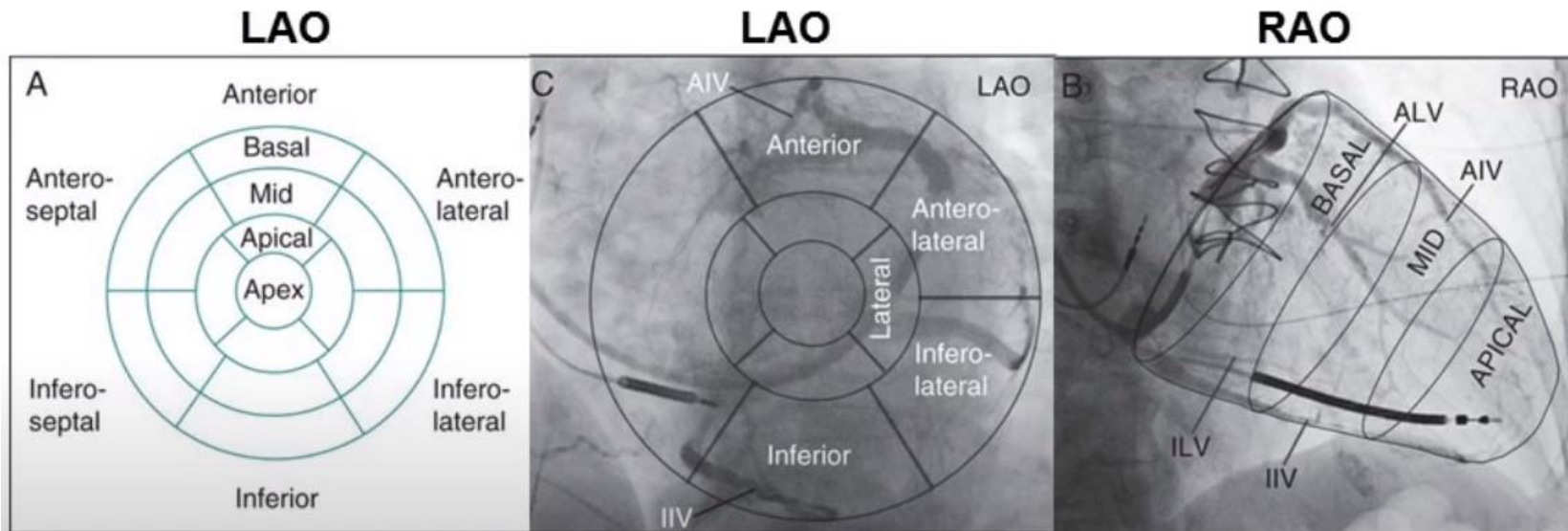
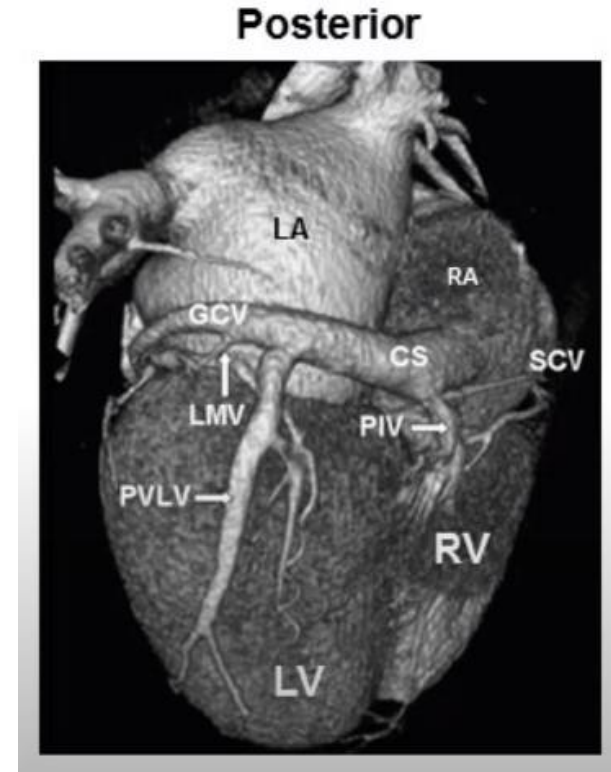
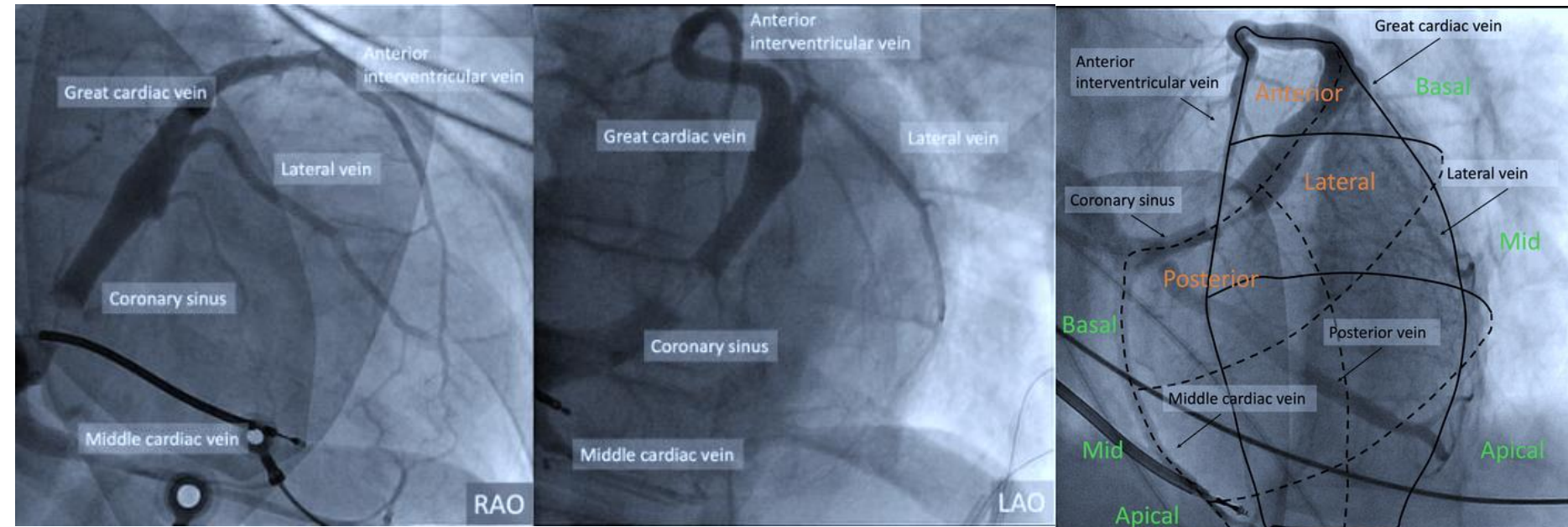


Decision Tree for CRT Non-responders

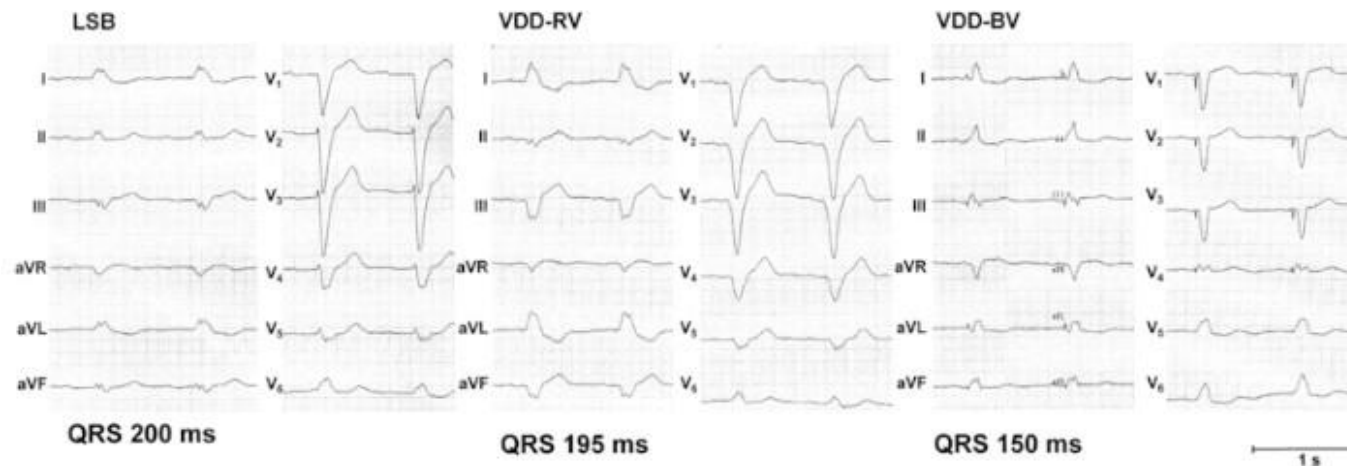
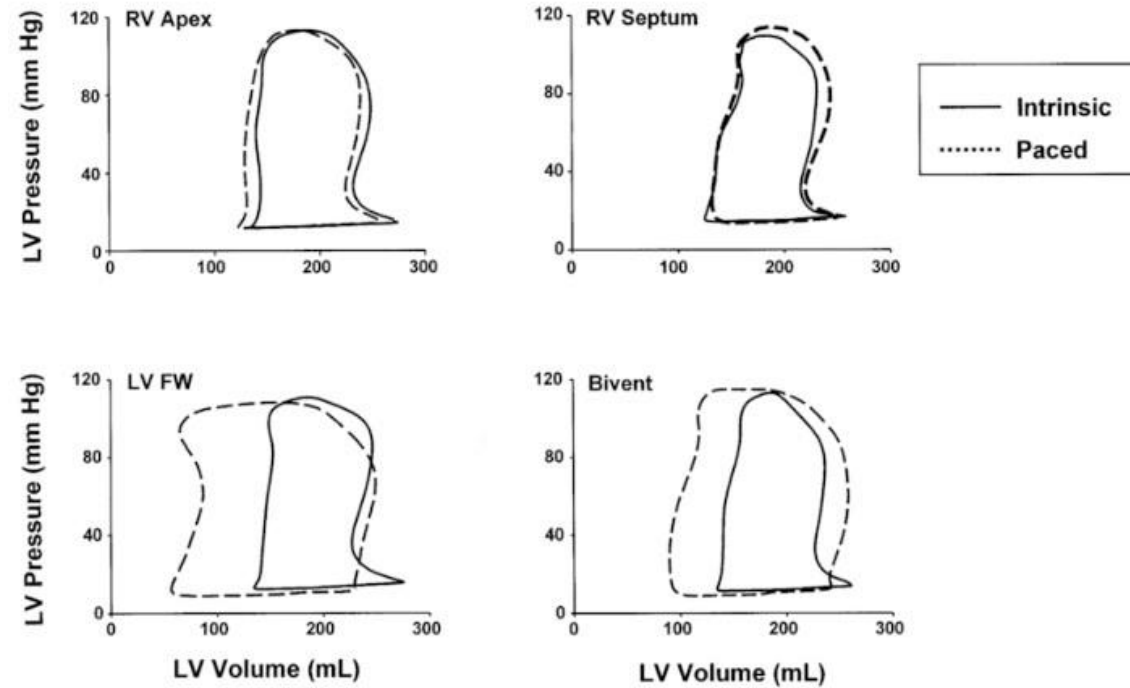


Coronary venous anatomy

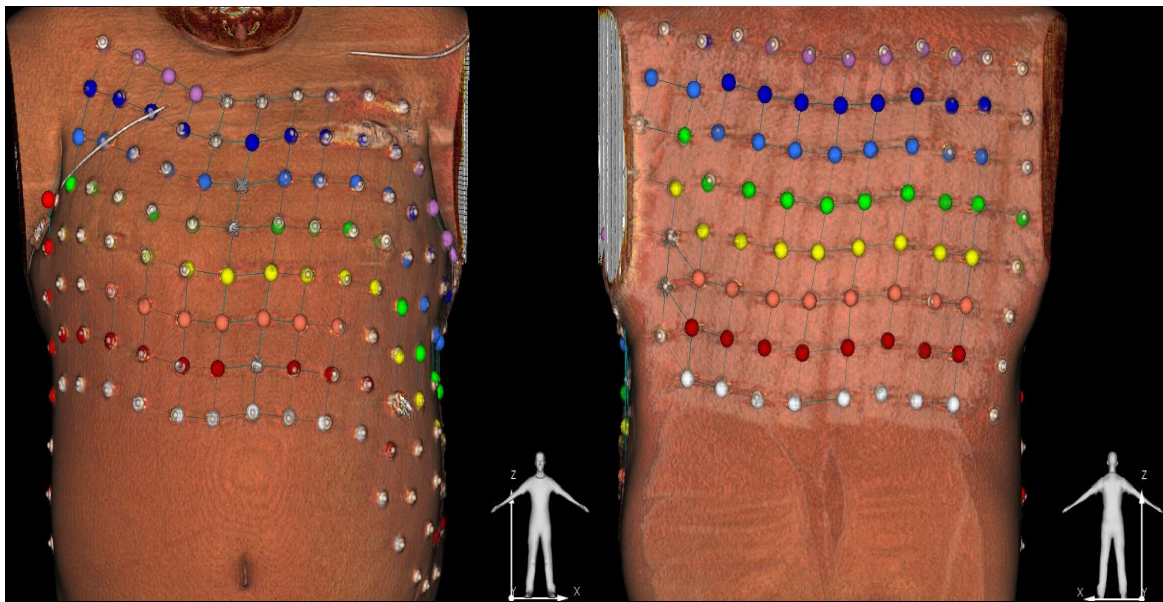
The coronary venous tree as seen on a rotational angiogram.



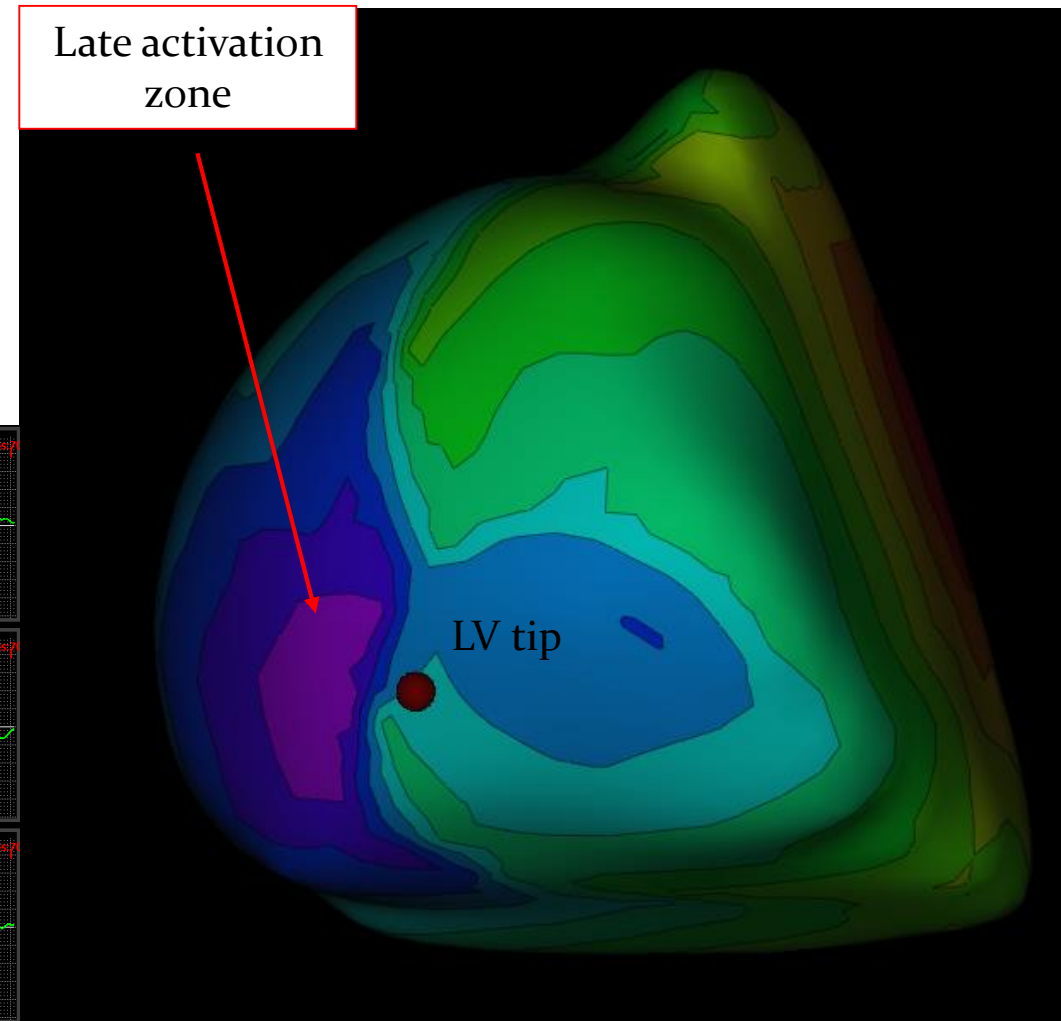
Pressure-volume (PV) loops from a patient with LBBB



Non-invasive Activation Mapping of the Heart



Late activation zone

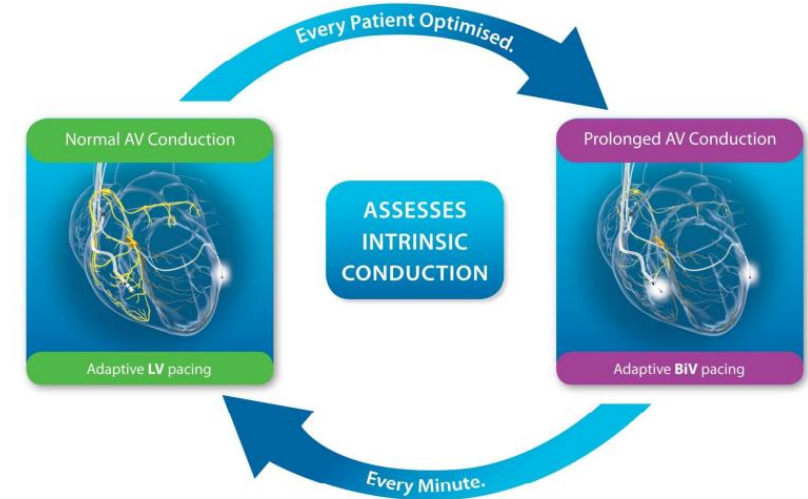
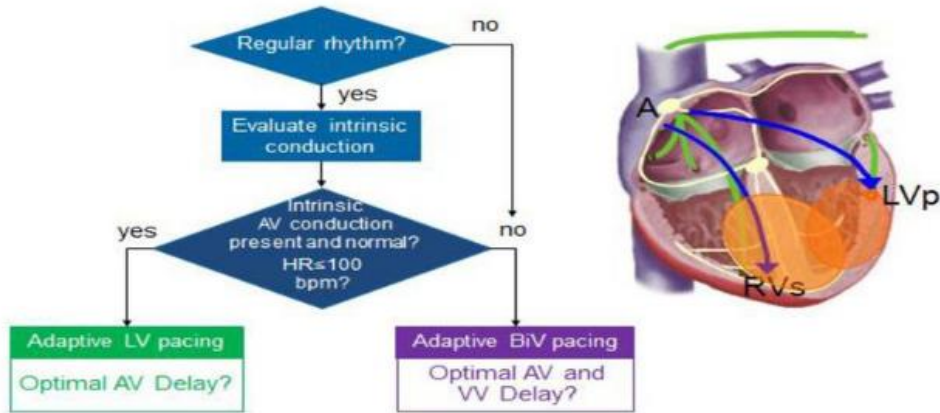


CRT – Optimization

Adaptiv CRT (Adaptiv BiV + LV)

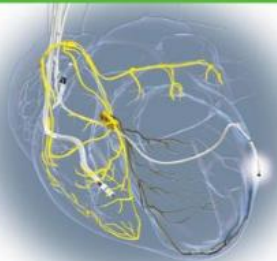
LV compared to BiV pacing: Do you really need RV pacing?

AdaptivCRT®: Operation



Adaptive LV Pacing

Normal AV Conduction

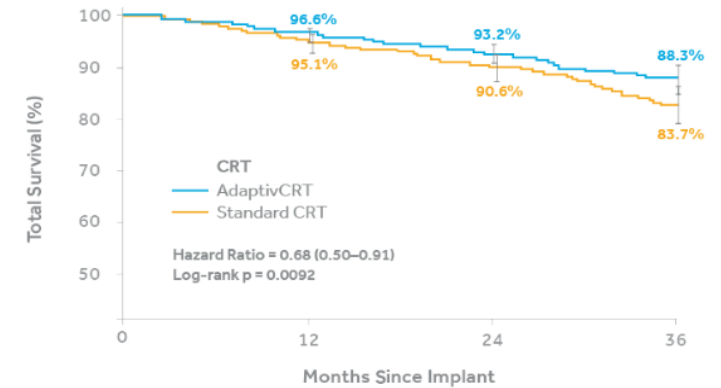


Adaptive LV pacing leverages intrinsic RV conduction by pre-pacing the LV to synchronize with intrinsic RV activation.

- AdaptivCRT® promotes physiologic pacing by reducing RV pacing by 44%¹
- In addition to the potential for an increase in CRT response, reducing RV pacing increases device longevity^{1,2}

Adaptive LV pacing

TOTAL SURVIVAL ADAPTIVCRT VERSUS STANDARD CRT



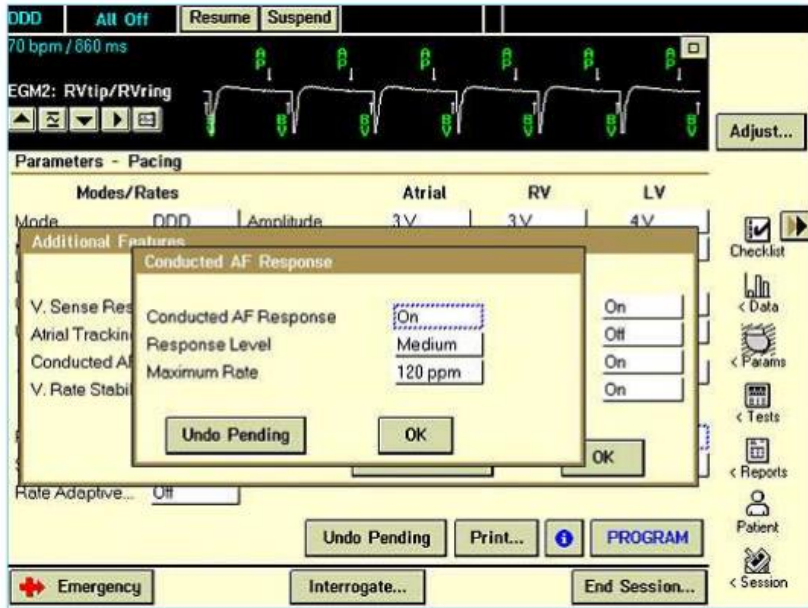
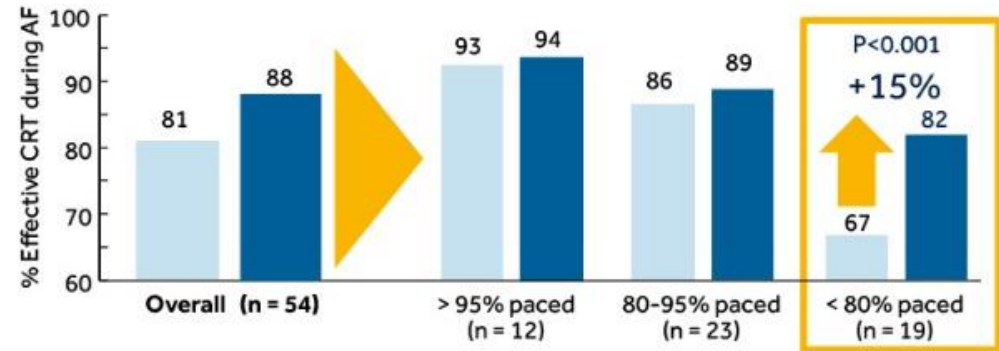
No. at Risk	1,162	856	548	242
Number	1,162	856	548	242
Remaining	652	529	395	257

*Patients who received AdaptivCRT were associated with a 29% relative reduction in all-cause mortality versus conventional CRT (after adjusting for other potential risk factors including age, gender, LVEF, NYHA class, QRS duration, AF, CAD, hypertension, AV block, and LBBB).

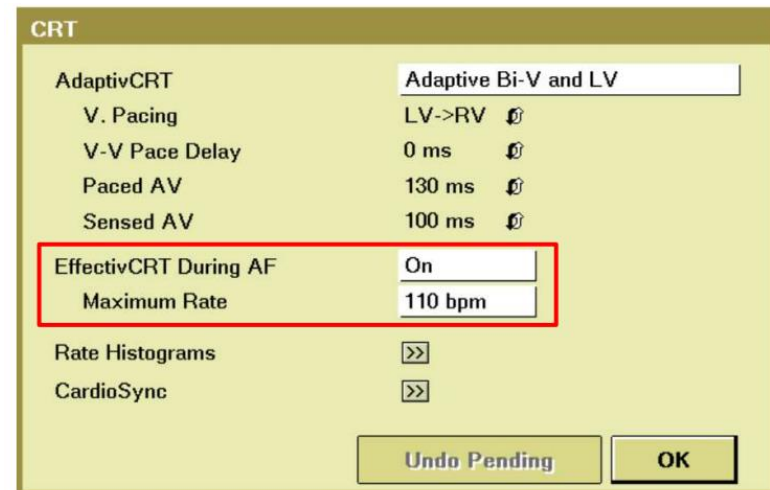
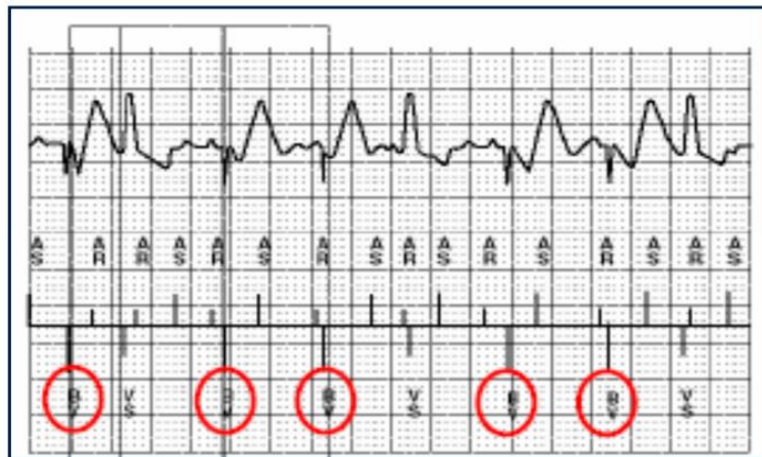
Effective CRT During AF Algorithm

The EffectivCRT™ During AF Algorithm automatically changes the pacing rate to increase effective CRT delivery during AF by up to 15%¹

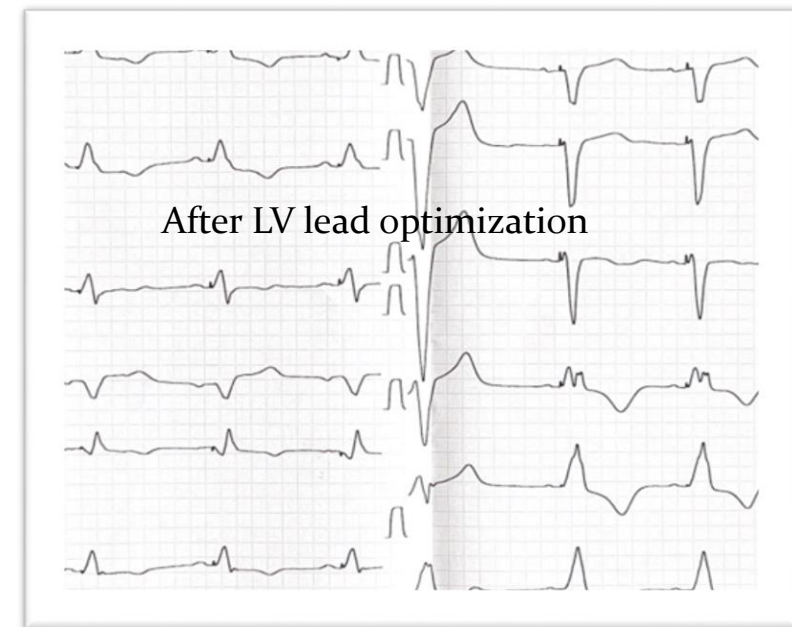
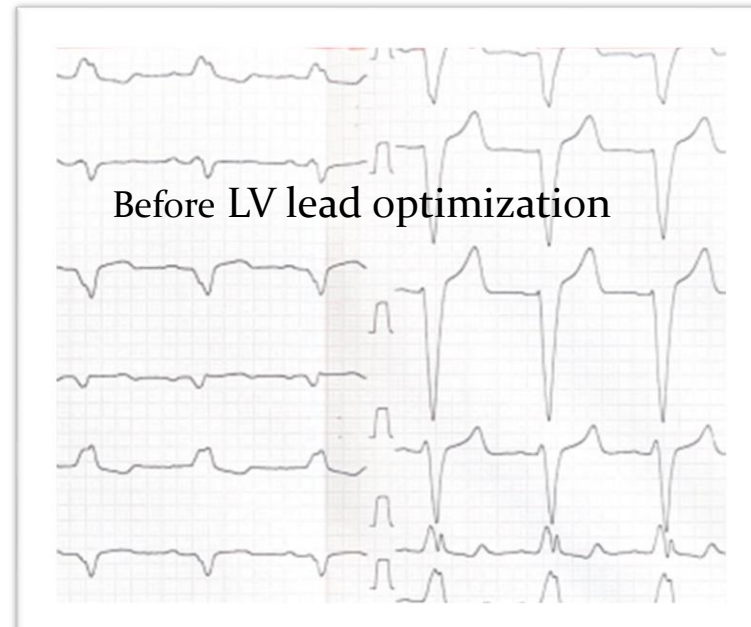
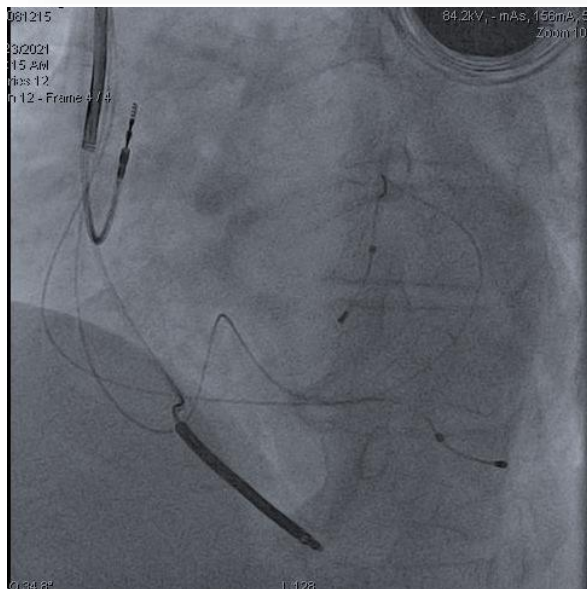
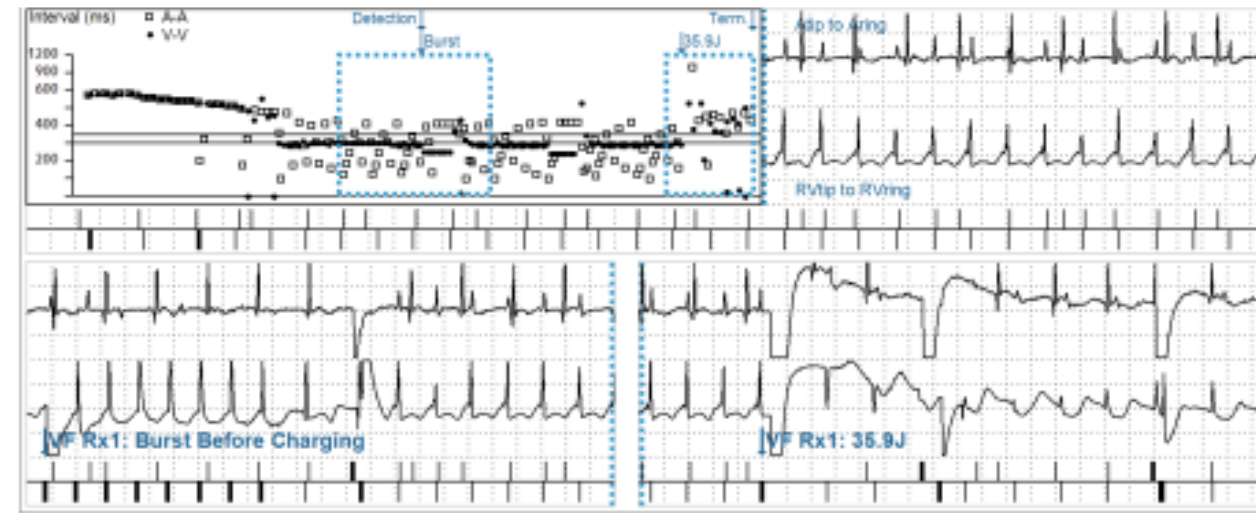
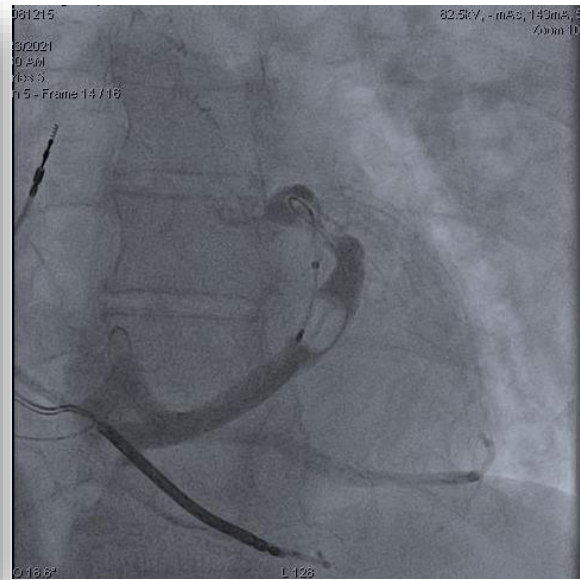
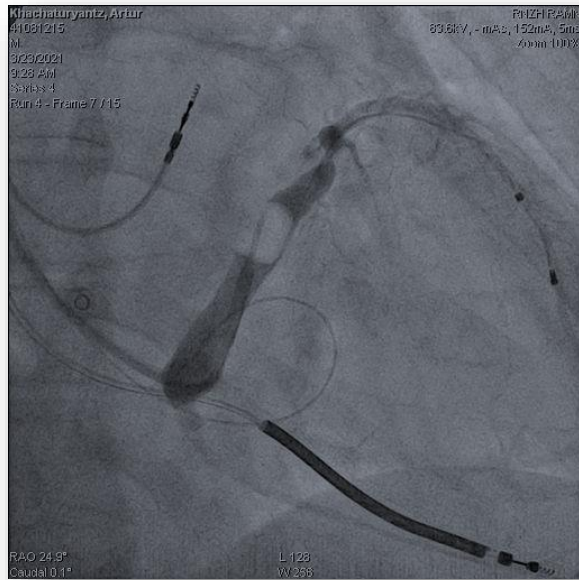
- EffectivCRT During AF increased effective pacing, from 81% to 88% ($p < 0.001$).
- Heart rate increased by 3 beats per minute, from 77 to 80 BPM ($p < 0.001$).
- Patients with baseline (< 80%) paced received the greatest benefit.



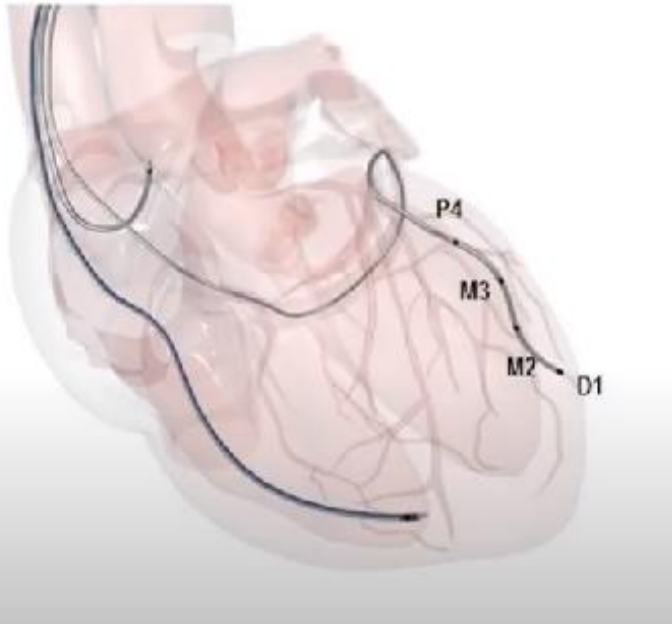
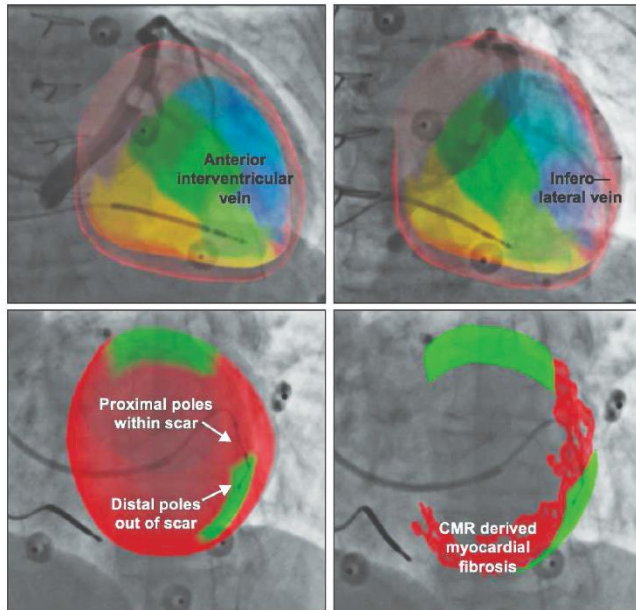
Conducted AF Response



Case №3. Patient X, 63 y.o. DCM. Paroxysmal AF/AT. VT. LBBB. HF – II-III (NYHA). CRT-D – 2015, Ablation- VT- 2021г, Ablation AF/AT – 10.03. 2021г, re CRT-D + LV lead optimization 23.03.2021г.



New approaches to LV stimulation to improve resynchronization therapy



Benefits of using a quadripolar LV lead

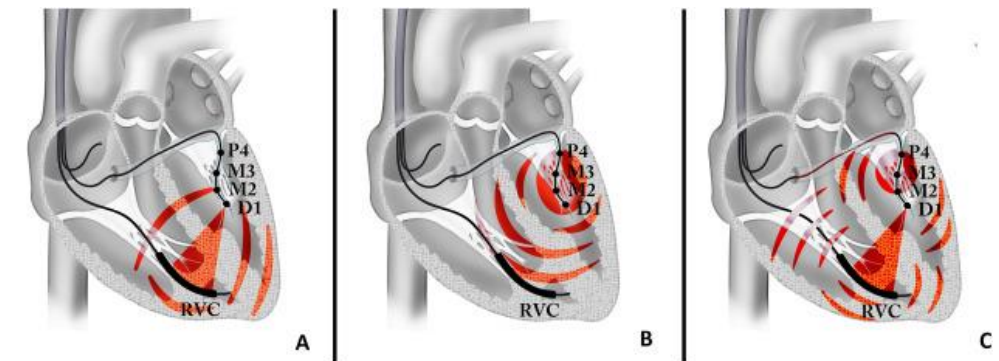
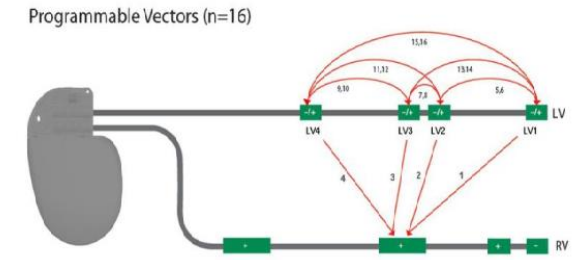
- **Better CRT**
- Implant at most stable location
- Pace at anatomically superior sites for CRT
- Lateral LV, Basal to Mid LV

- **Lead stability**
- Implant at most stable site
- Least chance of dislodgement
- Pace from available poles

- **Phrenic Nerve Capture**
- Change pacing poles to eliminate phrenic capture without moving lead

- **Lowest Threshold**
- Multiple Pacing Vectors
- Superior vectors for CRT
- Best pacing threshold

16 Programmable Pacing Vectors Provide Flexibility in Customizing CRT Delivery for Each Patient



The Family of quadripolar leads



Attain Performa 4598
5.3 Fr; S-shape



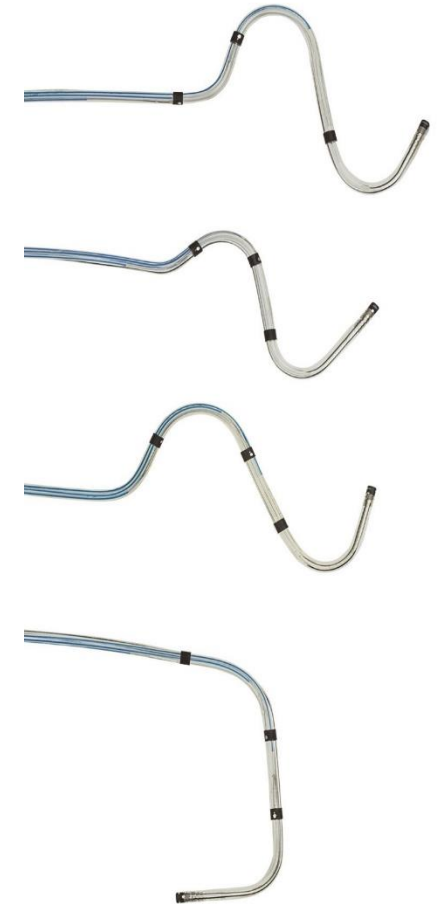
Attain Performa 4298
5.3 Fr; double-canted



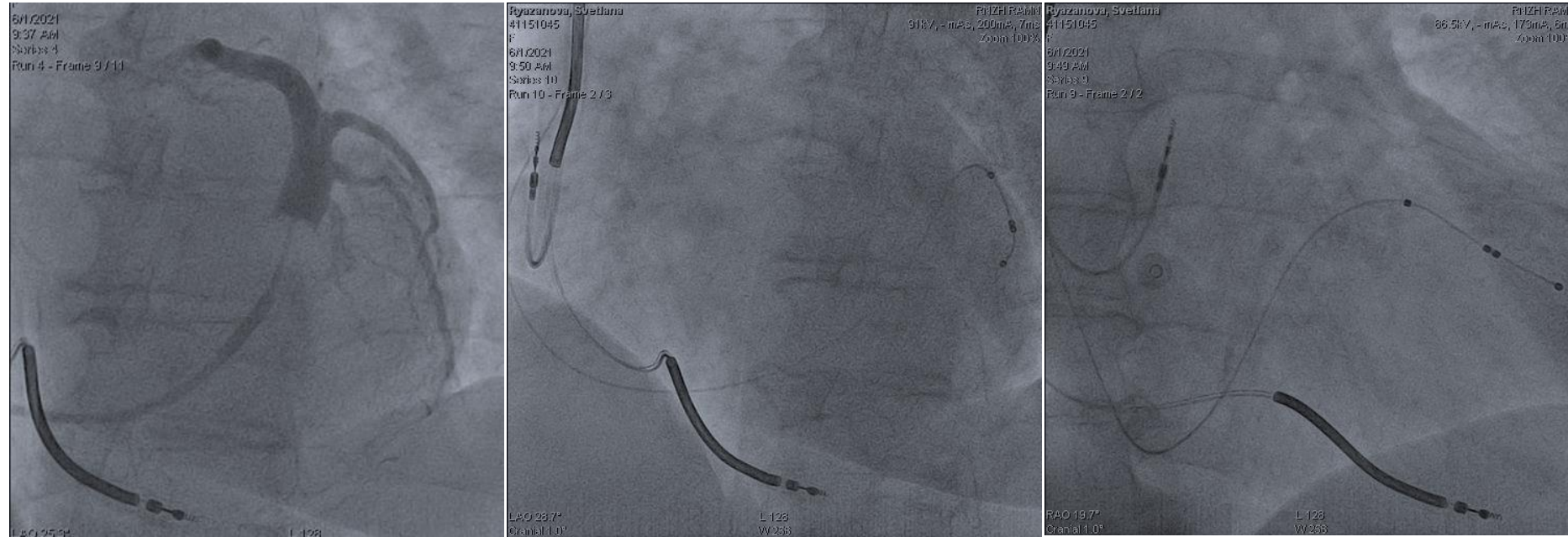
Attain Performa 4398
5.3 Fr; straight with tines



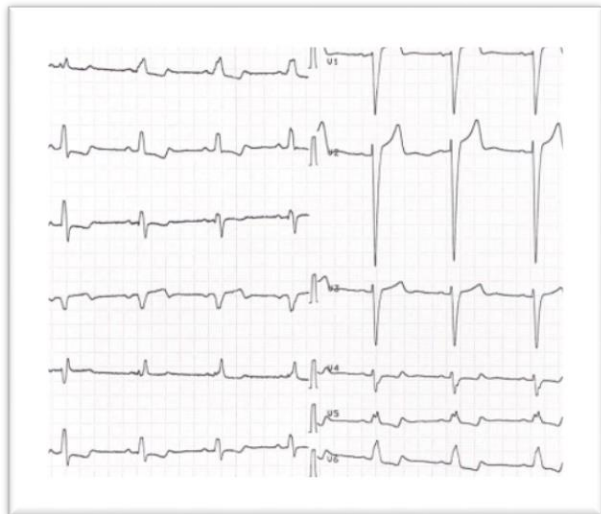
Attain Stability Quad 4798
4.4 Fr; single cant with active fixation side helix



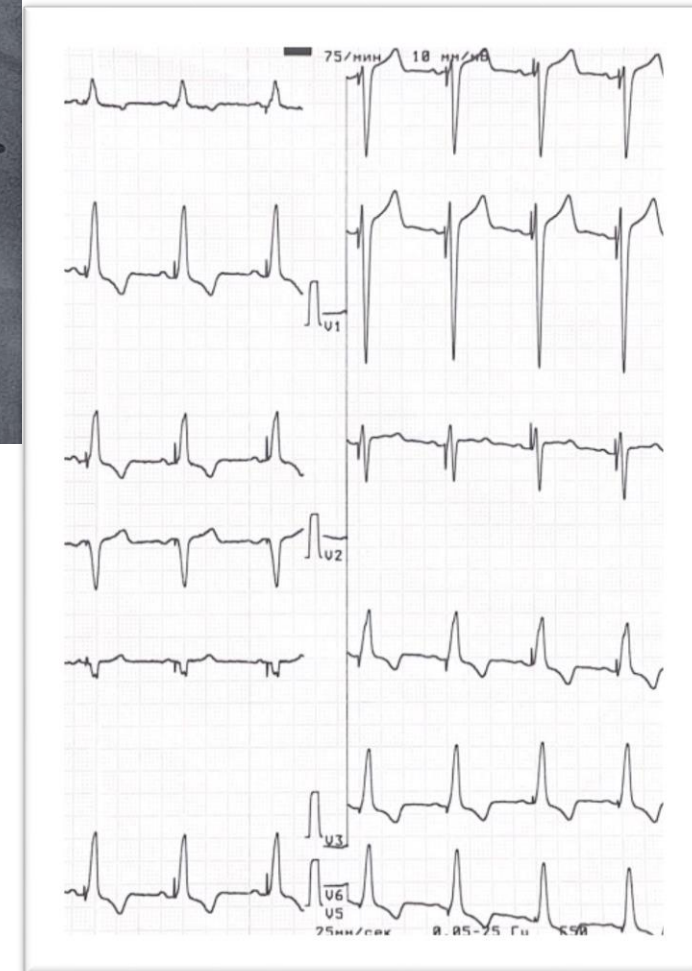
Case №2. Patient R. women 72 y.o. Ds: DCM. OA – angioplastic (08.12.2018г). LBBB (I type). HF - III (NYHA).



After CRT-D, EF- 53%,
QRS – 120ms.



ECHO – EF 27%. ECG – LBBB (QRS – 160 ms.)



Case № 4 Patient: X., man 57 y.o.

Ds: ICM 2006 г. LIMA - LAD, CABG-DA, DOR – procedure (2007 г.). LBBB. VT. HF - III (NYHA).

2006

- Myocardial infarction

2007

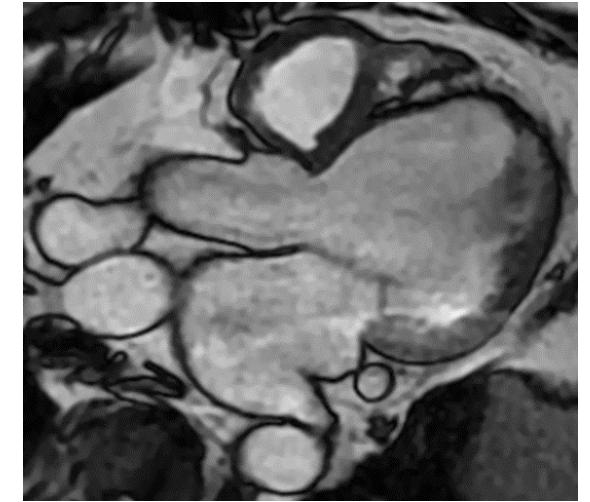
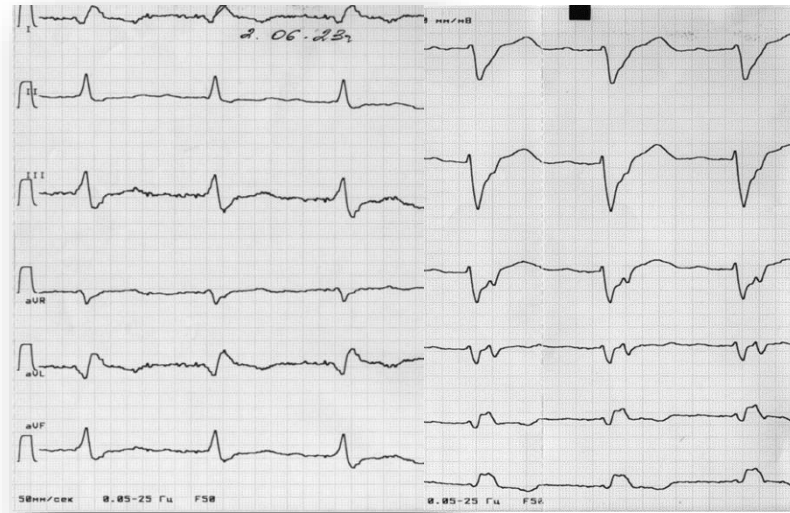
- Angiography: LAD – occlusion, aneurysm LV
- ECHO: - EF- 37%
- LIMA - LAD, CABG-DA, DOR - procedure

2022

- Covid - 19

2023

- ECG - normal sinus rhythm, LBBB
- ECHO: EF – 24%, LVEDV – 263 ml

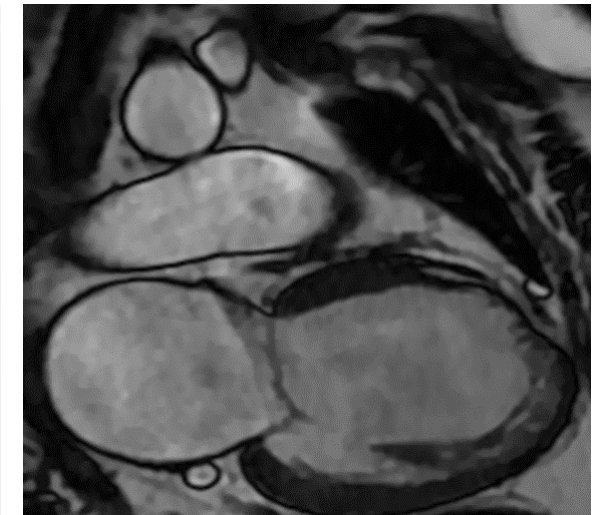


Левый желудочек

КДР- 8,1 см (N до 5,5см), КСР- 7,6 см, ТМЖП- 1,0 см, тЗСЛЖ- 1,3 см, КДО- 263 мл, КСО- 193 мл, УО- 70 мл, КДОинд- 108,0 мл/м², КСОинд- 79,3 мл/м², ФИ- 27 % (по Симпсону), VSфкмк-бок 5 см/с (N 7-11 см/с), VSфкмк-перег 3 см/с (N 6-8 см/с)

Локальная сократимость верхушка закруглена, перегородочно-верхушечные сегменты представлены рубцовой тканью, акинетичны, визуализируется тень от заплаты (пластика левого желудочка), нельзя исключить наличие тромба в области верхушки, размерами 1,4x2,6, неоднородной эхогенности, с включениями кальция, парадоксальное движение МЖП

	СЕГМЕНТЫ:		
	Базальный	Средний	Верхушечный
Передний	нормокинез	гипокинез	акинез (рубец)
Передне-перегородочный	акинез (рубец)	акинез (рубец)	заплата
Перегородочный	акинез (рубец)	акинез (рубец)	заплата
Нижний	гипо-акинез	гипо-акинез	акинез (рубец)
Задний	нормокинез	гипокинез	акинез (рубец)
Боковой	нормокинез	гипокинез	акинез (рубец)

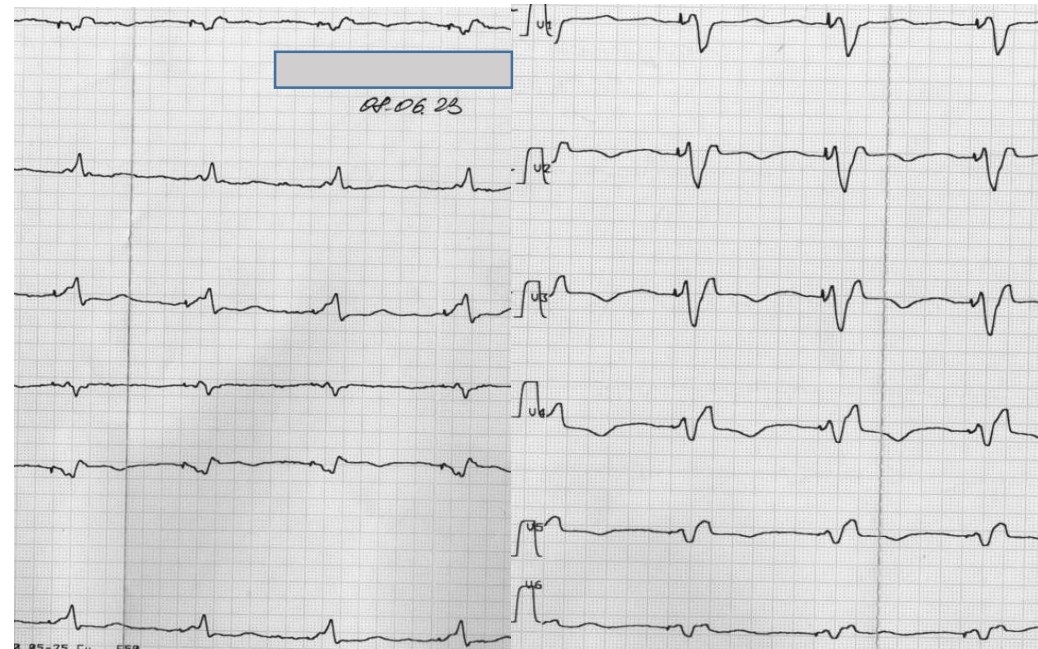
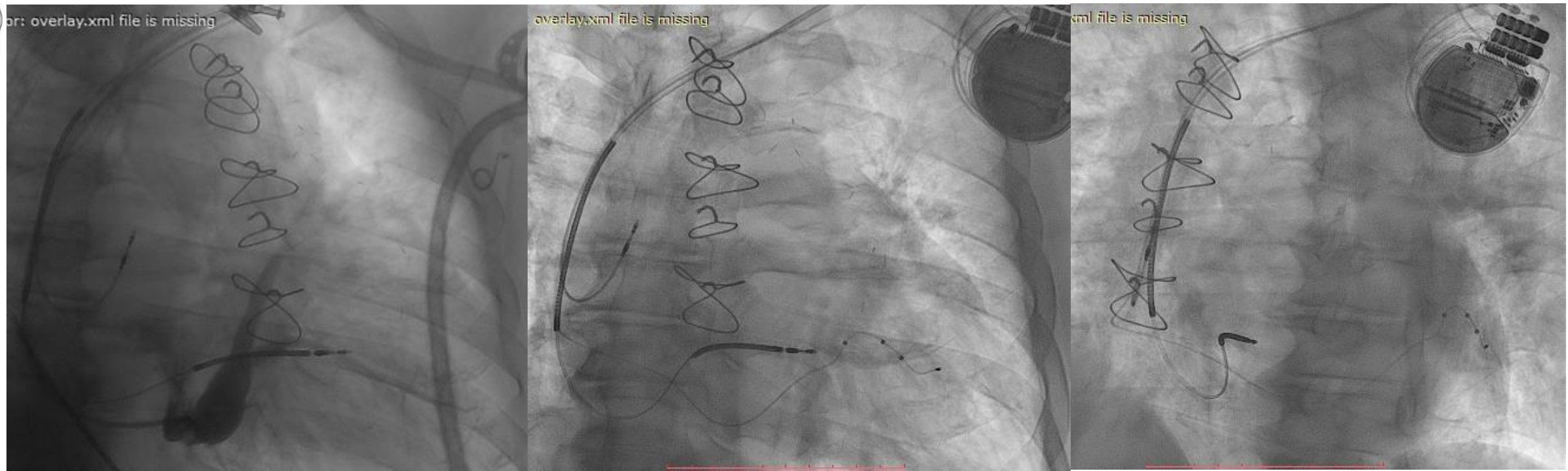




or: overlay.xml file is missing

overlay.xml file is missing

ml file is missing



Case №5. Patient T. man, 45 y.o. Ds: AV Block - III. IPG (2015г). DCM. HF -II (NYHA).
Muscular Dystrophy.

before 2015

- At the age 25 years, the onset of muscular dystrophy was diagnosed.
- DCM, muscular dystrophy twin brother.

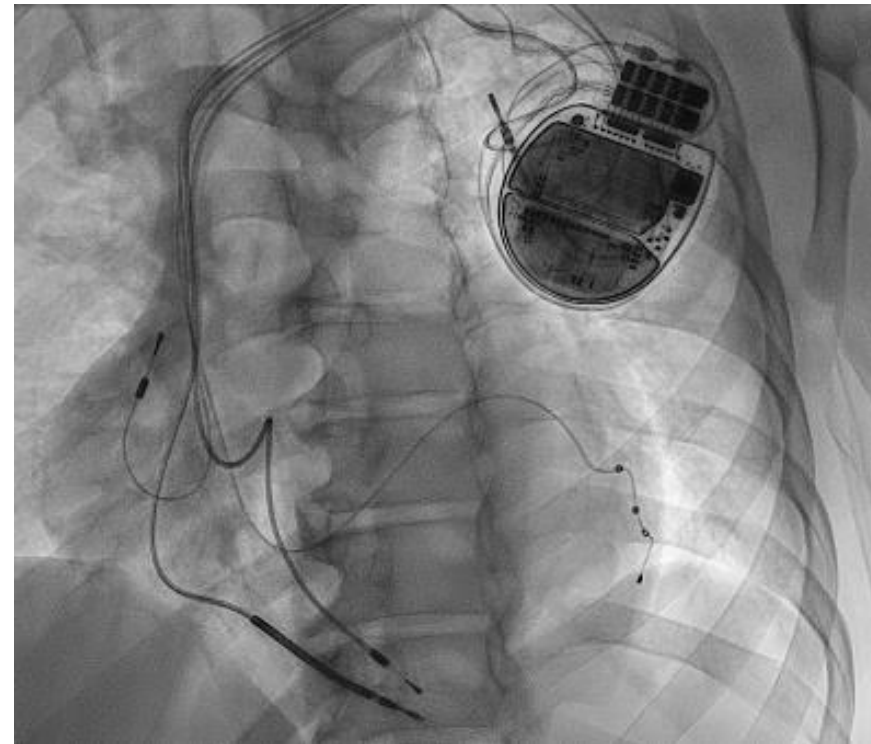
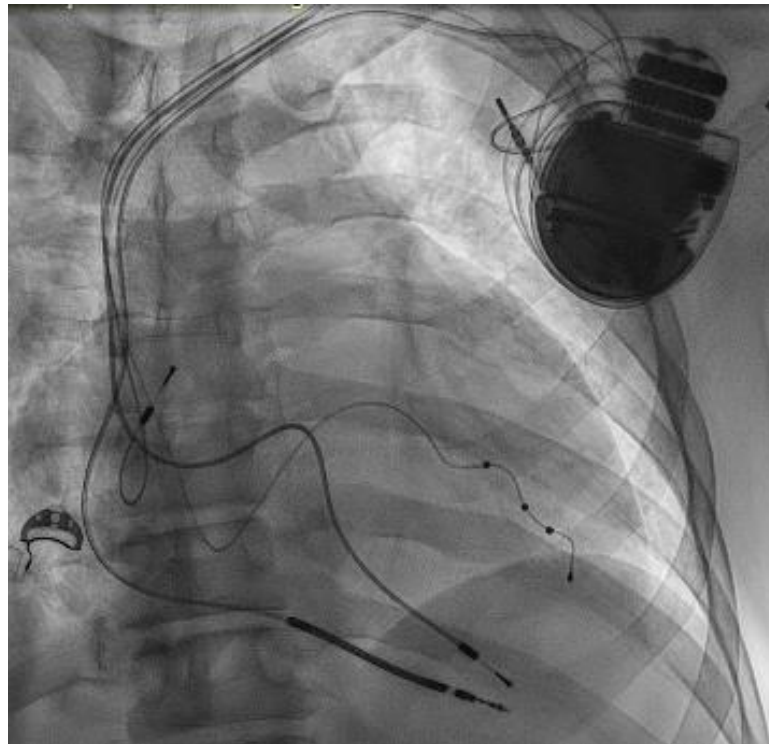
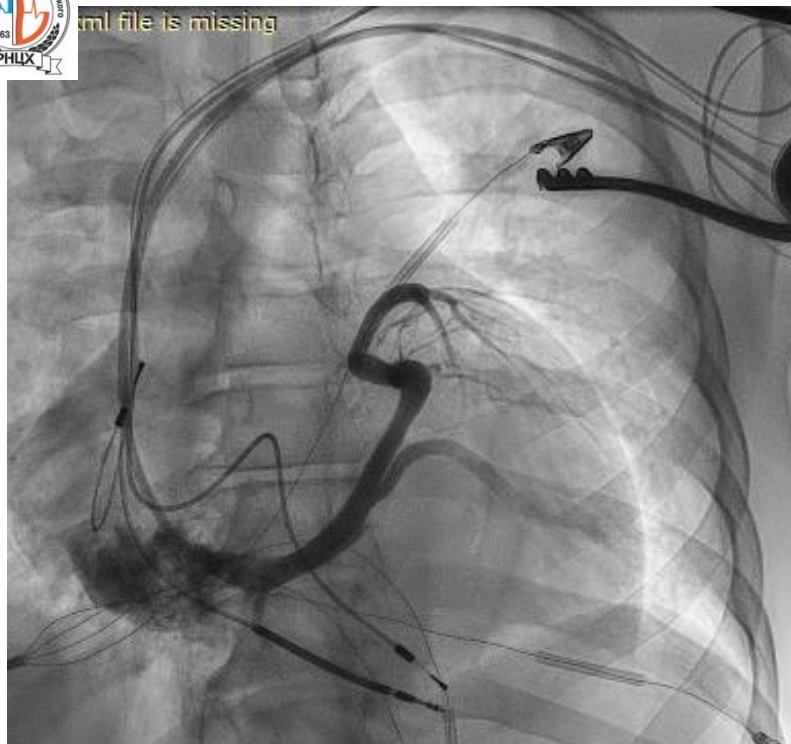
2015

- Syncope (MAS).
- ECG: AV Block III.
- ECHO: EF 66%.
- IPG 06.11.2015.

2023

- ECHO-04.04.2023: LVEDV- 343 ml, EF 21%.
- GDMT.





ECHO before CRTD:

Левый желудочек

КДР- 7,5 см (N до 5,5см), КСР- 6,7 см, ТМЖП- 1,0 см, тЗСЛЖ- 0,9 см, КЛО- 270 мл, КСО- 210 мл, УО- 60 мл, КДОинд- 179,9 мл/м², КСОинд- 139,9 мл/м², ФИ- 22 % (по Симпсону).

VSфкмк-бок 8 см/с (N 7-11 см/с), VSфкмк-перег 8 см/с (N 6-8 см/с)

повышенная трабекулярность стенок, в области верхушки лоцируется несколько поперечных и диагональных хорд

Локальная сократимость асинхронное сокращение перегородочно-верхушечных сегментов на фоне работы ЭКС, гипокинез базальных сегментов боковой, нижней, передней, задней стенок, остальные сегменты - диффузный гипо-акинез

Правый желудочек 2,1 см (N до 3,0 см) На уровне ВТПЖ 2,7 см (N 2,1-3,5 см), приточный отдел 3,4 см (N 2,5-4,2 см), средний отдел 1,4 см (N 1,9-3,5 см), длинник 8,0 см (N 5,9-8,6см). VSфктк 11 см/с (N 9-14 см/с)

ECHO 1 day after CRTD:

Левый желудочек

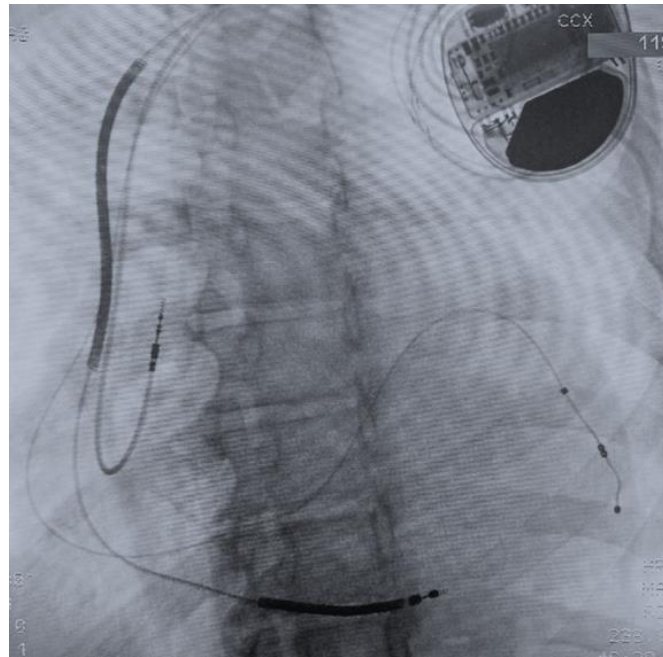
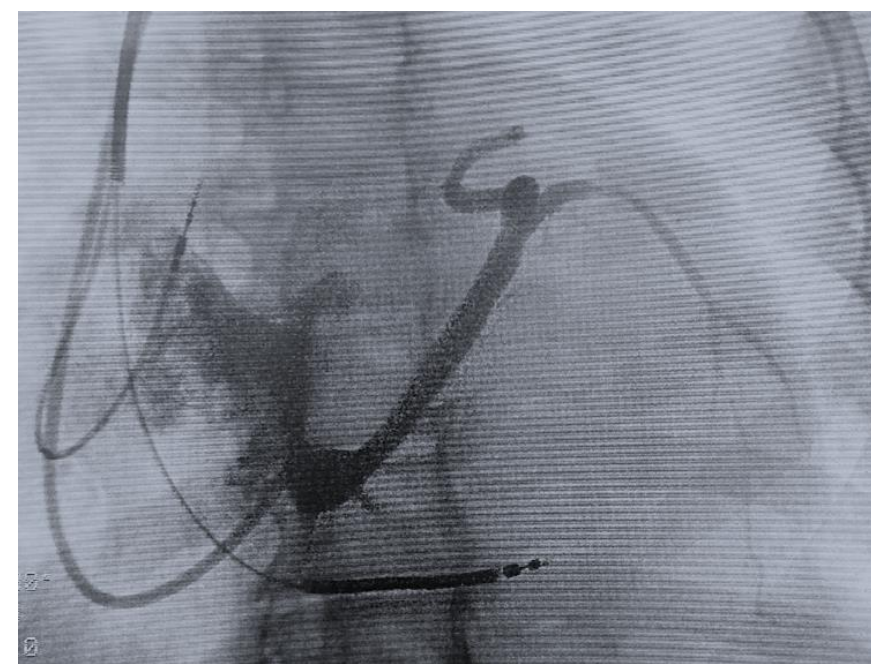
КЛО- 245 мл, КСО- 180 мл, УО- 65 мл, КДОинд- мл/м², КСОинд- мл/м², ФИ- 27 % (по Симпсону).

Локальная сократимость асинхронное сокращение перегородочно-верхушечных сегментов на фоне работы ЭКС, остальные сегменты - диффузный гипокинез

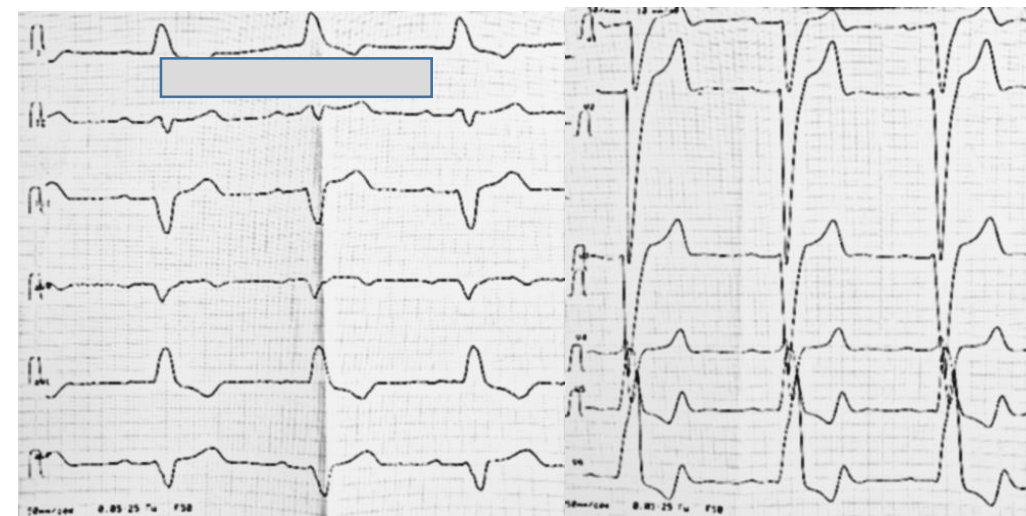
Оценка асинхронии:

Межжелудочковая (лево-правая) задержка: PEP (период предизгнания) Ao - ЛА = 170 - 140 = 30 мс (N < 40 мс).

Case №6. Patient T. Sergey, man 45 y.o. Ds: DCM. HF -III (NYHA).
Muscular Dystrophy. CRT-D Viva Quad XT 02.05.2023г.



**Attain Performa
4298**
5.3 Fr; double-
canted



Левый желудочек

КДР- 7,8 см (N до 5,5см), **КСР- 6,5 см**, **тМЖП- 0,7 см**, **тЗСЛЖ- 0,8 см**, **КЛО- 353 мл**, **КСО- 259 мл**, **УО- 94 мл**, **КДОинд- 232,0 мл/м²**, **КСОинд- 170,2 мл/м²**, **ФИ- 27 %** (по Симпсону).

VSфкмк-бок 5 см/с (N 7-11 см/с), **VSфкмк-перег 4 см/с** (N 6-8 см/с)

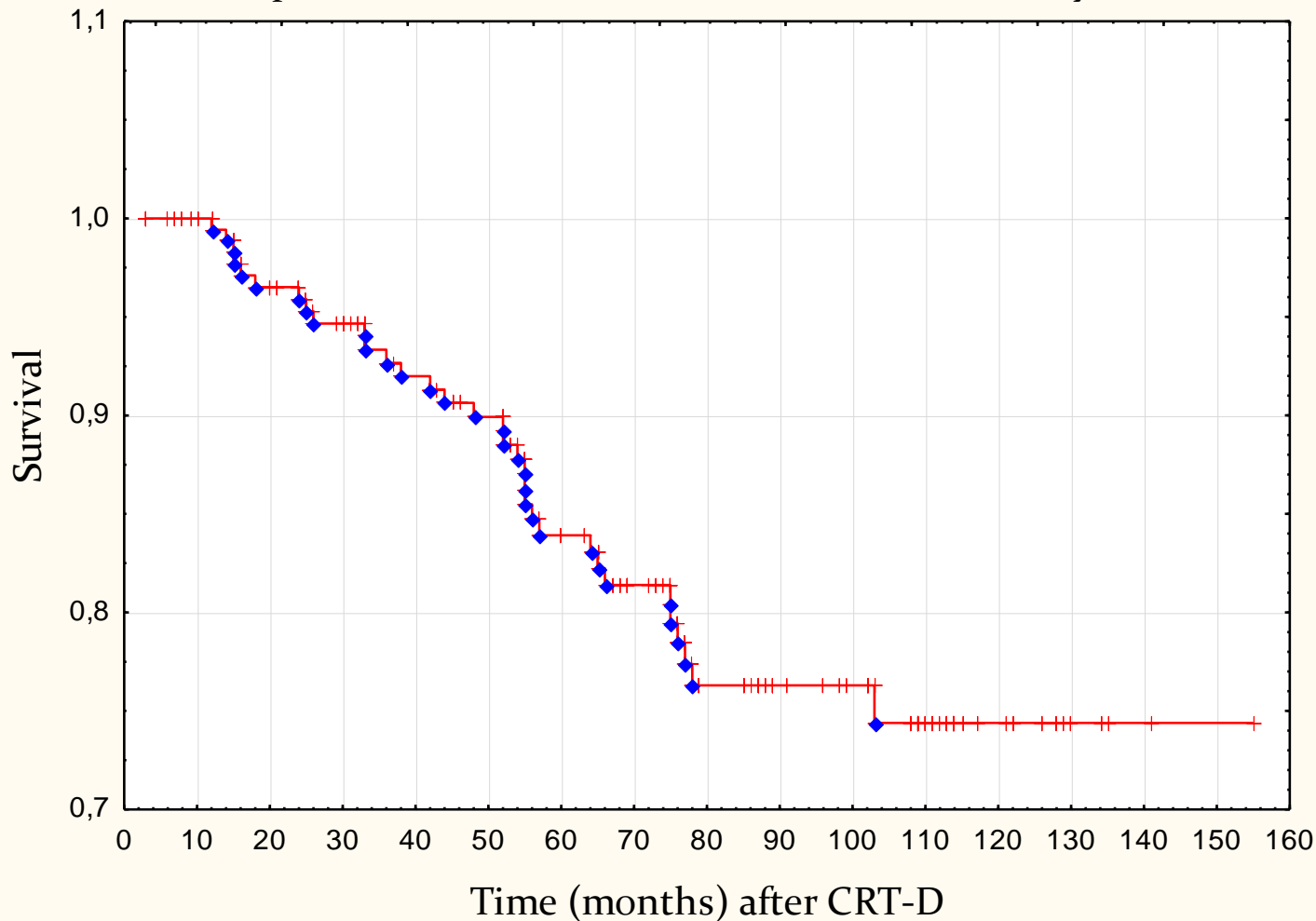
повышенная трабекулярность стенок ЛЖ

Локальная сократимость выраженное асинхронное сокращение перегородочно-верхушечных сегментов на фоне БЛНПГ, остальные сегменты - диффузный гипокинез

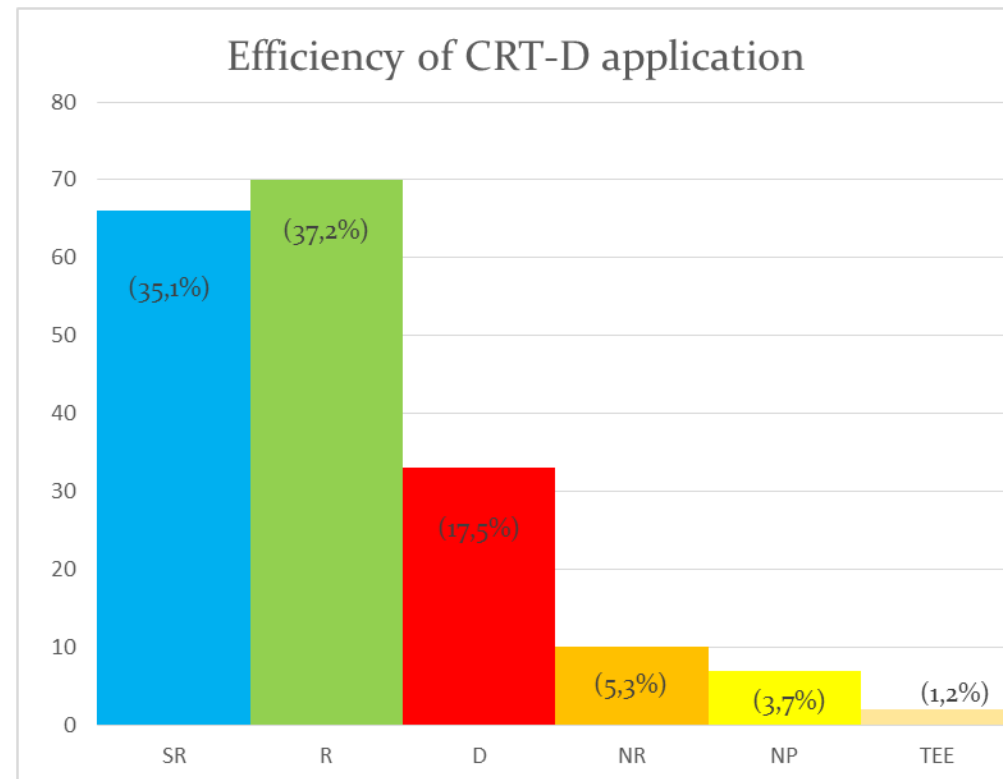
Оценка асинхронии:

Межжелудочковая (лево-правая) задержка: PEP (период предизгнания) **Ао - ЛА = 177 - 81 = 96 мс** (N <40 мс).

Kaplan-Meier Estimates of Cumulative Probability



Efficiency of CRT-D application



5 – year survival rate was – 162 (87%)
 10 – year survival rate was – 153 (82,3%)



RESULTS

The experience of surgical treatment of 188 patients with (HF) II-III (NYHA) and typical LBBB (during the observation period $67,4 \pm 2,7$ m (QRS 167.9 ± 1.5 ms), EF – before CRT-D $27.2\% \pm 0.5$; after treatment $44,5\% \pm 0.9$

Implantation of CRT-D/CRT-P with: quadripolar - 28, multipoint pace – 2, bipolar - 153, epicardial leads – 5.

The 152 patients are currently being monitored; 33(17,7%) -died; heart transplantation -1; explantation CRTD - 2 (pocket infection).

- LV lead repositioning – 32 (5 - quadripolar LV lead);

- AV node ablation – 22;

-AF/AT/VT - ablation– 14;

5 – year survival rate was – 162 (87%).

10 – year survival rate was – 153 (82,3%).

Initially the number of non-responders was 29.7%.

After the treatment, the number of non-responders and non – progression decreased to 9%.



CONCLUSIONS

- CRT is an affordable and clinically effective treatment for patients with HF and typical left bundle branch block.
- The position of the LV lead is one of the main factors determining the response to CRT.
- Systematic optimization of CRT parameters, the use of a remote monitoring system, optimization of the position of the LV lead using multipoint pacing, AV node/ AF/AT/VT - ablation against the background of optimal drug therapy, can improve the quality and life expectancy of patients, as well as significantly reduce the number of non-responders.

Thank you for your attention!

