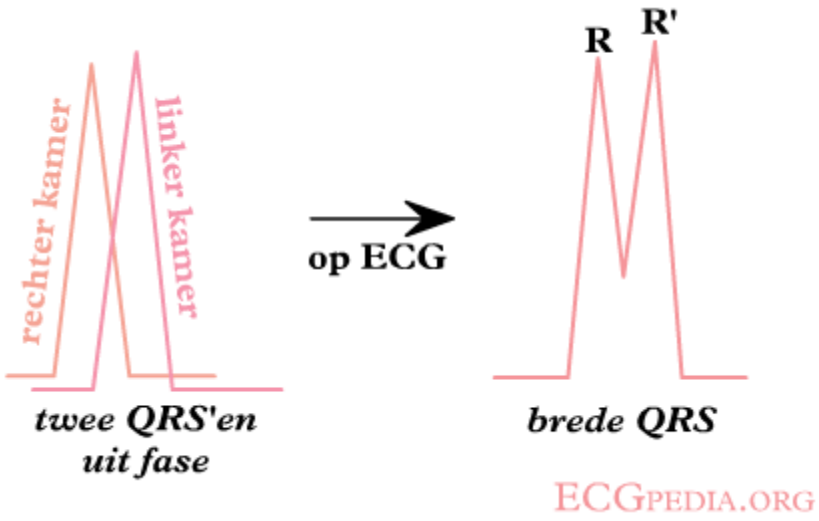
Hartfalen en het ECG

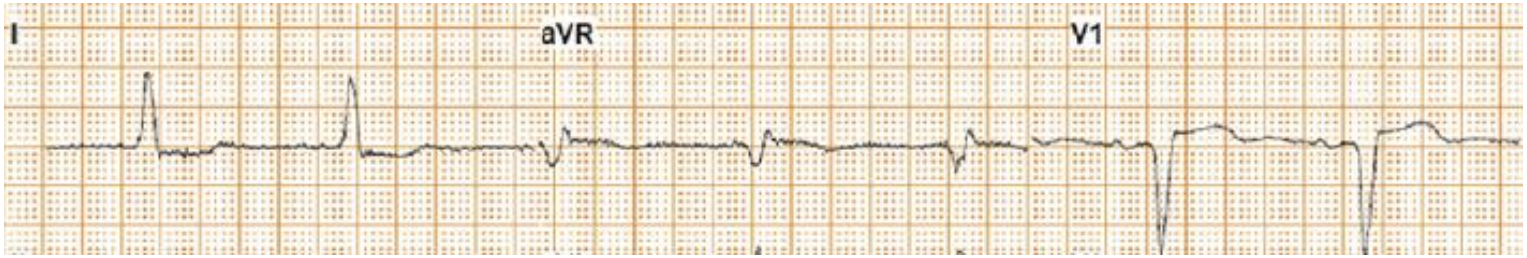


Michiel Zumbrink

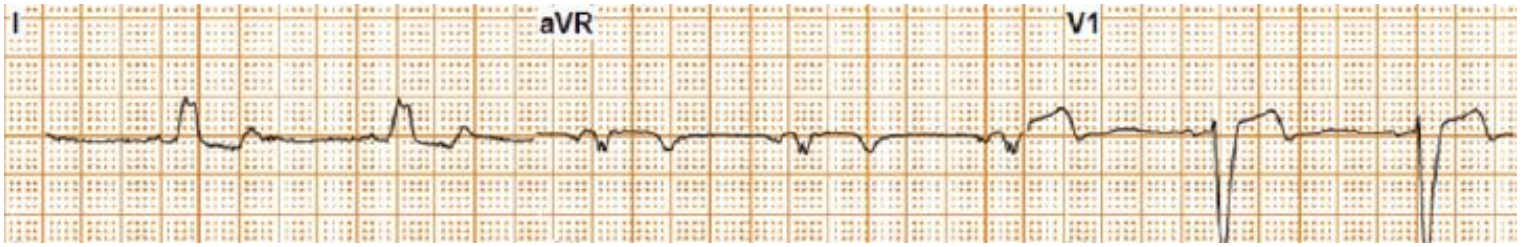
Pacemaker & ICD Techniek Amsterdam UMC

Welke is het echte LBTB?

a.



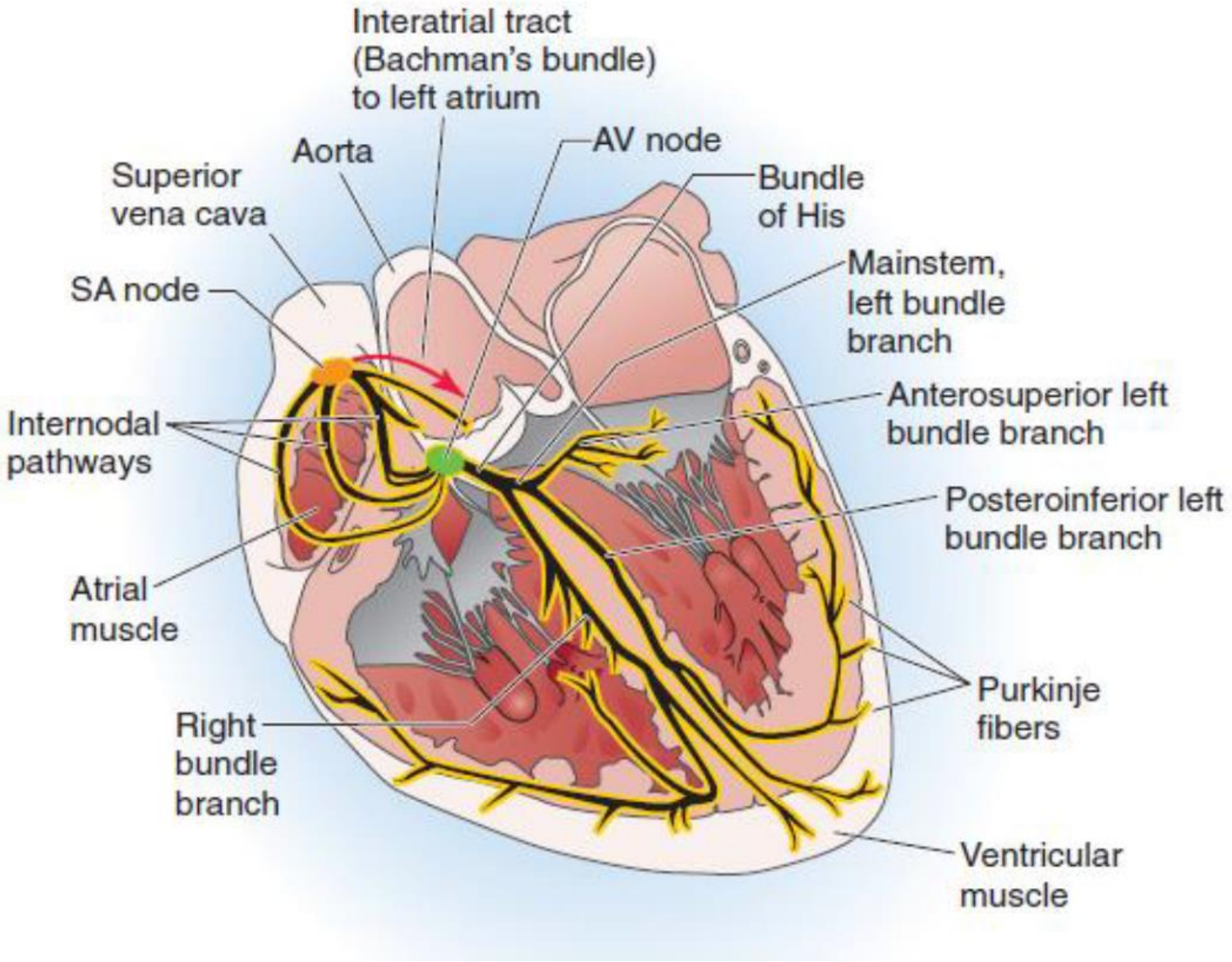
b.

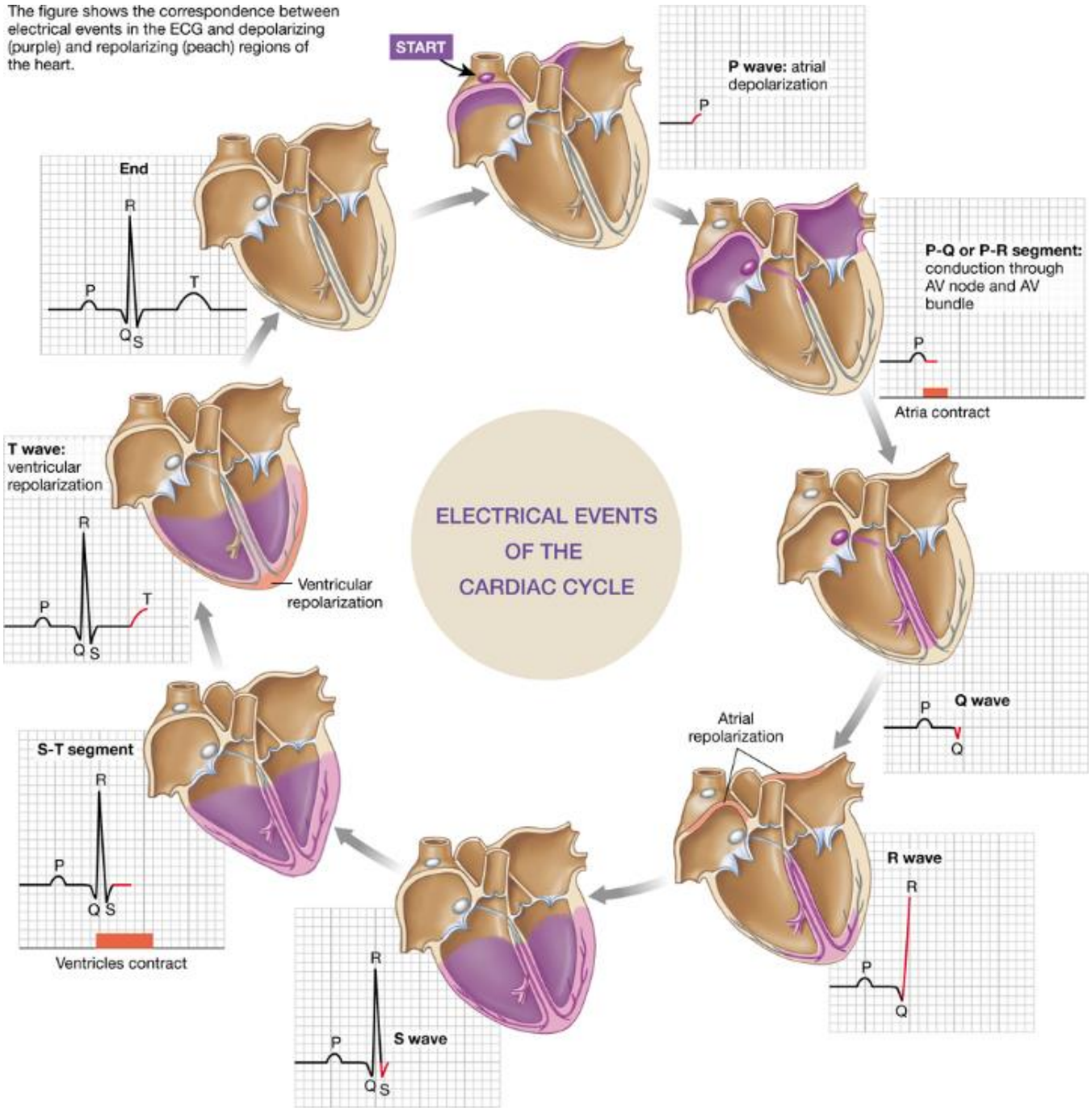


c.

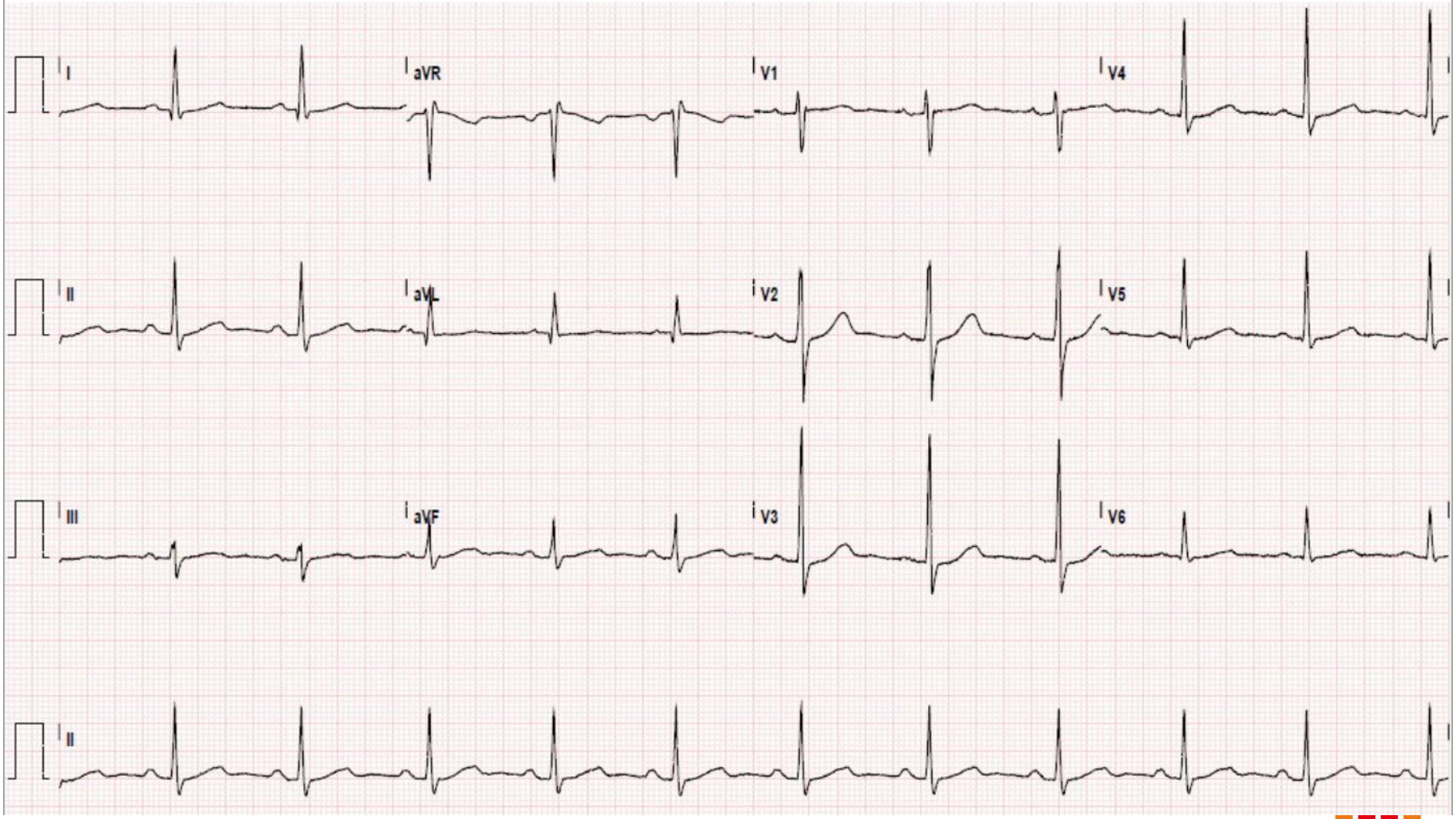
d.

Geleidingssysteem

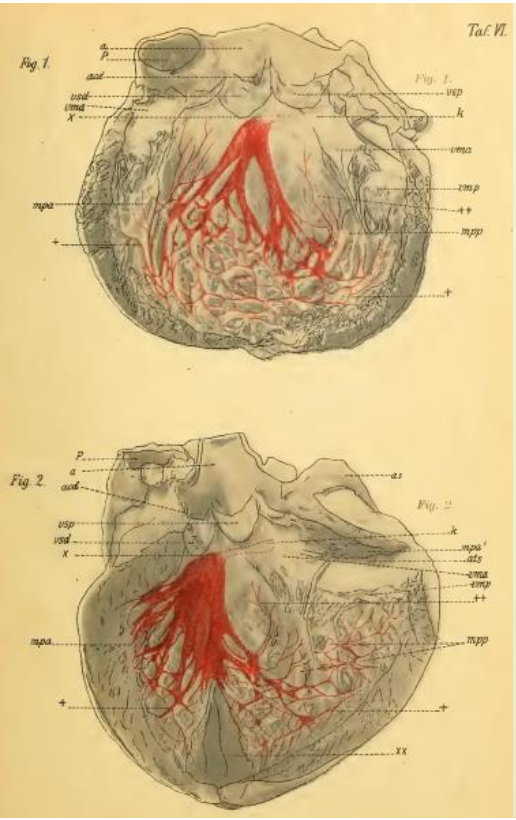


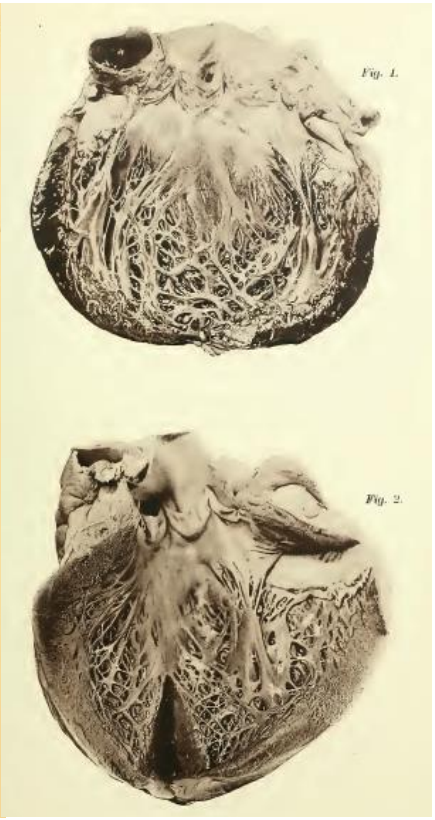

The figure shows the correspondence between electrical events in the ECG and depolarizing (purple) and repolarizing (peach) regions of the heart.
START
P wave: atrial depolarization
P
P-Q or P-R segment: conduction through AV node and AV bundle
Atria contract
Q wave
Atrial repolarization
R wave
S wave
Ventricles contract
S-T segment
T wave: ventricular repolarization
Ventricular repolarization
End
R
P
T
Q
S
ELECTRICAL EVENTS OF THE CARDIAC CYCLE

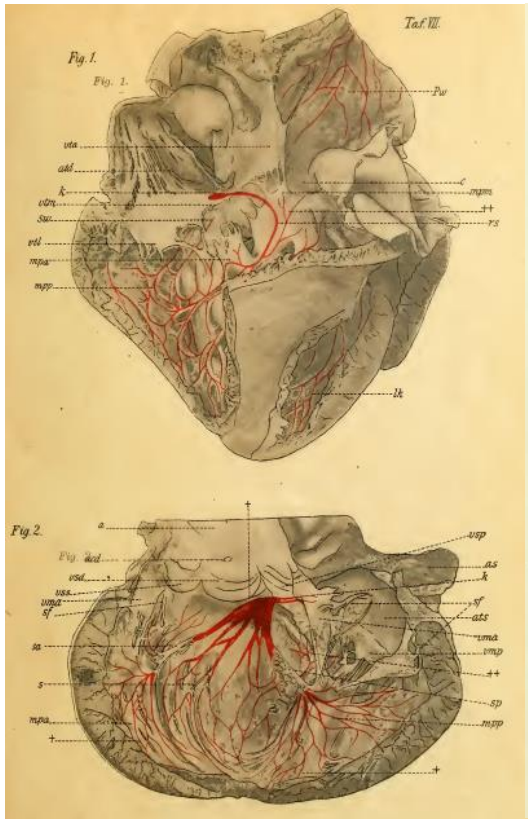
NORMAAL ECG



Anatomie







Tawara Aschoff - 1906

Physiology

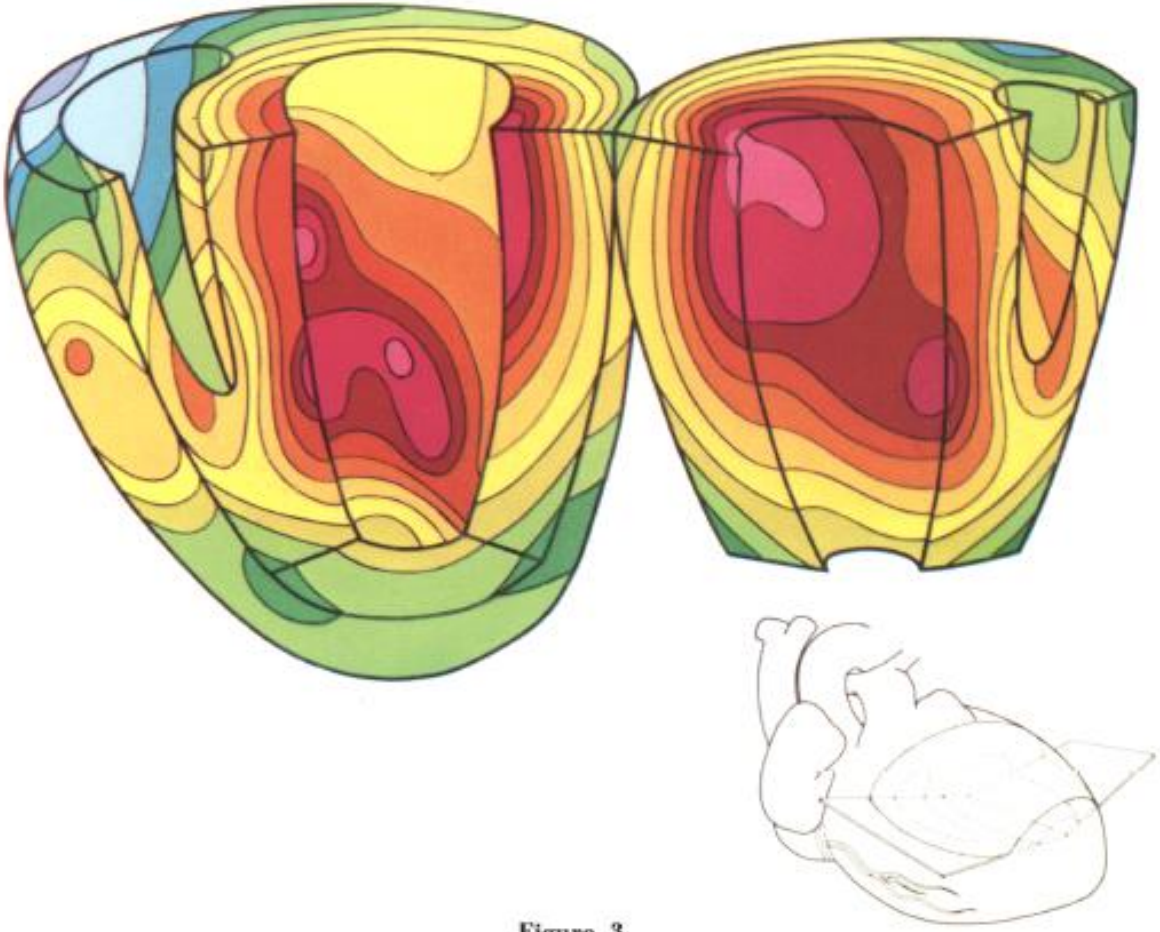
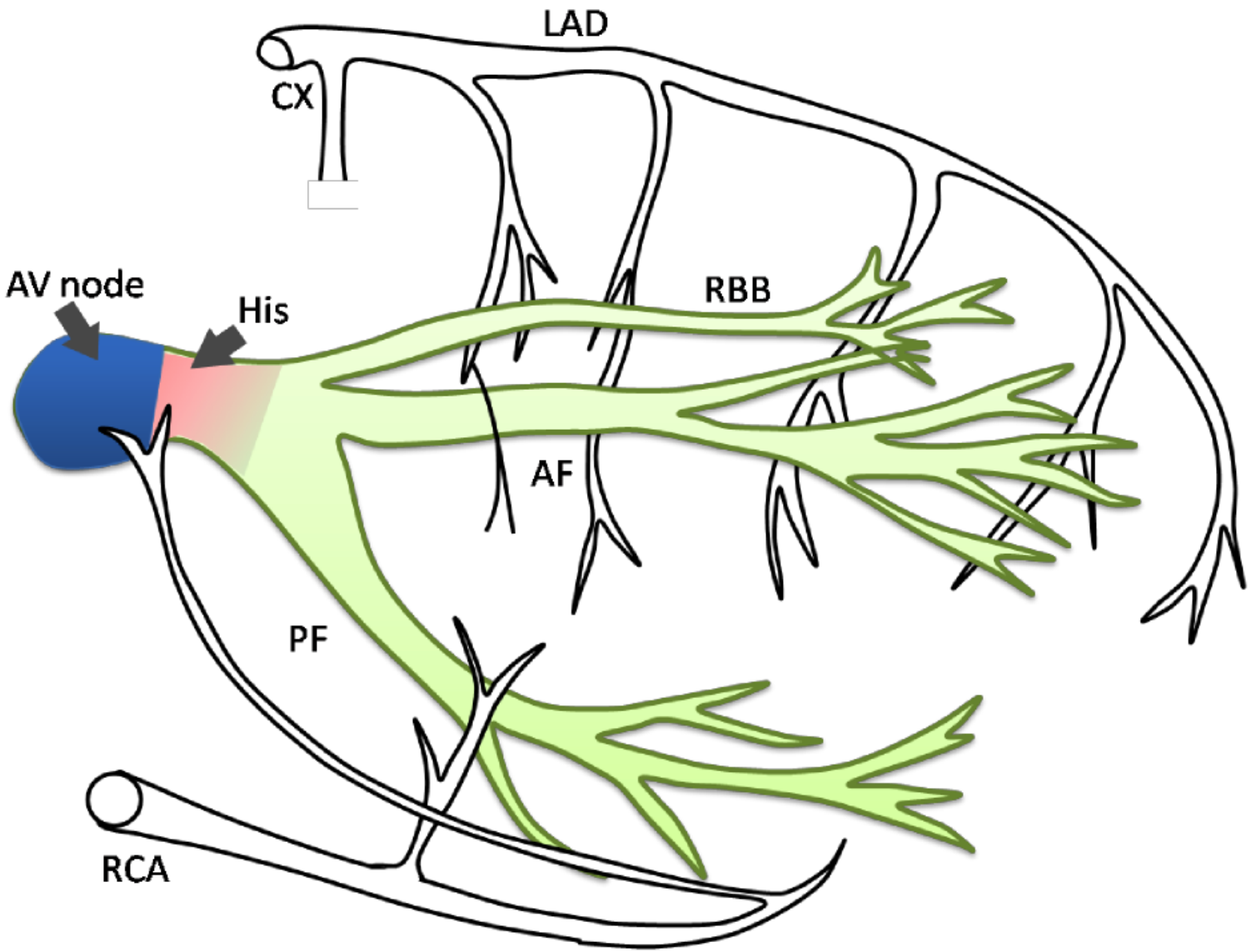


Figure 3

Three-dimensional isochronic representation of the activation of the same heart as in figure 1. Inset shows section levels. Color scheme identical to the one in figure 1.

Durrer ea. Circ 1970

Anatomy

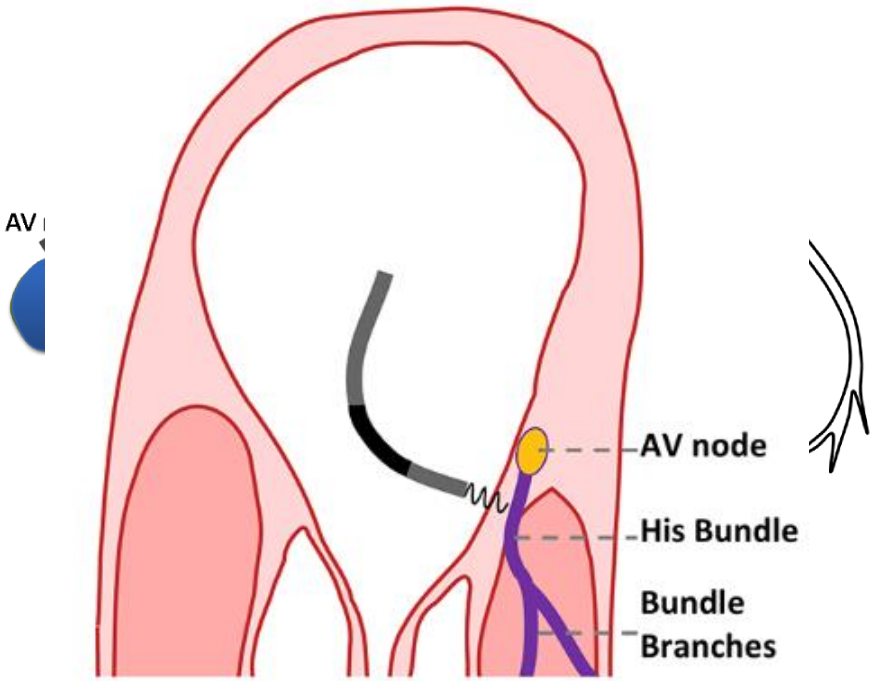


1. Oorsprong LBTB op hele traject van linkerbundel, fasciculi en daaruit voortvloeiende purkinjenetwerk

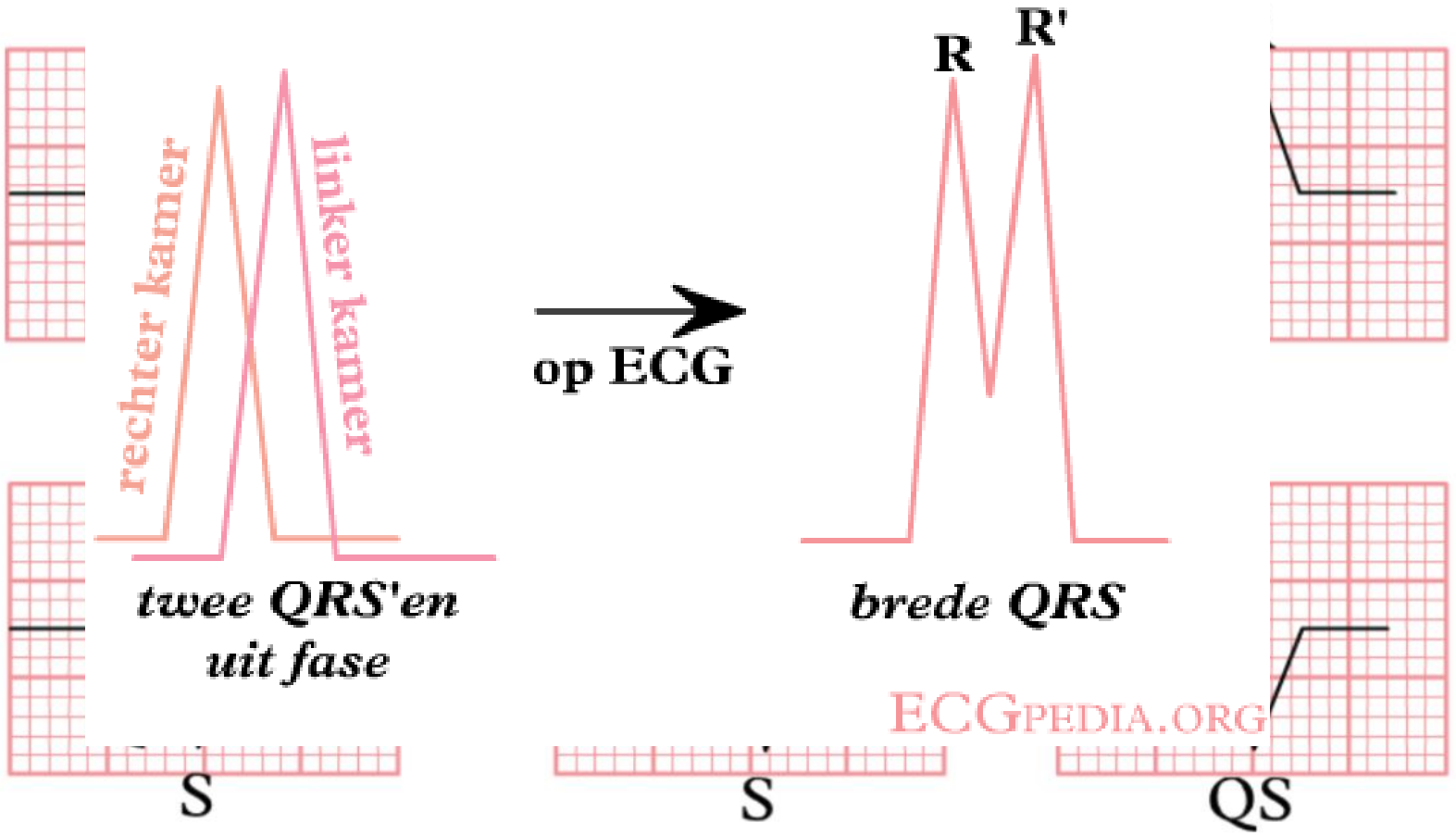
2. De-novo LBTB (4% na chirurgische AVR / 5 tot 65% na TAVI): datum én locatie van blok bekend (afhankelijk van type klep). Vaak proximaal blok ter hoogte van overgang His naar LBT

3. Ontstaan LBTB meestal sluipend door degeneratie en fibrotisering geleidingssysteem a.g.v. chronische evolutieve myocardiaal lijden (ischemie, kleplijden, hartfalen etc.). LBTB dan ook vaak proximaal > Hisbundelpacing!

4. Hisbundelpacing: stimulatie ter hoogte van bundel van His (proximaal) > verkorting QRS-duur én normalisatie QRS-morfologie bij pacing **distaal** van LBTB

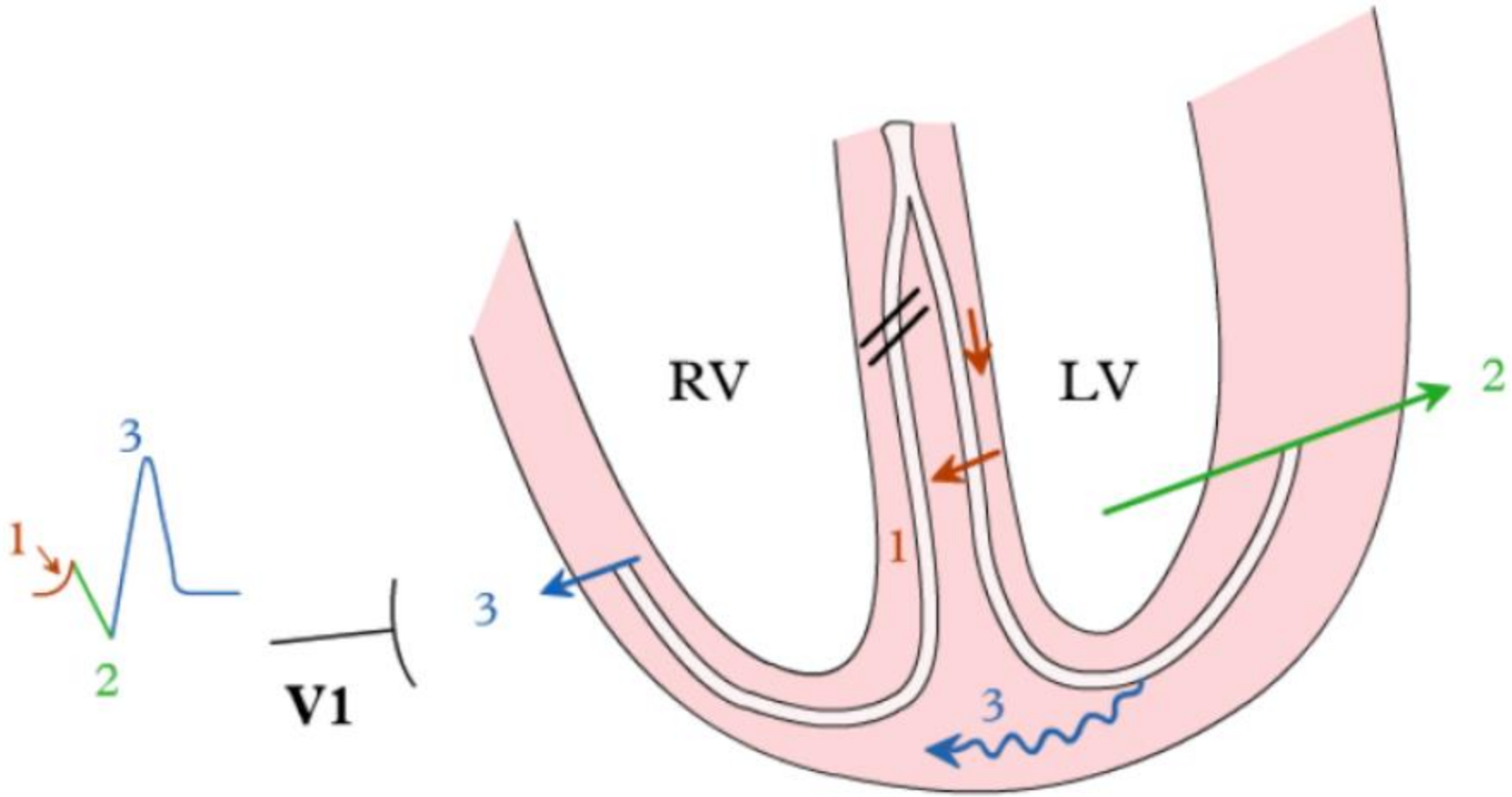


QRS MORFOLOGIE NOMENCLATUUR



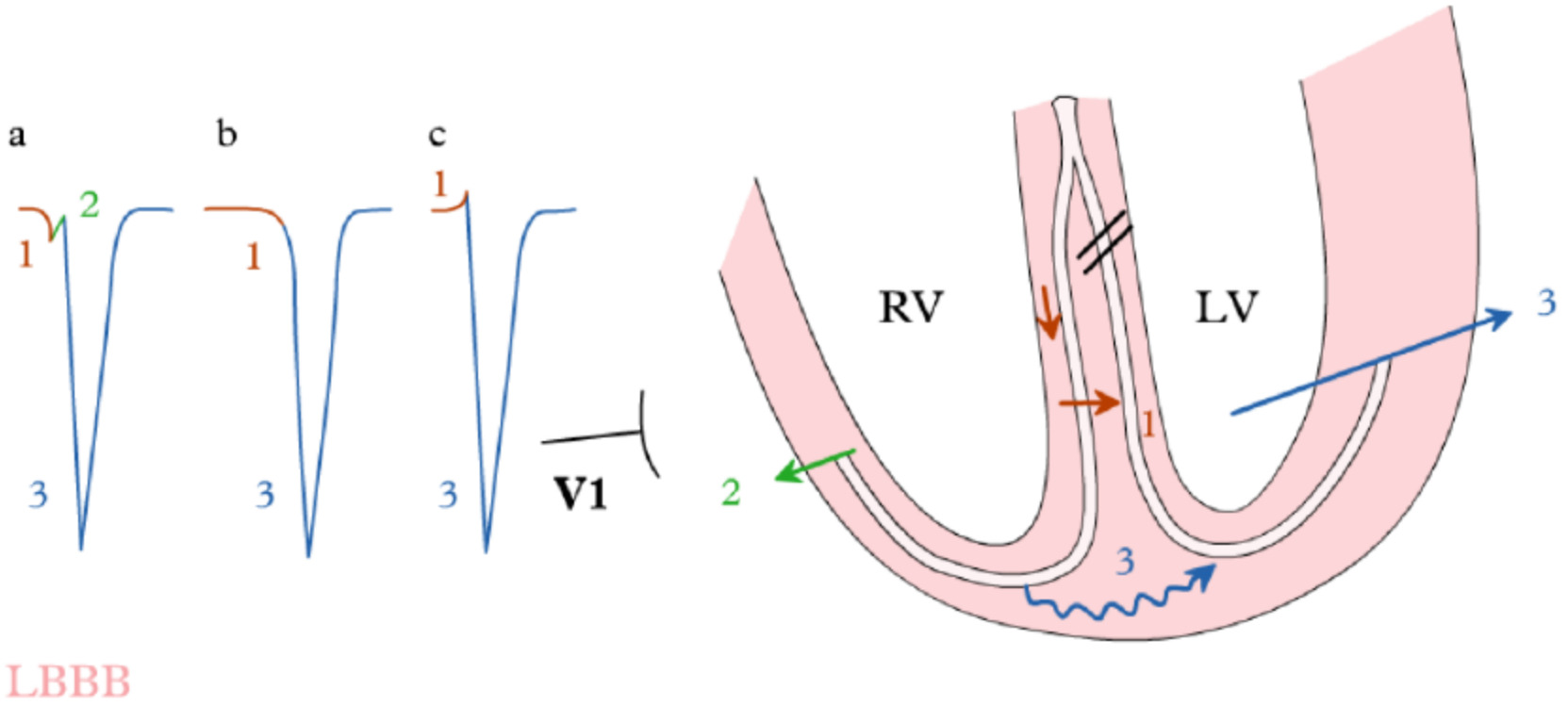
QRS shapes - ECGPEDIA.ORG

RECHTERBUNDELTAKBLOK



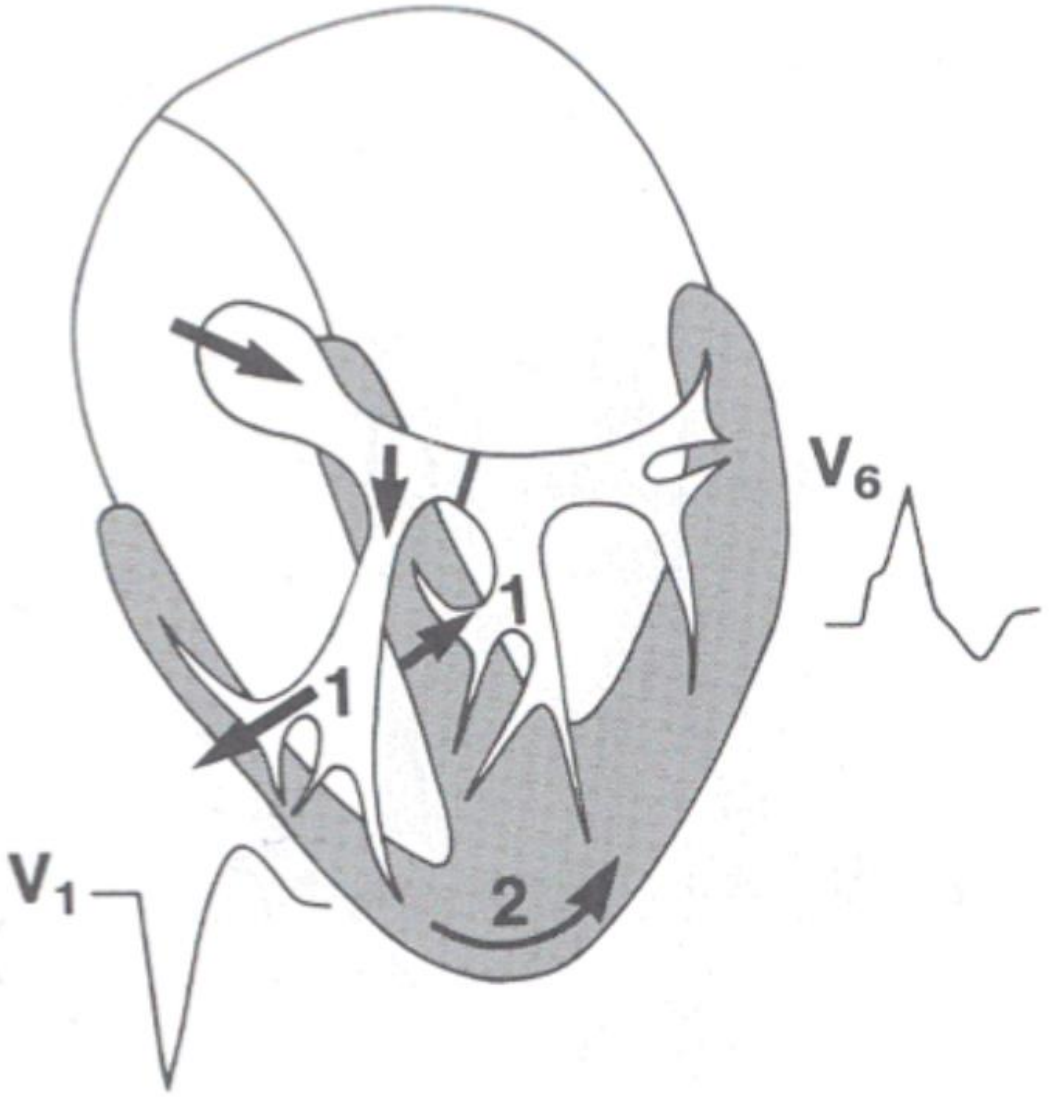
RBBB

LINKERBUNDELTAKBLOK

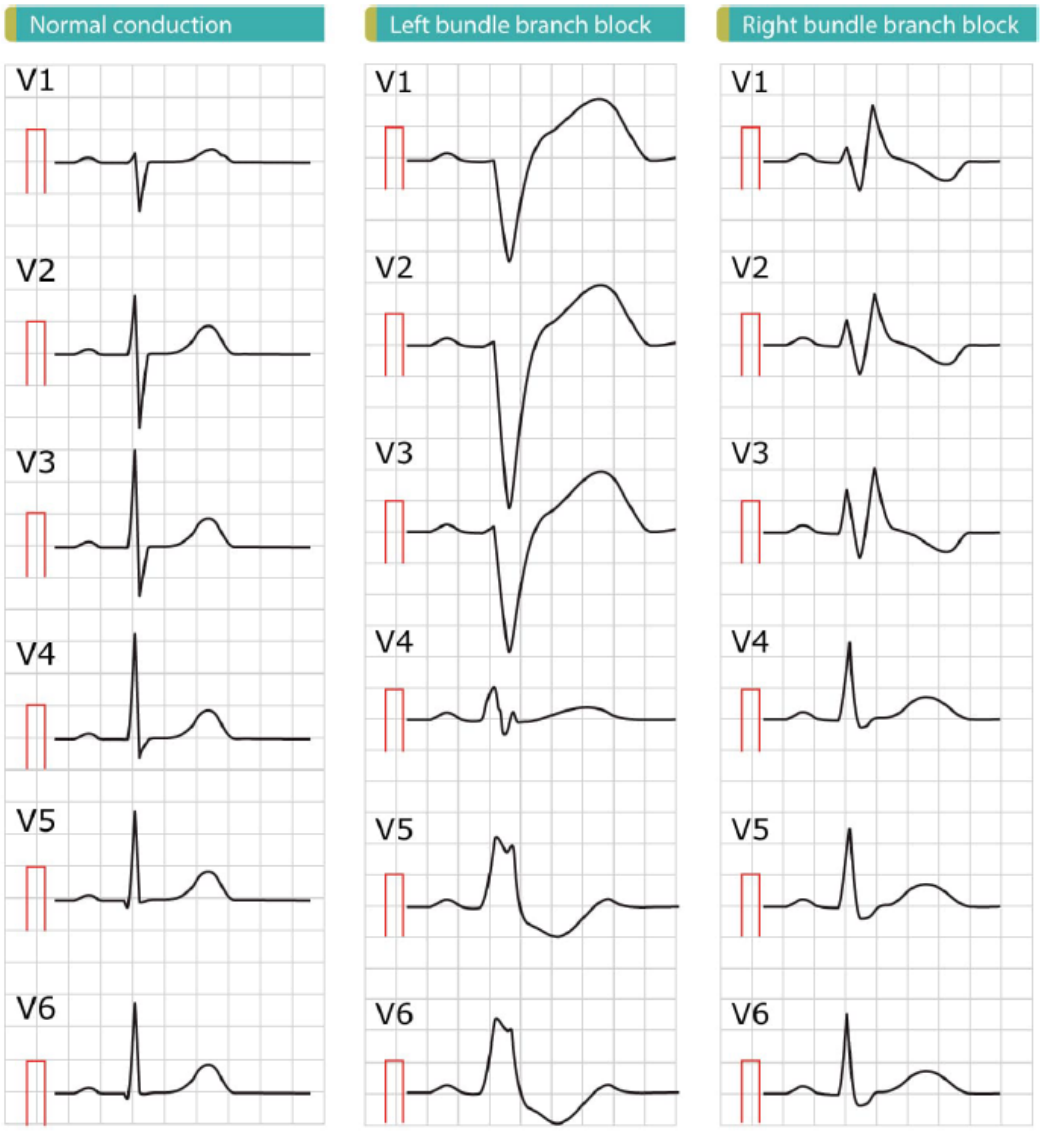


LBBB

LINKERBUNDELTAKBLOK

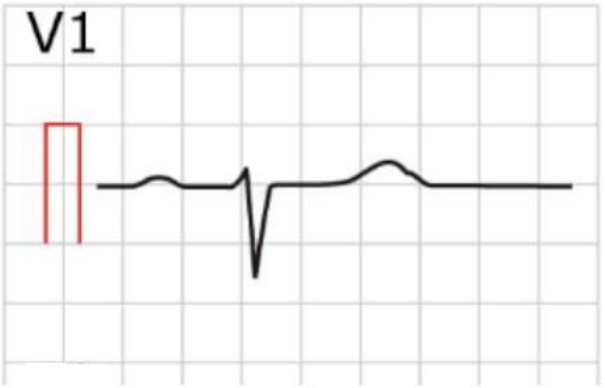


BUNDELTAKBLOK (2), QRS >120 MS

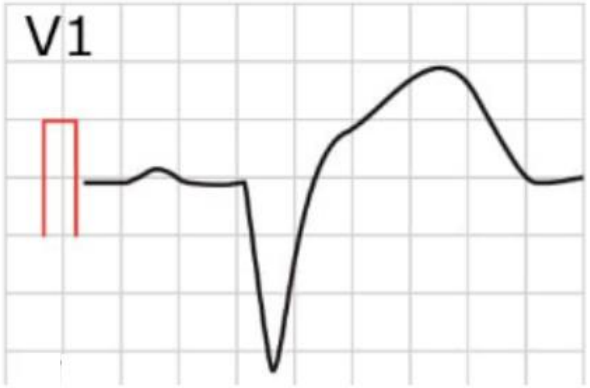


BUNDELTAKBLOK (3)

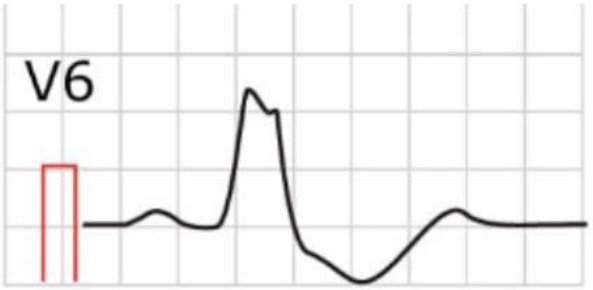
Normal conduction



Left bundle branch block

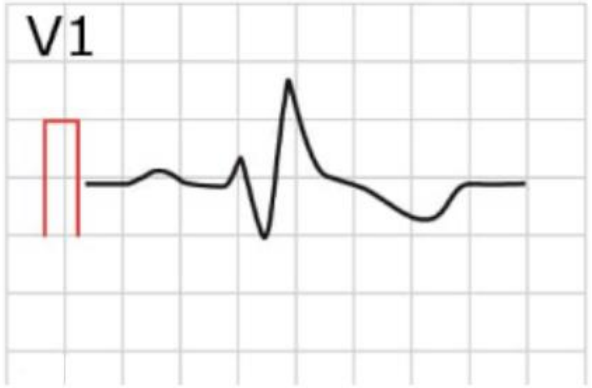


V1: (r)S

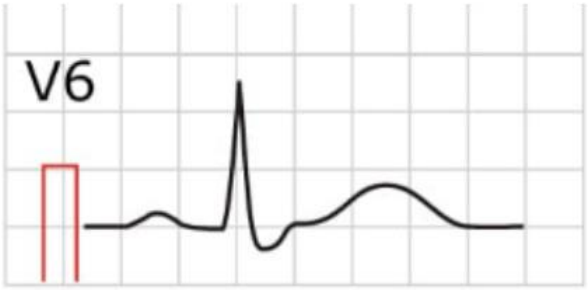


V6: R, geen q

Right bundle branch block

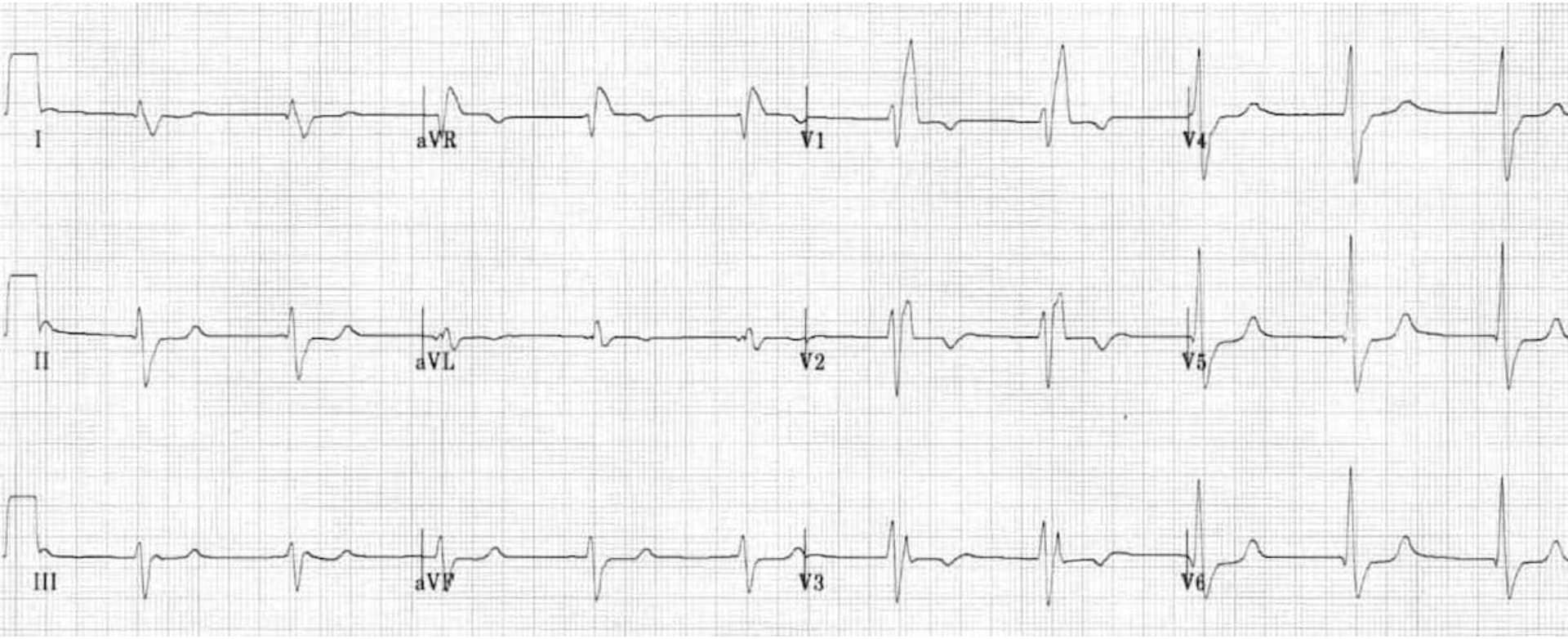


V1: rSR', R' >R

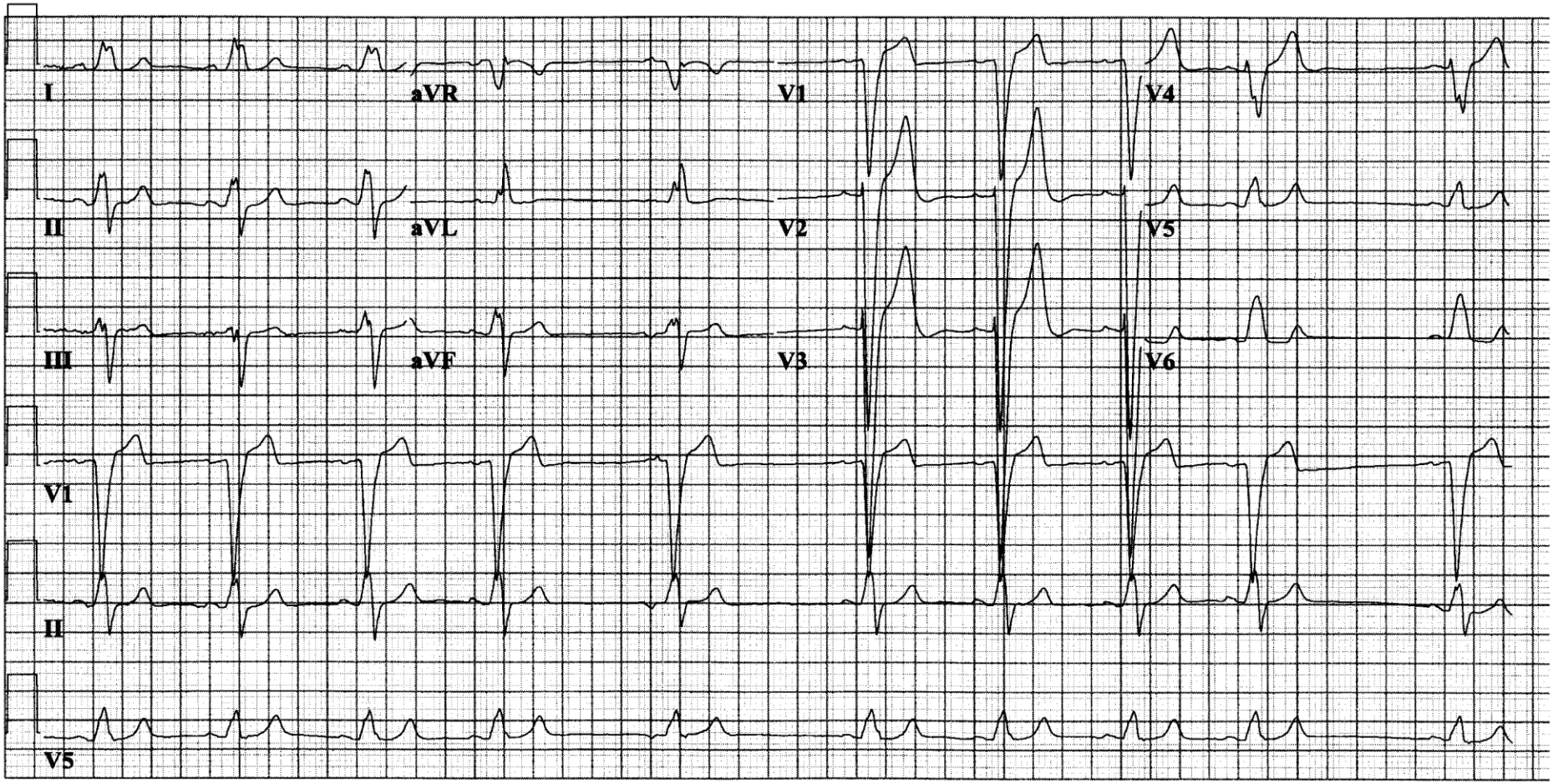


V6: brede s

LBTB of RBTB?



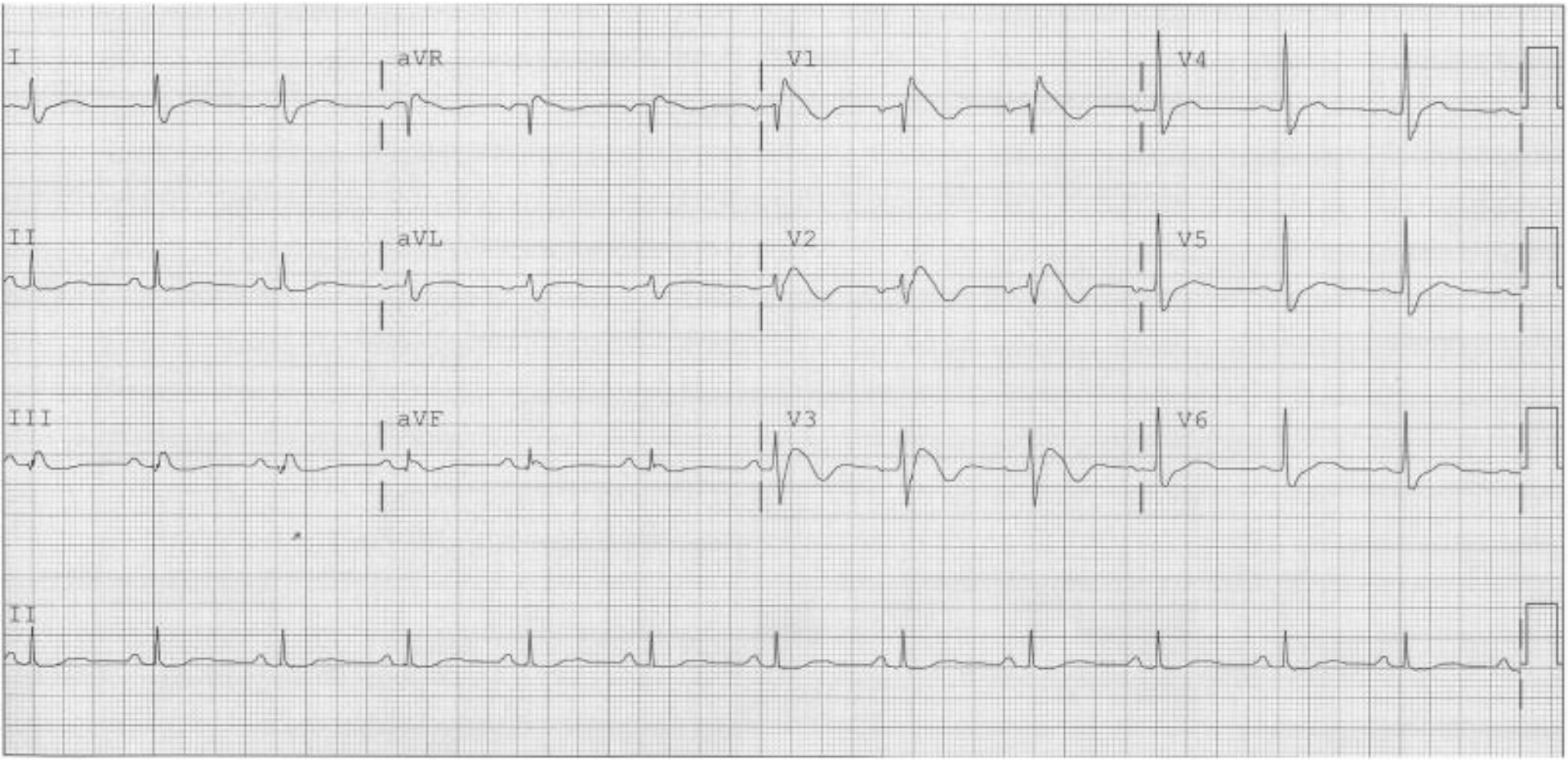
LBTB of RBTB?



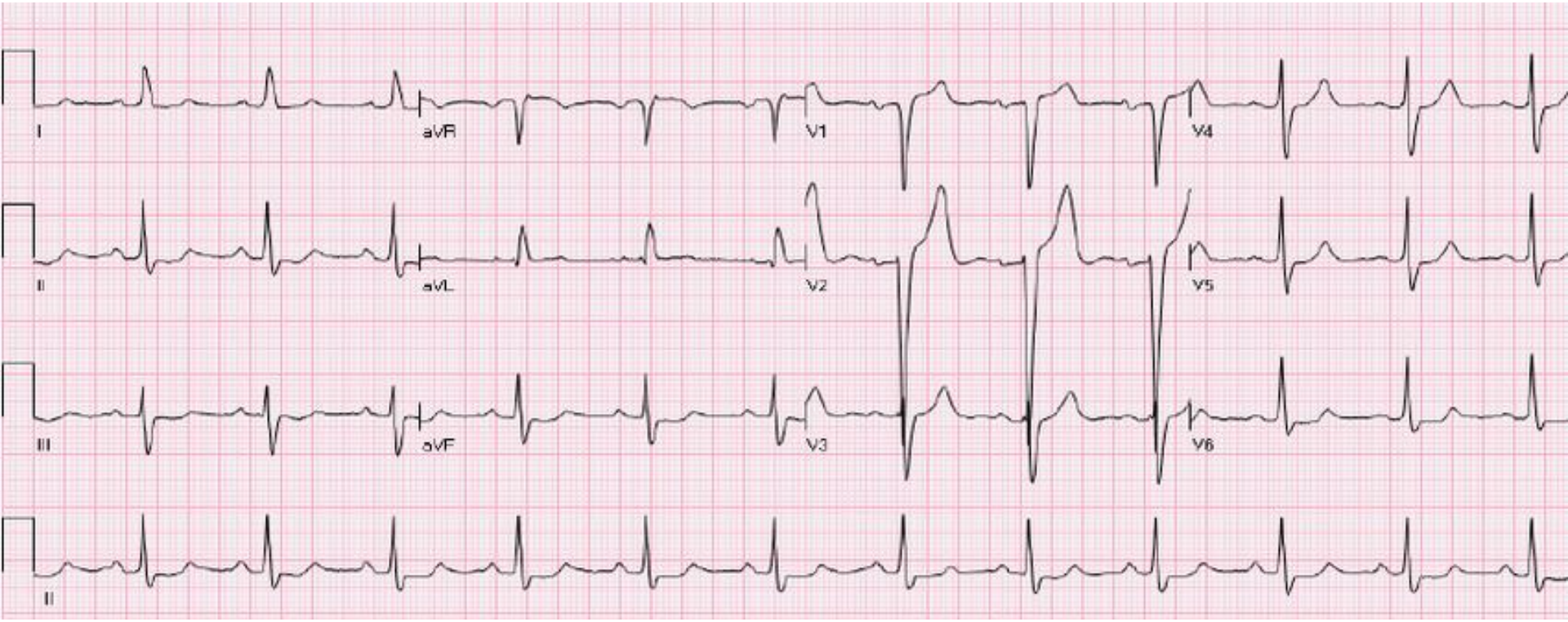
Courtesy of Vincent de Rover, RN & Device Technician, AMC, The Netherlands

ECGPEDIA.ORG
part of cardionetworks.org

LBTB of RBTB?



LBTB of RBTB?



Definitie LBTB

- Eerste definitie van LBTB opgesteld door Wilson in 1941
  - QRS-duur ≥ 120 ms, rS in afleidingen V1 en V2, grote gehaakte R-golf in afleidingen V5 en V6
  - 120 ms hoofdzakelijk gebaseerd op dierenonderzoek, bekrachtigd in 1985 door ‘WHO/ISFC Task Force criteria for conduction disturbanced’

- Door CRT-tijdperk meer belangstelling voor geleidingsstoornissen en aanpassing criteria LBTB
  - ‘Echt’ LBTB vs. LBTB-achtige kenmerken (LVH, linker anterior hemiblok etc.)

Definities

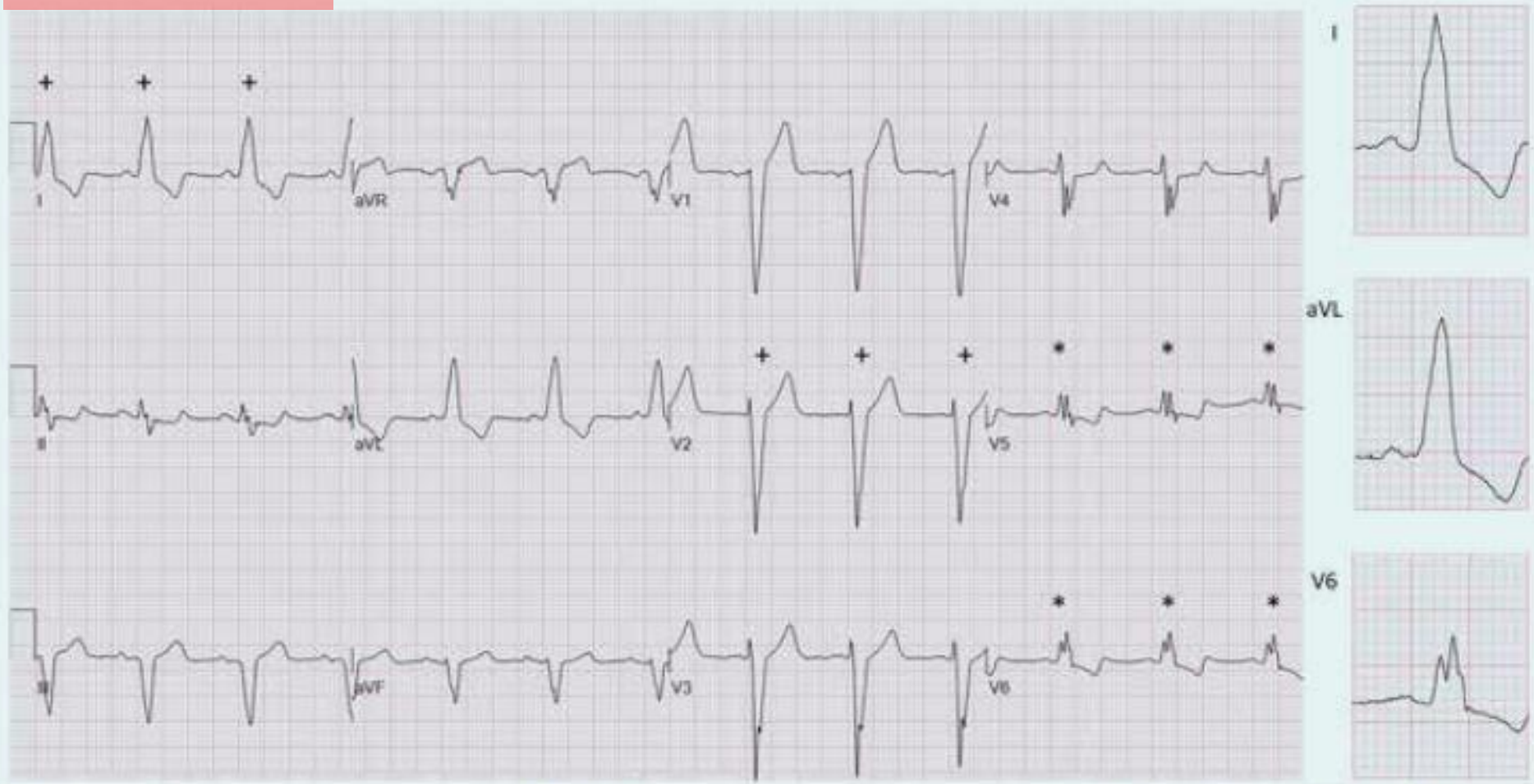
Tabel 1. Overzicht van de belangrijkste elektrocardiografische definities van LBTB[7, 10, 11, 25, 26]		
	QRS-duur	Bijkomende kenmerken
REVERSE-studie	≥ 120 ms	• QS of rS in afleiding V1 • R-golven in afleidingen I, aVL, V5 of V6 • Afwezigheid van q-golven in afleidingen V5 en V6
MADIT-CRT-studie	≥ 130 ms	• QS of rS in afleiding V1 • R-golven (frequent gehaakt of gehoekt) in afleidingen I, aVL, V5 en V6 • Afwezigheid van q-golven in afleidingen V5 en V6
Strauss	≥ 140 ms bij mannen ≥ 130 ms bij vrouwen	• QS of rS in afleiding V1 • Gehaakte of hoekige QRS-complexen in 2 of meer opeenvolgende afleidingen I, aVL, V1, V2, V5 en V6
AHA 2009	≥ 120 ms	• Gehaakte of hoekige R-golven in afleidingen I, aVL, V5 en V6 • Afwezigheid van q-golven in afleidingen I, V5 en V6 • Discordante ST-segmenten en T-golven
ESC 2013	≥ 120 ms	• QS of rS in afleiding V1 • Gehaakte of hoekige R-golven in afleidingen I, aVL, V5 of V6 • Afwezigheid van q-golven in afleidingen V5 en V6

Samenvattend

1. QRS-duur ≥ 120 ms
2. QS of rS in afleiding V1
3. R-golven (gehaakt / gehoekt) in afleidingen I, aVL, V5 en V6
4. Geen q-golven in afleidingen V5 en V6

Figuur 1. Elektrocardiografische voorbeelden van variabele LBTB-morfologie

Figuur 1A toont het ecg van een 54-jarige man met een 'echt' LBTB dat voldoet aan de strikte definities van Strauss en de *European Society of Cardiology*. Gehaakte (*) en hoekige (+) QRS-complexen in de afleidingen I, aVL, V1, V2, V5 en V6 werden gemarkeerd.

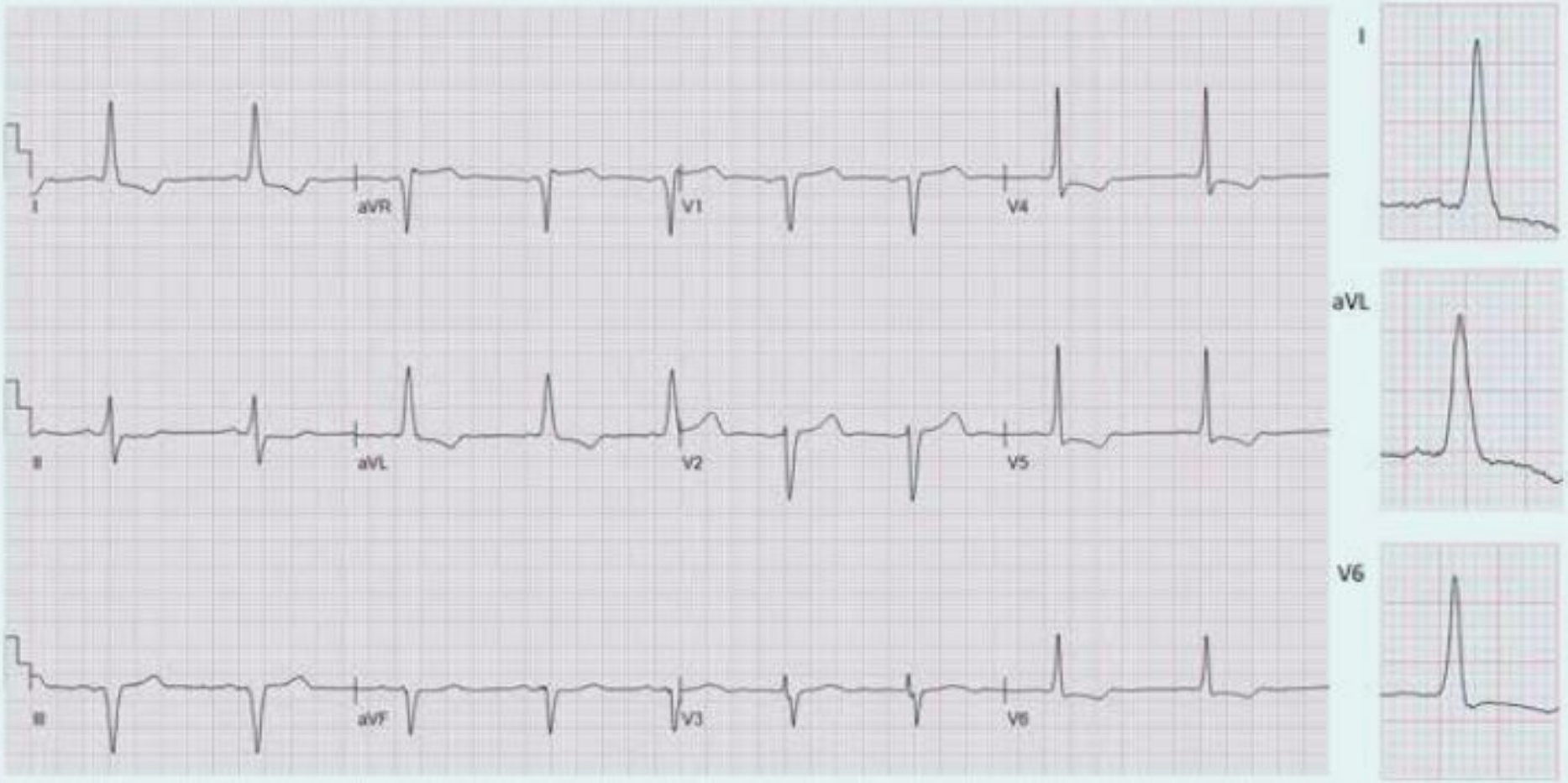


Hartfrequentie: 74/min
QRS-duur: 142 ms

PR-interval: 160 ms
QRS-as: -30°
QT/QTc-interval: 430/477 ms
QS in afleiding V1 en V2

Afwezigheid van q-golven in afleidingen I, V5 en V6
Gehaakte QRS-complexen in afleidingen V5 en V6
Hoekige QRS-complexen in afleidingen I en V
Discordante ST-segmenten en T-golven

Figuur 1B toont het ecg van een 81-jarige vrouw met aspecifieke intraventriculaire geleidingsvertraging dat niet voldoet aan de strikte definities van LBTB.



Hartfrequentie: 57/min
QRS-duur: 144 ms

PR-interval: 150 ms
QRS-as: -24°
QT/QTc-interval: 492/478 ms
QS in afleiding V1

Afwezigheid van q-golven in afleidingen I, V5 en V6
Afwezigheid van gehaakte of hoekige QRS-complexen in afleidingen I, aVL, V1, V2, V5 en V6
Discordante ST-segmenten en T-golven

LBTB anno nu

- Prevalentie LBTB in algemene bevolking laag (< 1%)
- Neemt toe met leeftijd (0,5% bij 50 jaar tot 5% bij 80 jaar)
- Weinig data m.b.t. etiologie en precieze ontstaansmechanisme
- Associatie met arteriële hypertensie, CAD, kleplijden, myocarditis, CMP en LVH
- LBTB is een “handtekening” op het ECG van bovenstaande cardiale aandoeningen maar…
- Studies tonen aan dat aanwezigheid v.e. LBTB een rechtstreekse en onafhankelijke invloed uitoefent op de LVF
- LBTB zelf aanleiding geven tot hartfalen met ↓ EF
- LBTB op zichzelf een onafhankelijke predictor van mortaliteit binnen deze patiëntenpopulatie

Why bother?

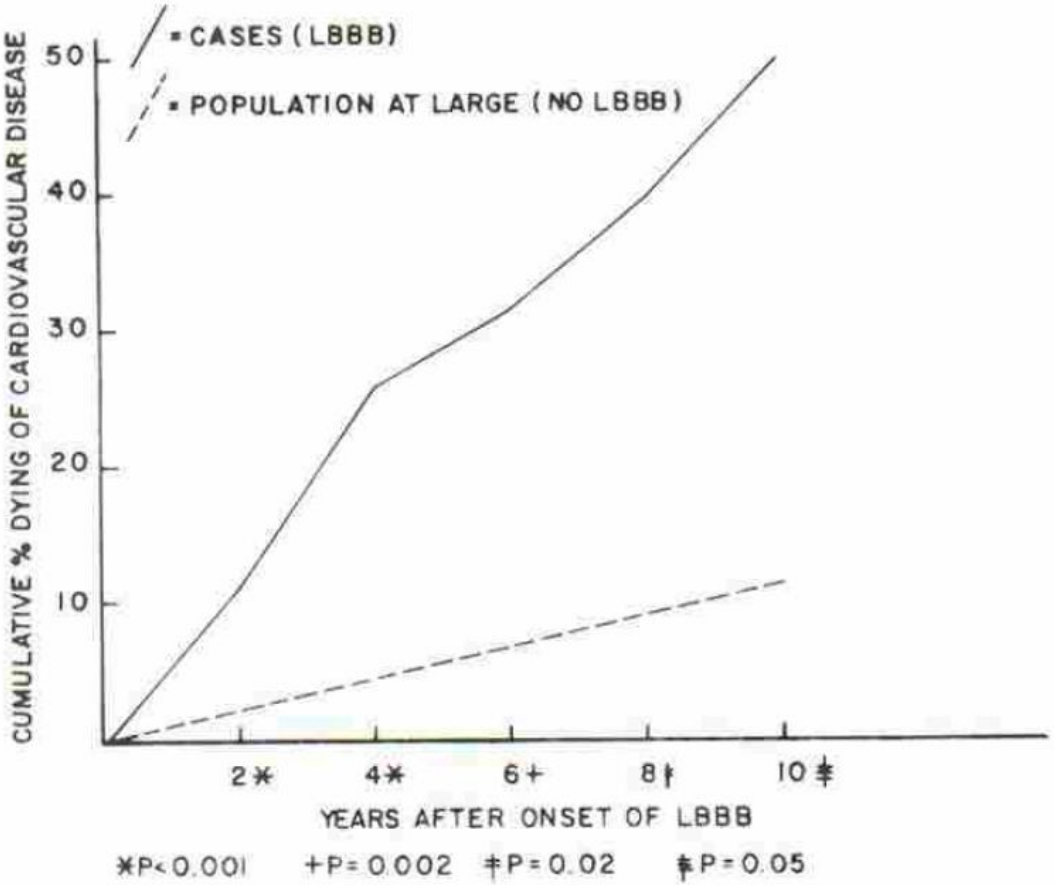


Figure 4. Comparison of cumulative mortality rates from cardiovascular disease in the cases versus the population-at-large free from left bundle-branch block (*LBBB*). Starting point for the mortality rate calculations in the cases was the age at onset of LBBB, and in the population-at-large free from LBBB was the mean age of 62 years.

Framingham Study - Schneider ea. Ann Intern Med 1979

Why bother?

Henry Ford Hospital-Intensive Care Unit Data Base

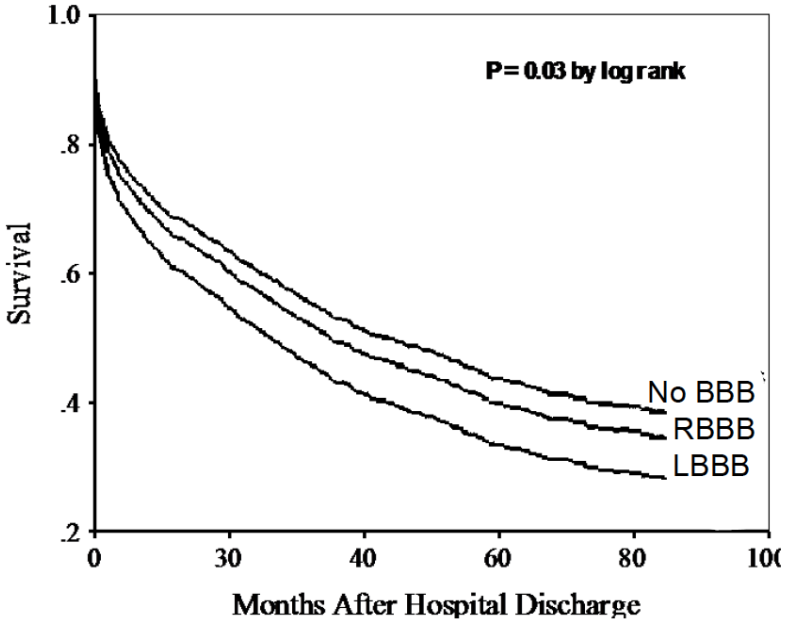
Detroit,MI. Period: 1990-1998; EP: Mortality at discharge ICU;
FU:Vital status (Death Certificate Registry) 27±28 months

Clinical profile

	No BBB (n=2,310)	LBBB (n=386)
Age	63±13	63±14
Male (%)	54	54
Previous MI(%)	32	42*
LVEF(%)	40±15	29±15*
Renal insufficiency (%)	33	40
Severe MV Regurgitation(%)	6.5	9.3

* p<0.001

Survival



HR (adjusted for age,sex, LVEF,renal dysfunction, prior MI.)
RBBB+LBBB: 1.17 (1,03-1.31), p=0.01

Left and Right BBB are independently associated with higher all-cause mortality after discharge for severe HF

McCullough ea. Int J Cardiol 2005, Cinca ESC 2012

Why bother?

Italian Network on Congestive Heart Failure

150 cardiology centers, FU:1 year (2000); EP:cardiac death
Inclusion: CHF NYHA I-IV; N= 5,517

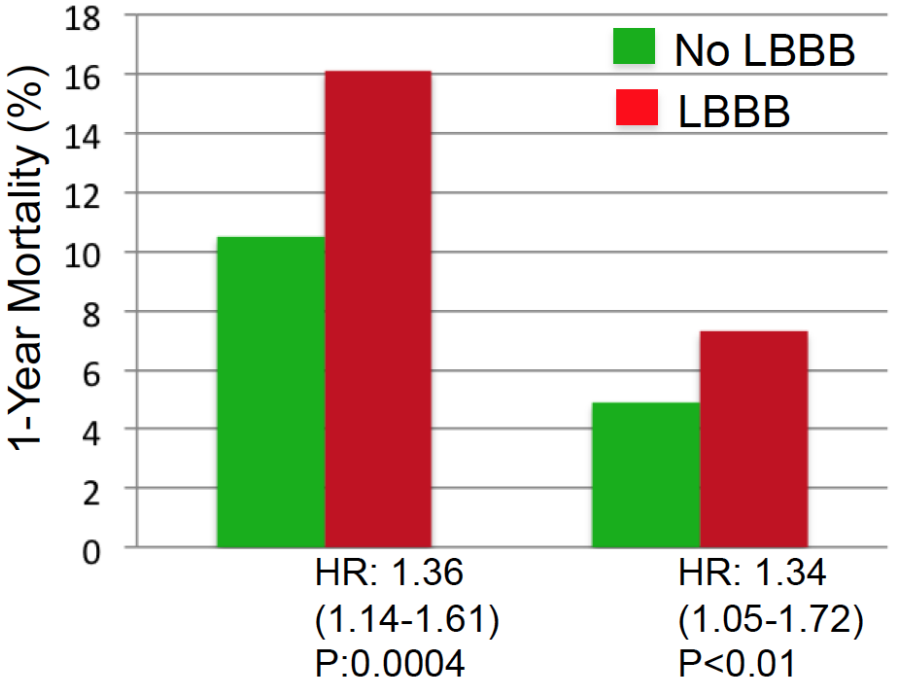
Clinical profile

	No BBB (n=4,126)	LBBB (n=1,391)
Age >70 years (%)	30	31
Male (%)	88.5	70.7*
Dilated CM (%)	31.6	49.3*
NYHA III-IV (%)	26.4	32.8*
LV EF <30% (%)	30.4	49.2*

* p<0.001

All-cause Death

Sudden Death



LBBB is an unfavorable prognostic marker in patients with CHF, independent of age, HF severity, and drug prescriptions

Baldasseroni ea. Am Heart J 2002, Cinca ESC 2012

Why bother?

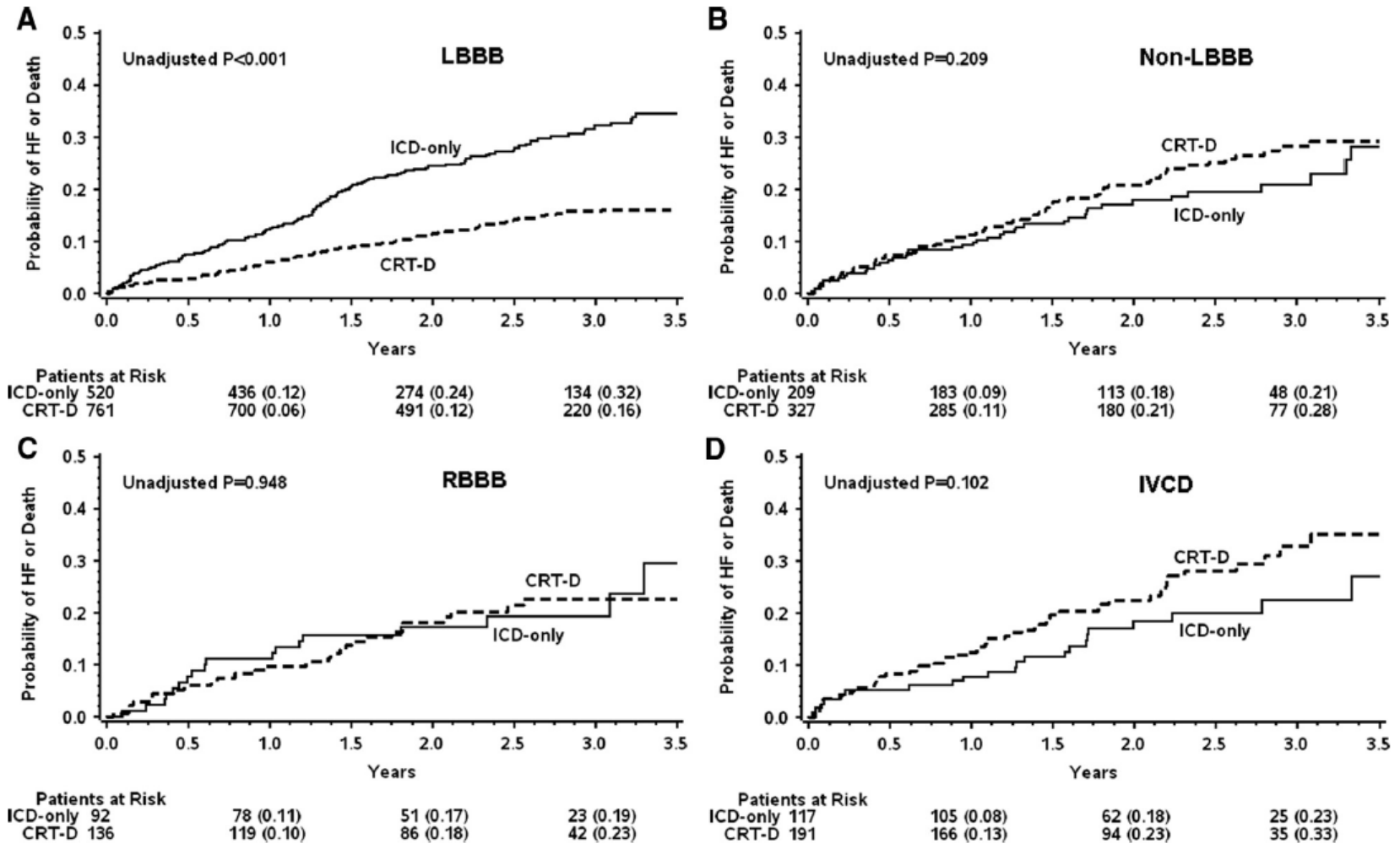
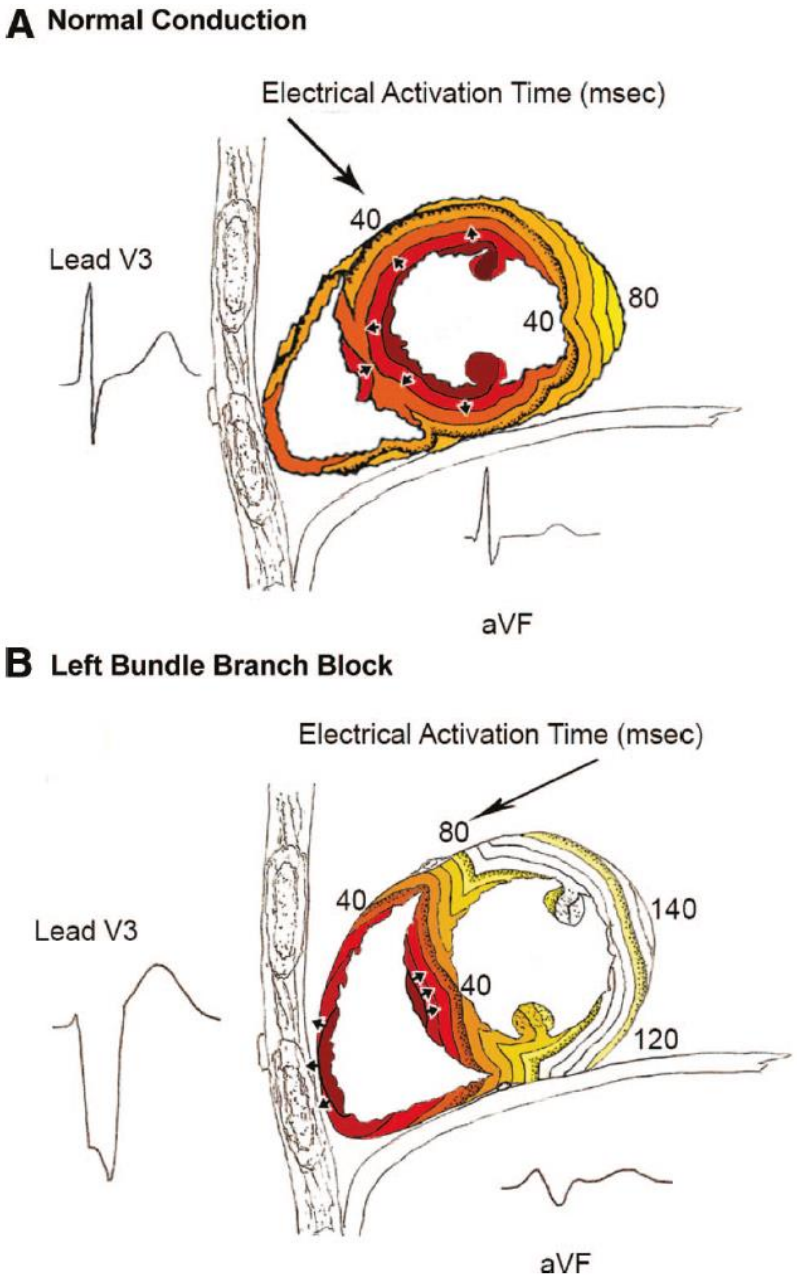


Figure 2. Cumulative probability of heart failure (HF) event or death according to treatment (cardiac resynchronization therapy with defibrillator [CRT-D] versus implantable cardioverter defibrillator [ICD] only) in patients with left bundle-branch block (LBBB), non-LBBB, right bundle-branch block (RBBB), and intraventricular conduction disturbances (IVCD) in Multicenter Automatic Defibrillator Implantation Trial–Cardiac Resynchronization Therapy (MADIT-CRT) patients.

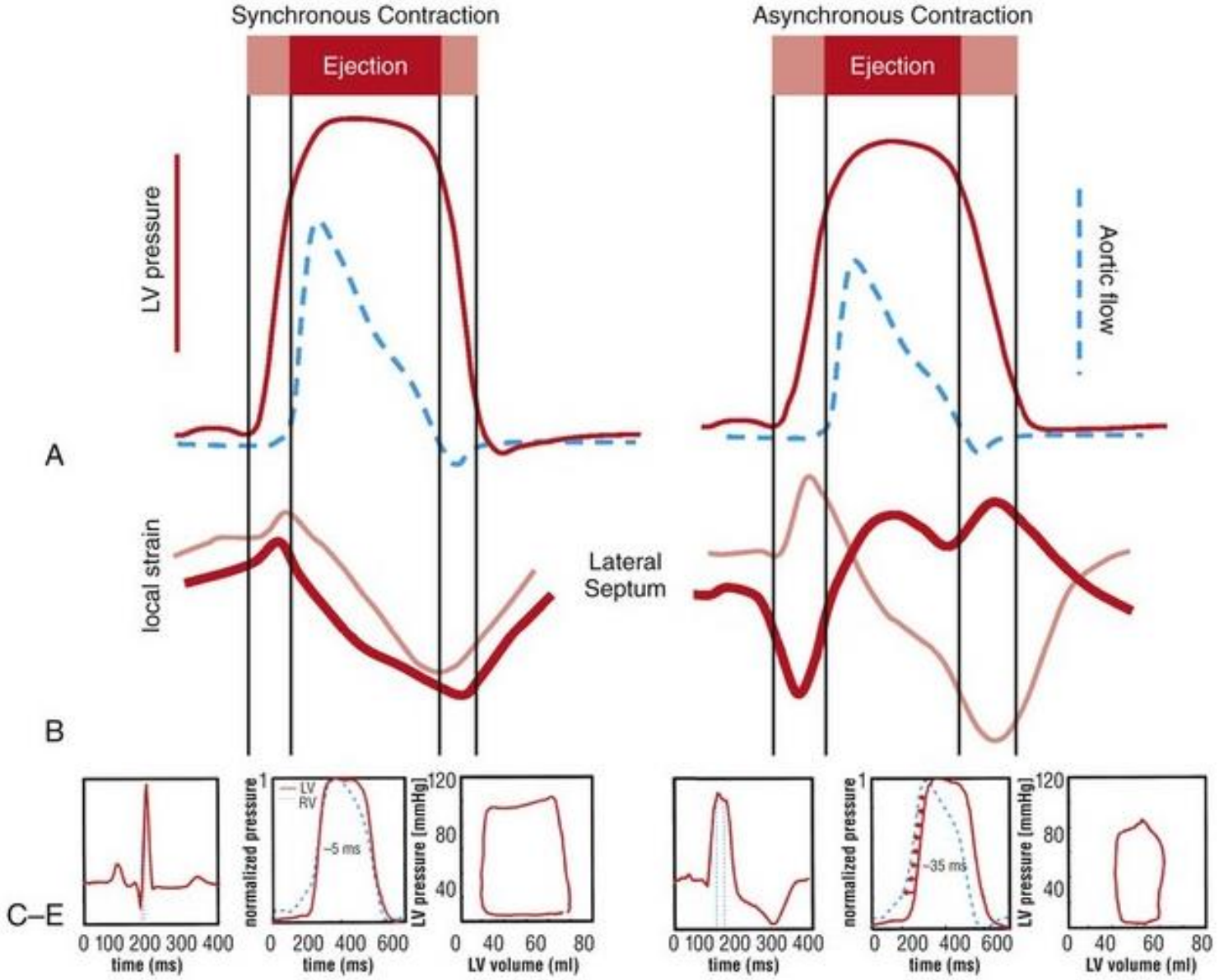
Zareba ea. MADIT-CRT Circ 2011

Physiology



Strauss ea. Circ AEP 2008

Consequenties



Wat komt er eerst?

Krijg je een LBTB van hartfalen

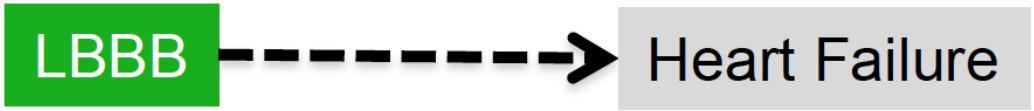
of

Krijg je hartfalen van een LBTB?

Allebei waar?

Pathophysiological relationship between LBBB & HF

I) Primary cause of HF

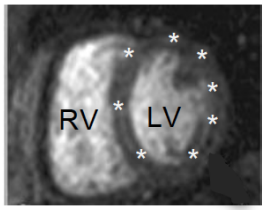


II) Secondary condition aggravating HF

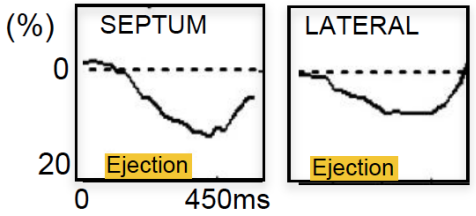
LBBB in healthy dogs (RF-ablatie)

LV Circumferential Shortening

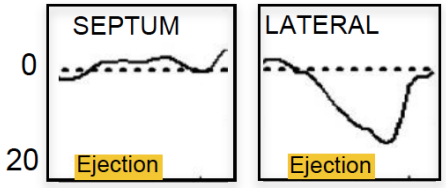
BASELINE



MRI- Dogs (n=8)
Ablation of the LBB



LBBB (RF ablation)



- LV asynchrony
(reduction of cardiac output)

Echocardiographic parameters

	Baseline	16 Weeks LBBB
LV Ejection Fraction (%)	43±4	33±6*
LV Wall Mass (g)	126±31	145±30*
LVED Volume (mL)	104±31	135±53*

* $p<0.05$

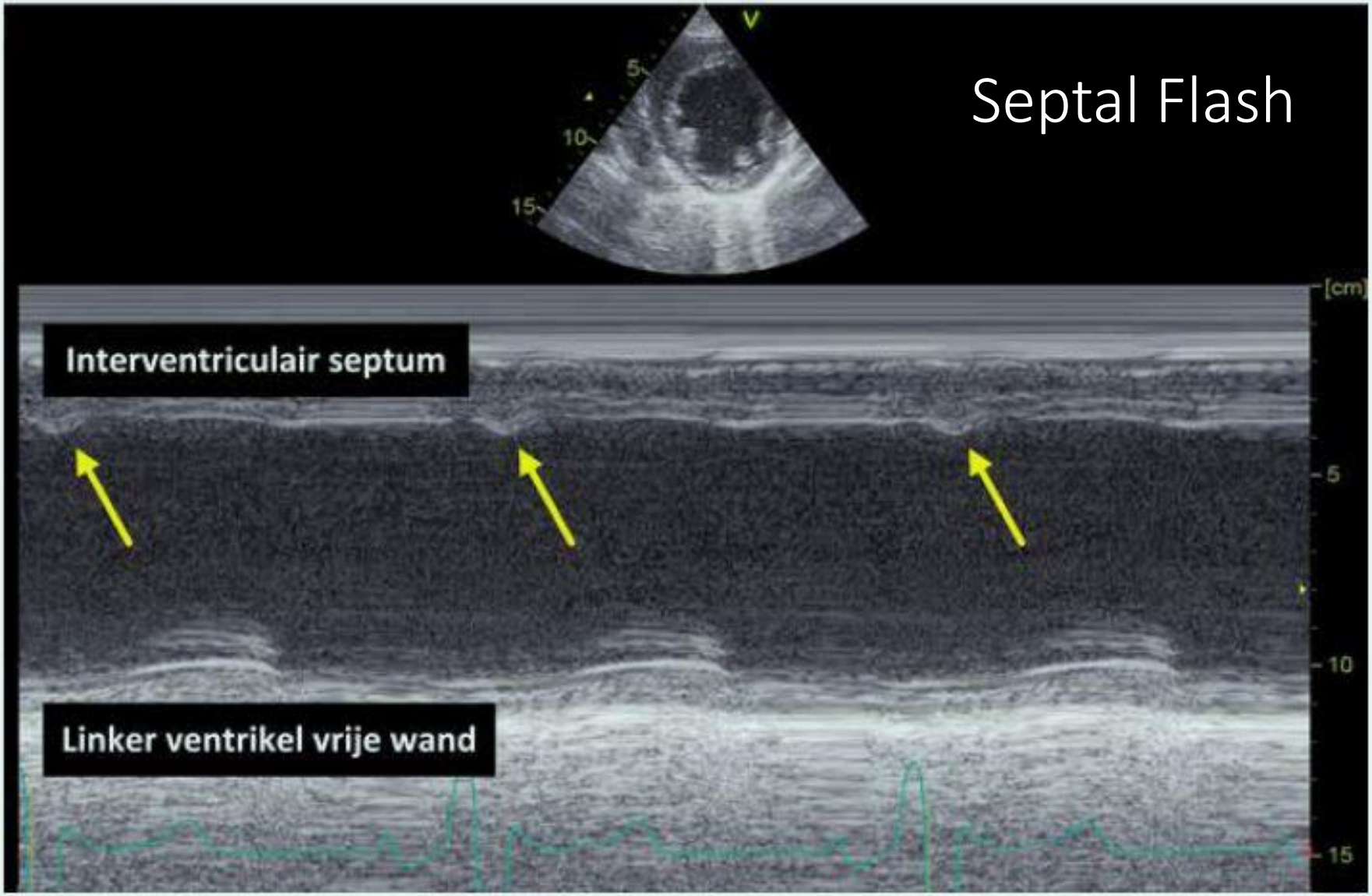
- LV Remodelling
(dysfunction, hypertrophy, and dilation)

Vernooy ea. EHJ 2005, Cinca ESC 2012

Dus…

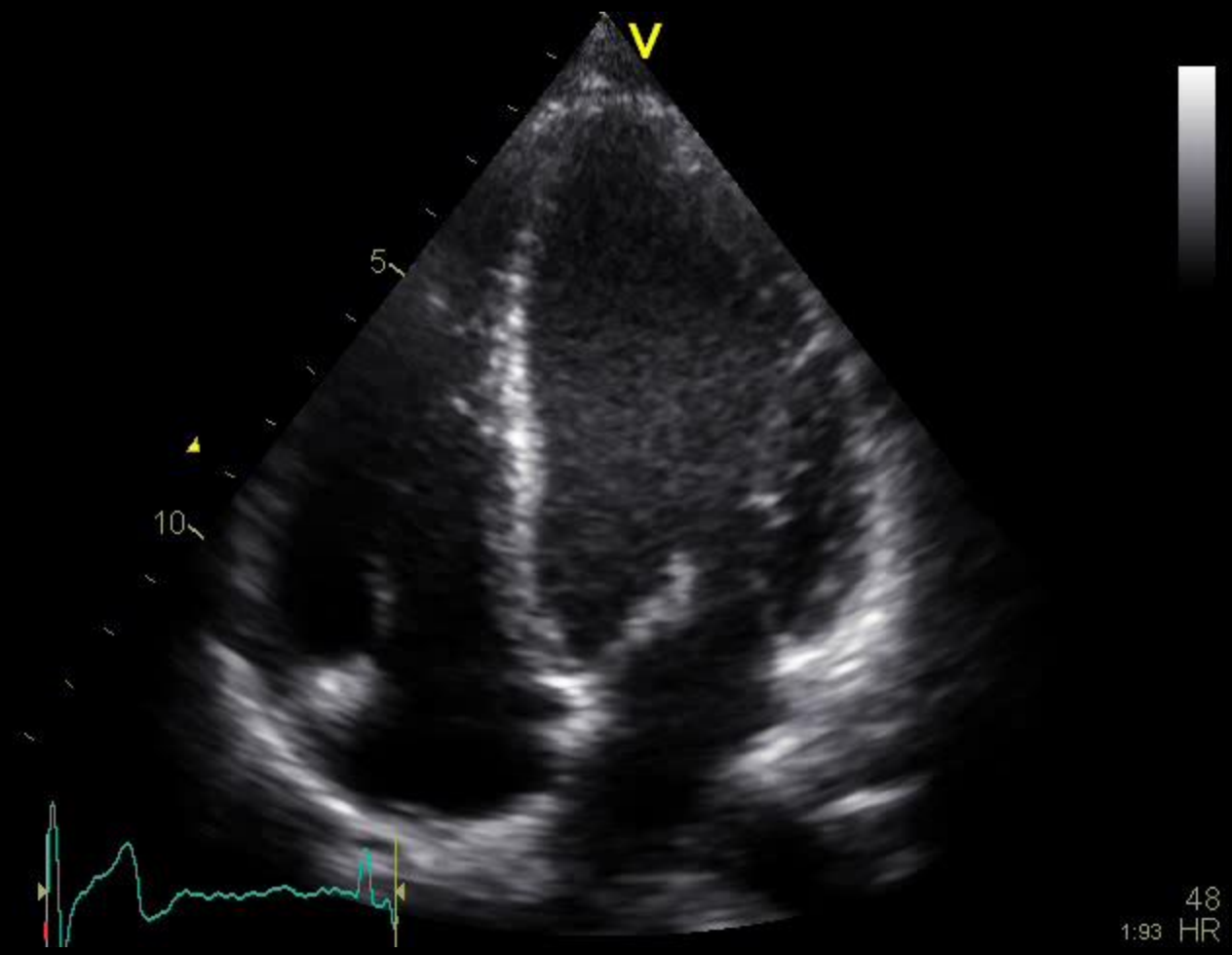
- LBTB kan een primaire oorzaak zijn van LV remodelering
  - ↓septal workload, ↑dilatation, ↑asymm LVH
- LBTB verergerd LV dysfunctie in patiënten met hartfalen
  - ↓LV filling, ↑MR, ↑dilatation, ↑asynchrony
- Maar niet iedere patiënt met hartfalen krijgt een LBTB!

Figuur 2. Cardiale dissynchronie bij een 69-jarige man met LBTB, weergegeven aan de hand van M-mode

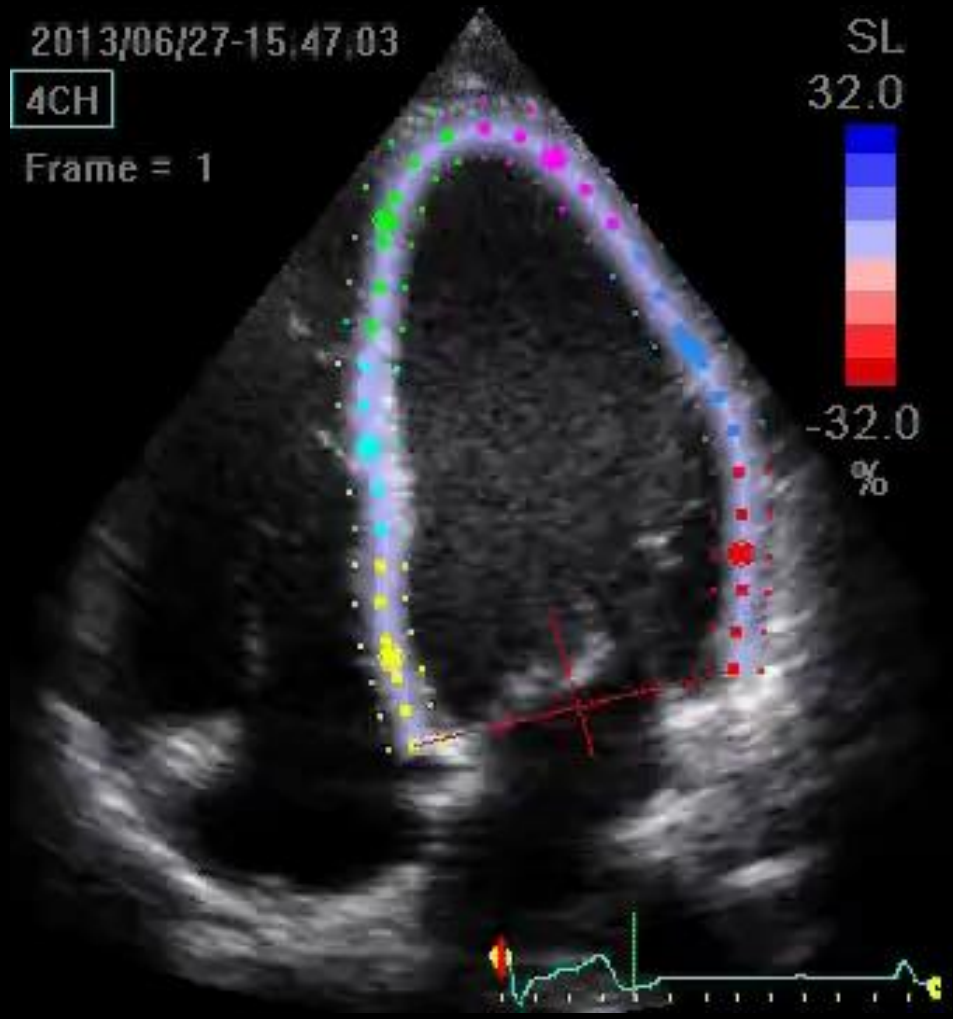


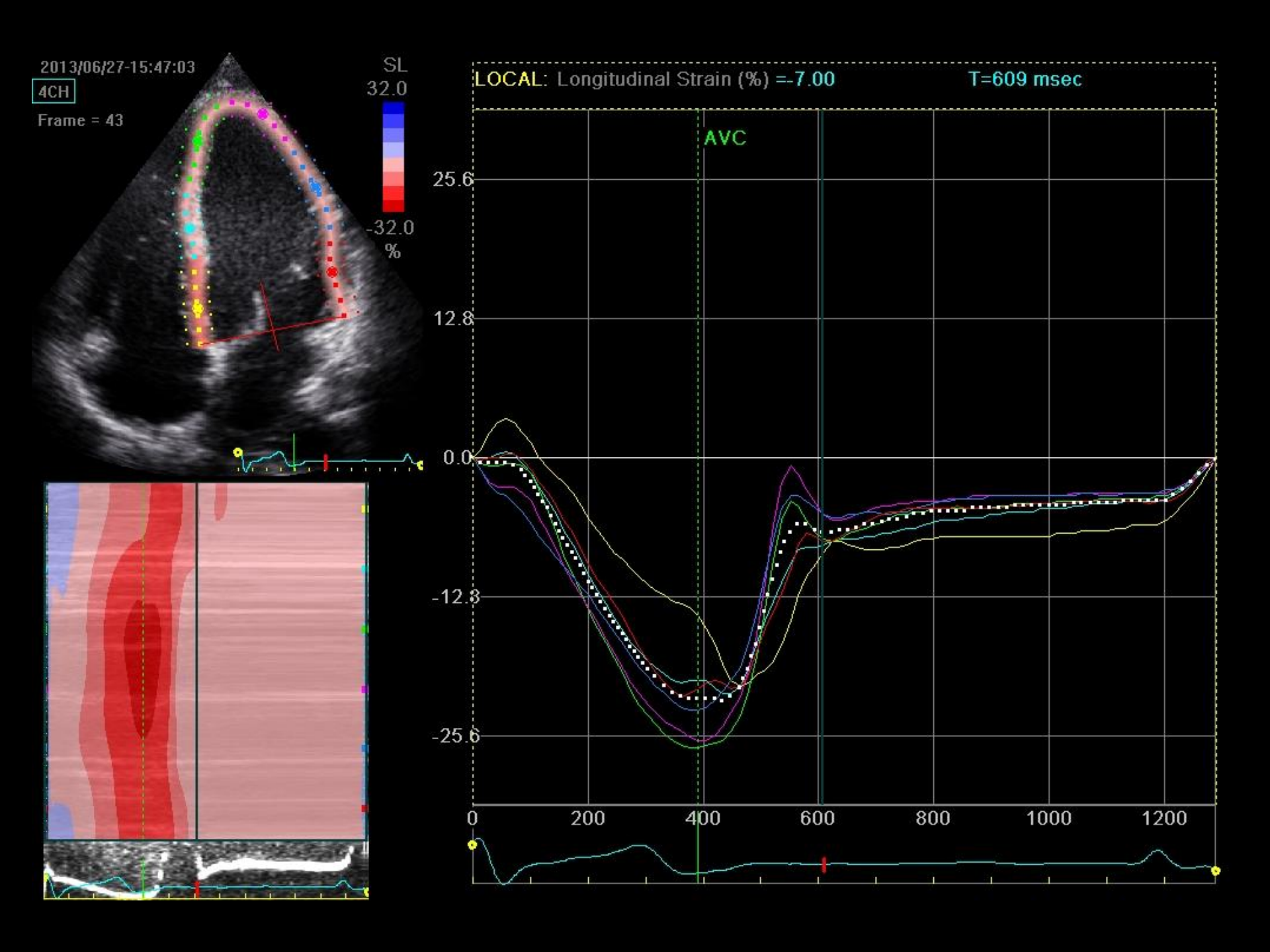
De vroegtijdige activatie van het interventriculair septum of 'septale flash' werd aangeduid met gele pijlen.

Normaal hart

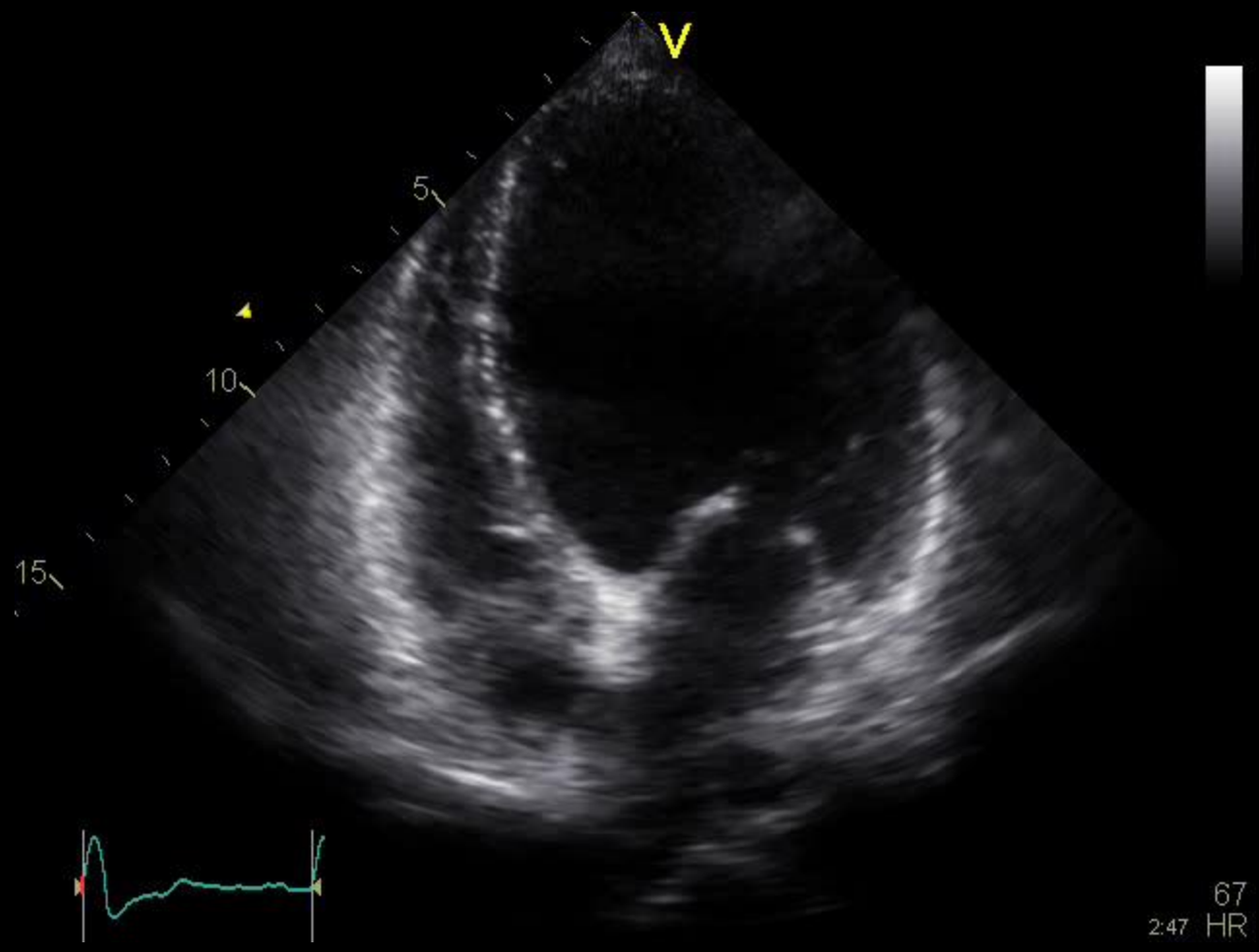


Specle Tracking Normaal Hart

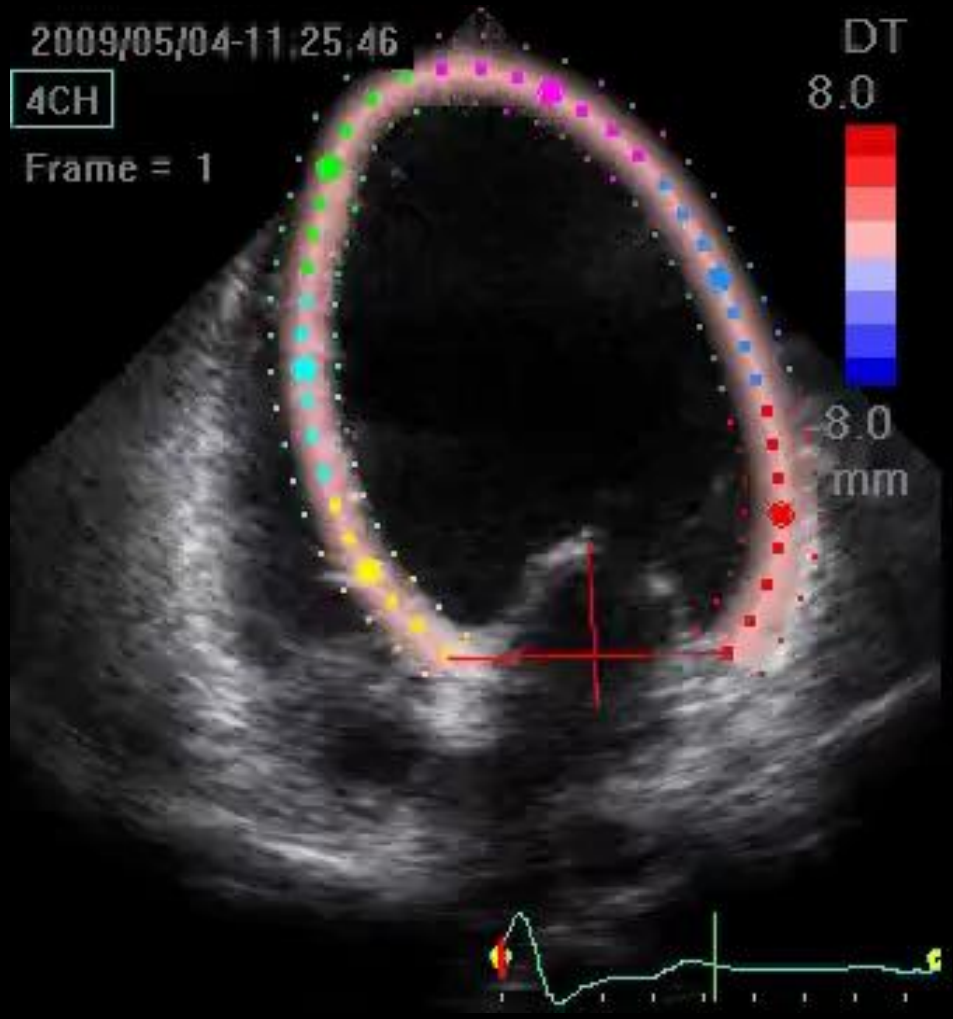


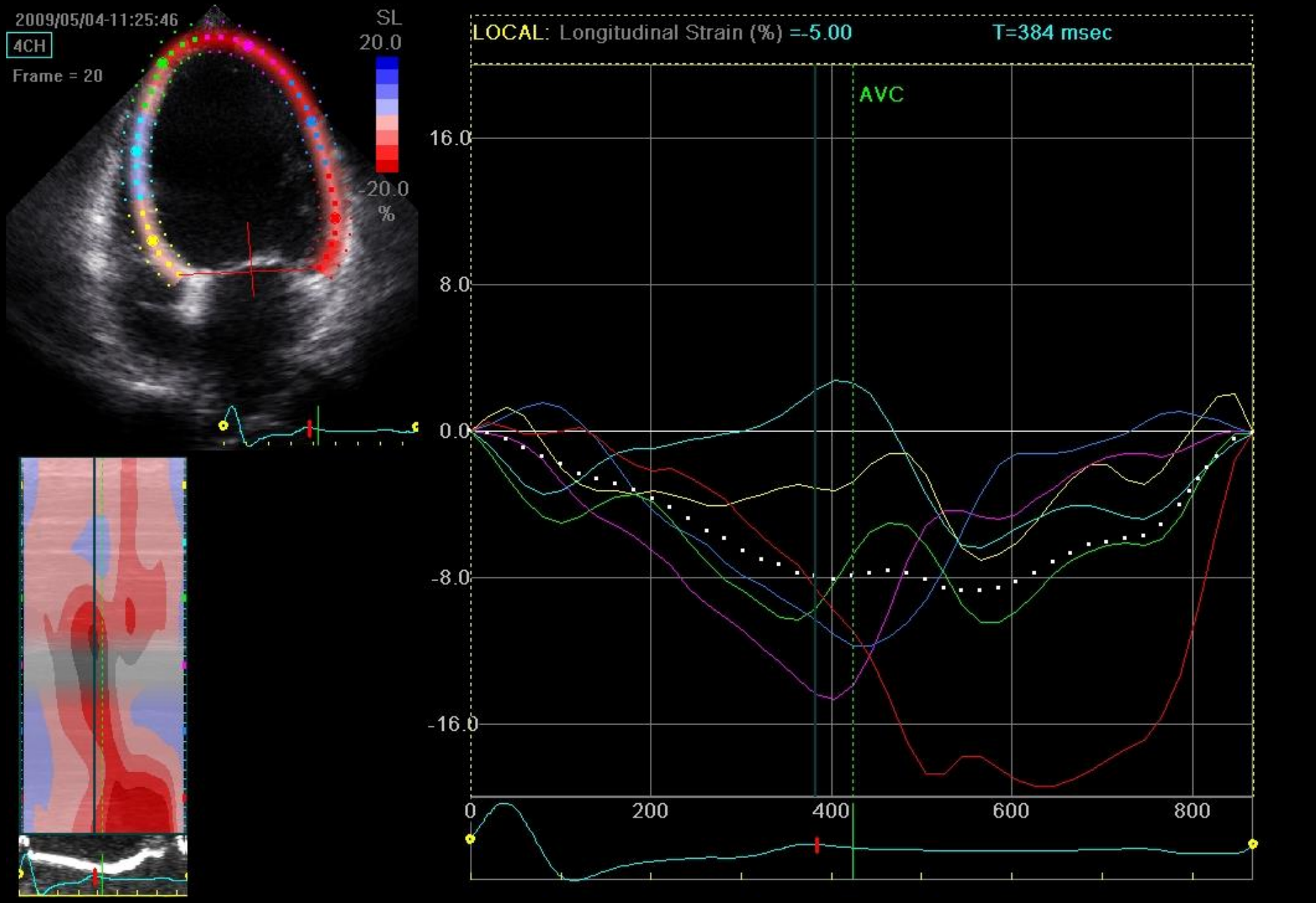

2013/06/27-15:47:03
4CH
Frame = 43
SL
32.0
-32.0
%
LOCAL: Longitudinal Strain (%) =-7.00
T=609 msec
AVC
25.6
12.8
0.0
-12.8
-25.6
0
200
400
600
800
1000
1200

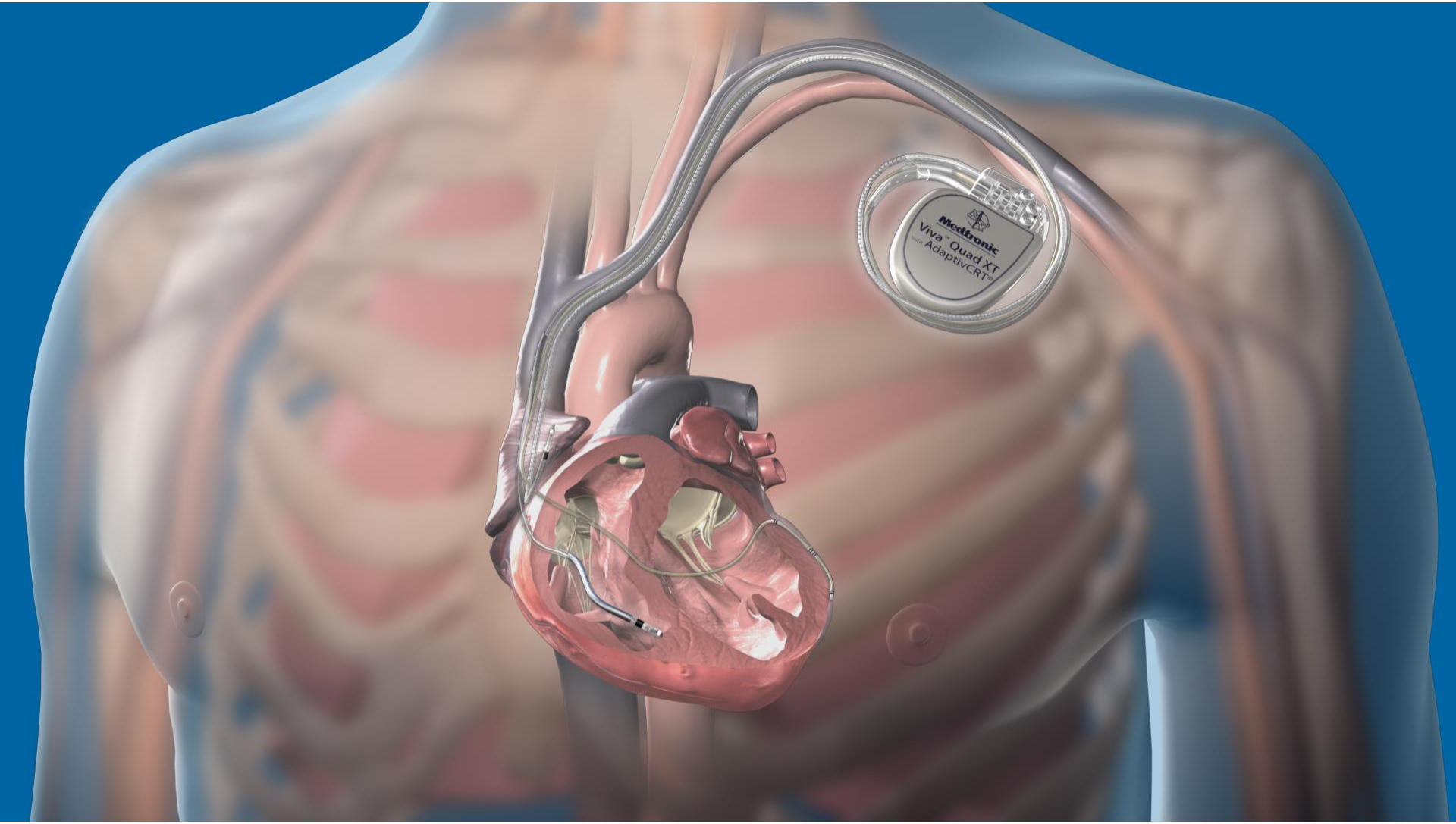
LBTB (Asynchrone LV)



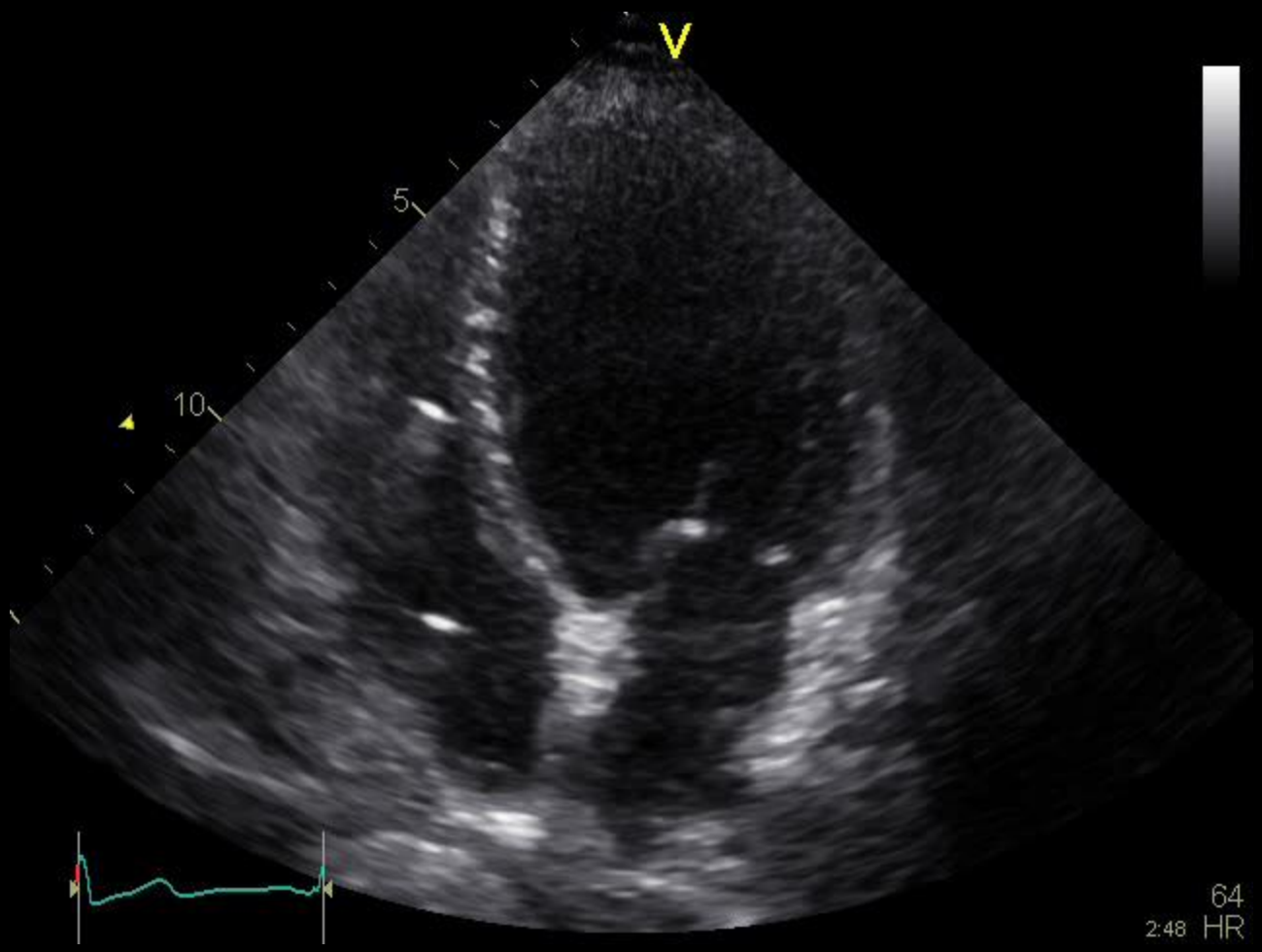
Speckle Tracking LBTB



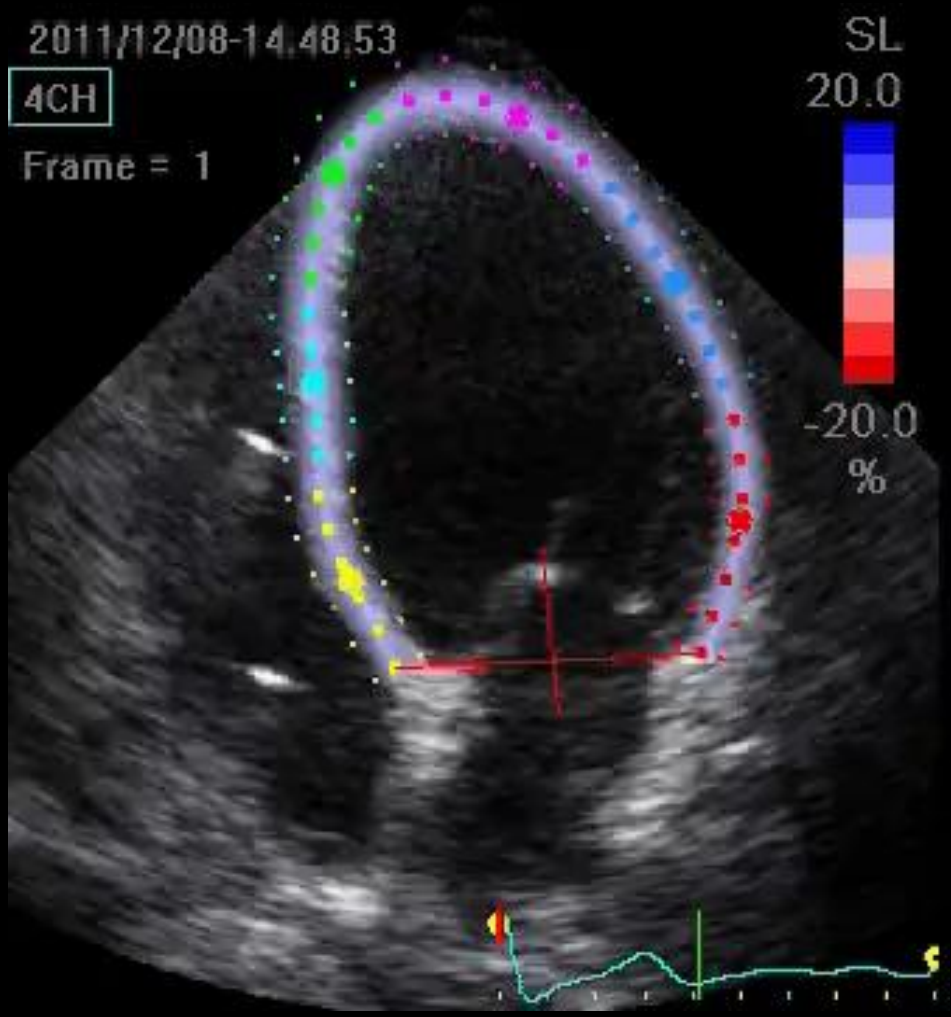

2009/05/04-11:25:46
4CH
Frame = 20
SL
20.0
-20.0
%
LOCAL: Longitudinal Strain (%) =-5.00
T=384 msec
AVC
16.0
8.0
0.0
-8.0
-16.0
0
200
400
600
800

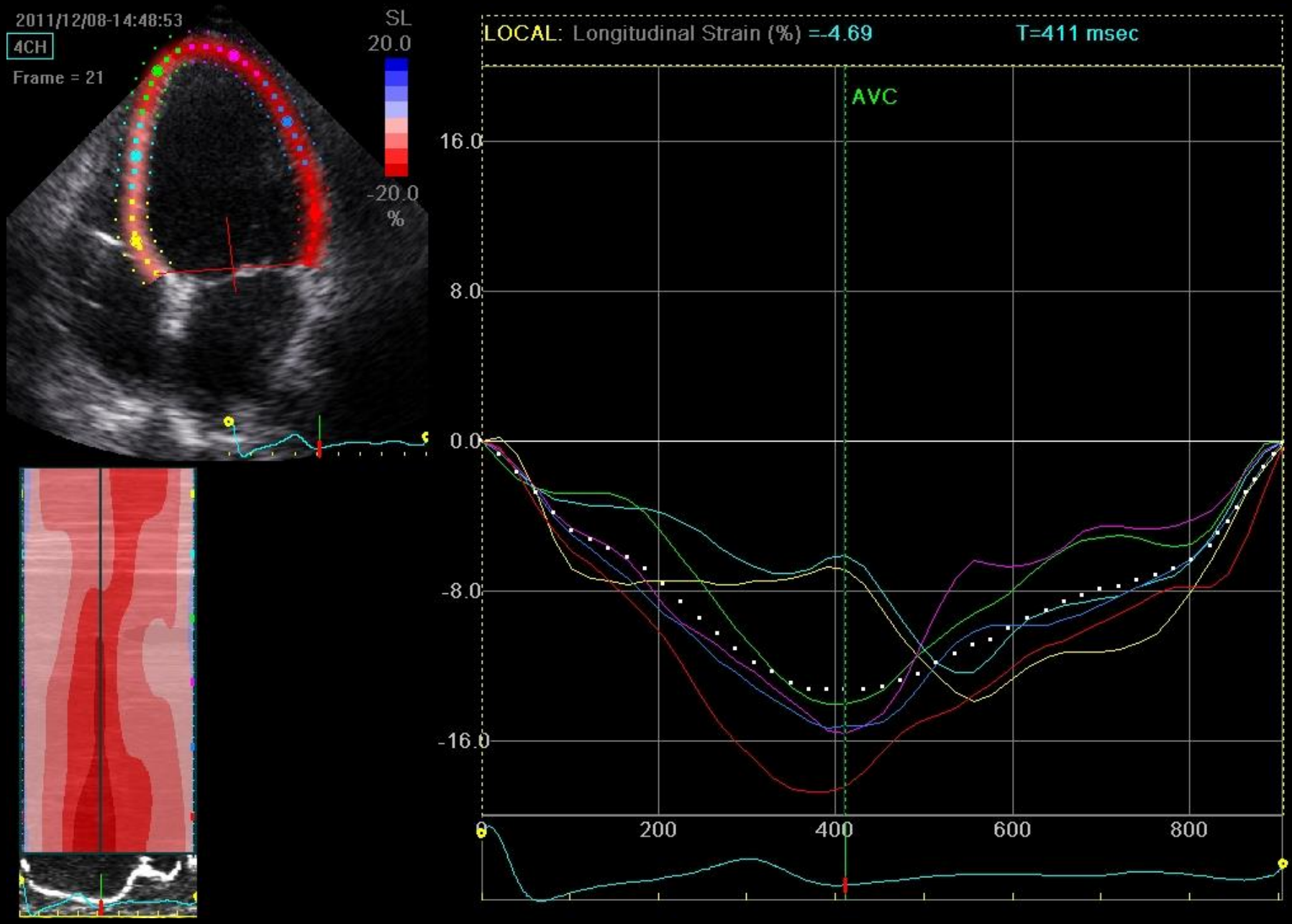

Medtronic
Viva Quad XT
with AdaptivCRT

CRT



Speckle Tracking CRT




2011/12/08-14:48:53
4CH
Frame = 21
SL
20.0
-20.0
%
LOCAL: Longitudinal Strain (%) =-4.69
T=411 msec
AVC
16.0
8.0
0.0
-8.0
-16.0
0
200
400
600
800

Het ‘echte’ LBTB

waar CRT waarschijnlijk wél helpt:

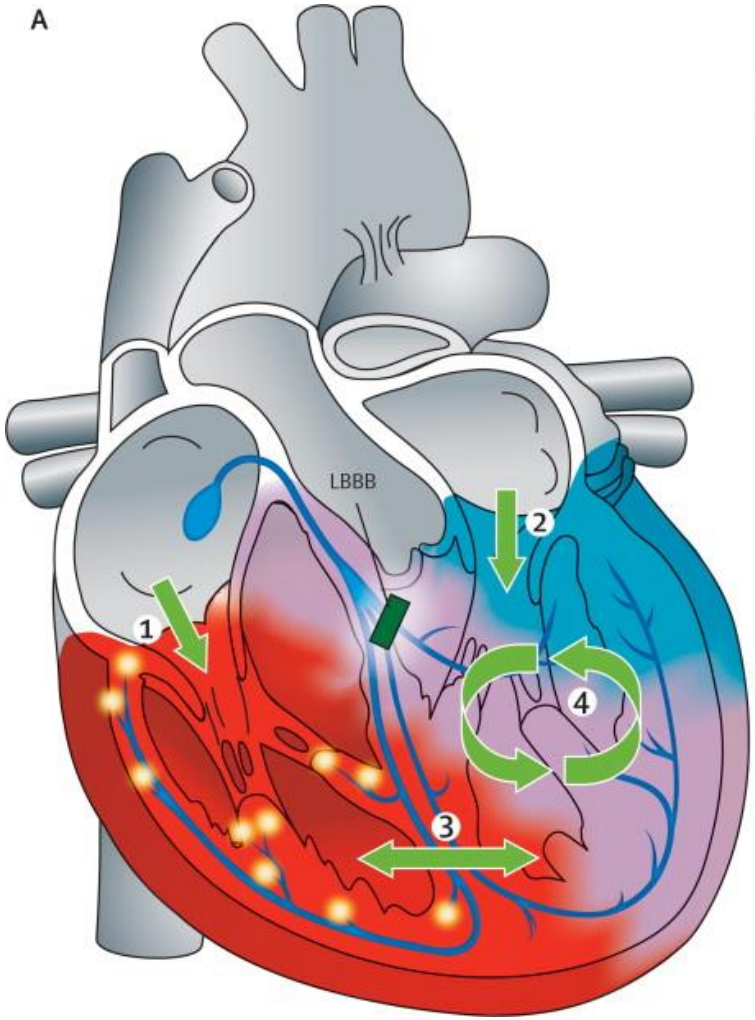
- Is breed
- Is genotched

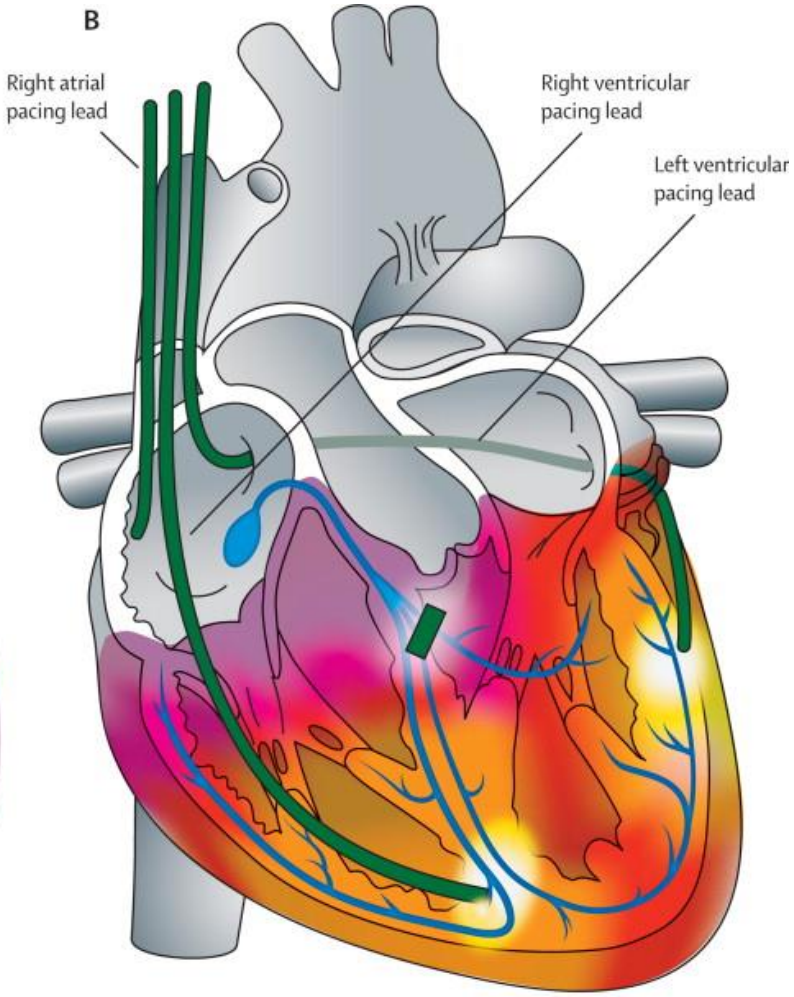
LBTB

- Vroege activatie septum/RV
- Late activatie lateraal

CRT

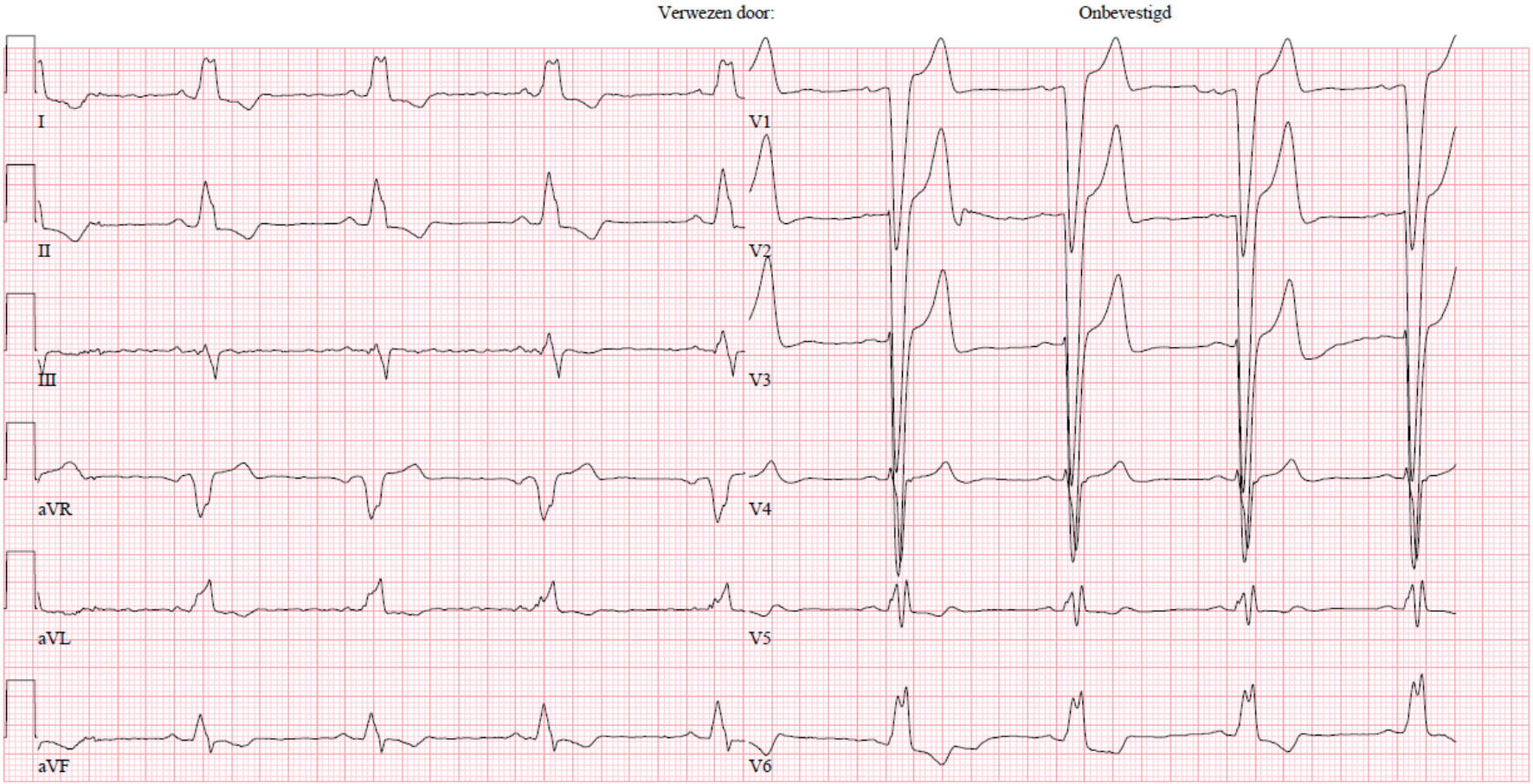
- Meer synchrone activatie lateraal/septum/RV





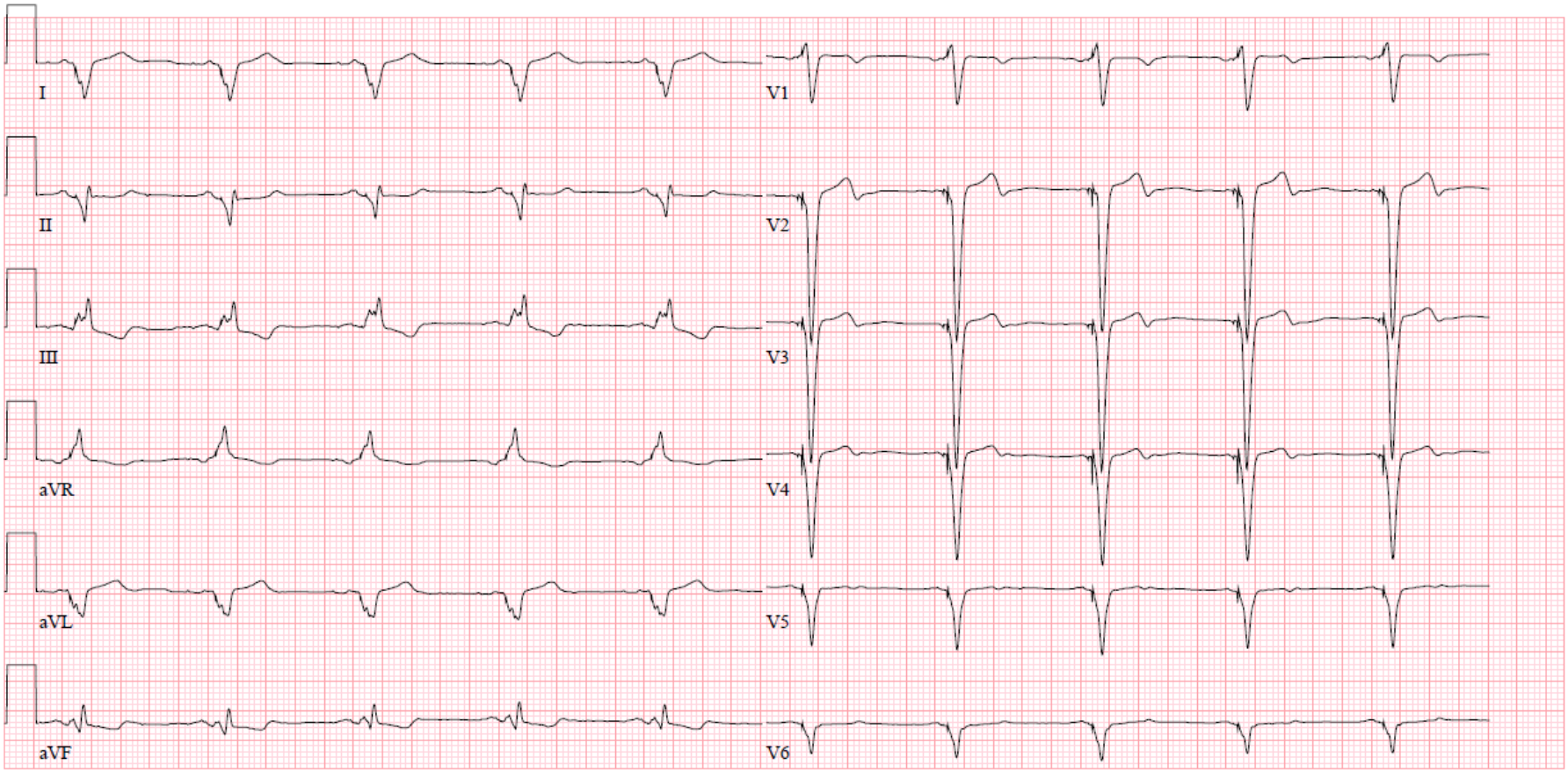
Wat wil je zien ná implantatie?

- Man, 68 jaar
- Non-iCMP
- LVEF 28%
- Dyssynchronie op echo cor

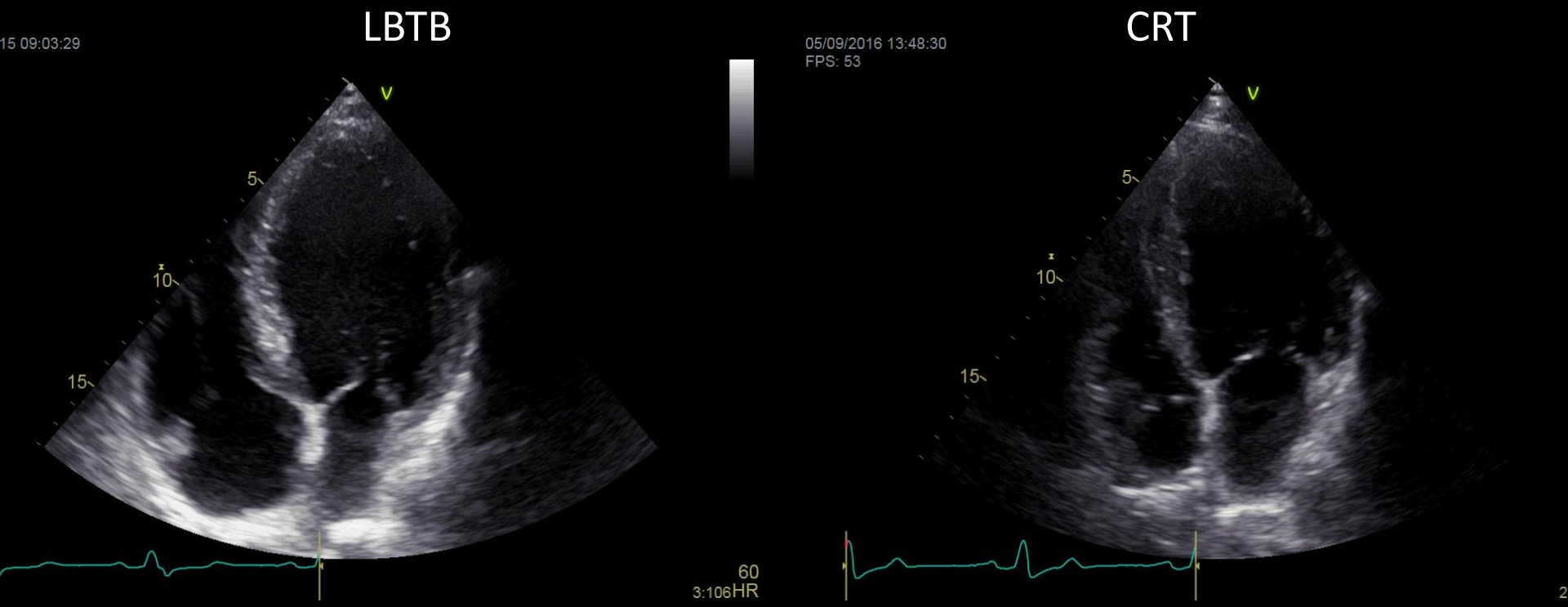


ECG Post-implantatie

- Man, 68 jaar
- Non-iCMP
- LVEF 28%
- Dyssynchronie op echo cor

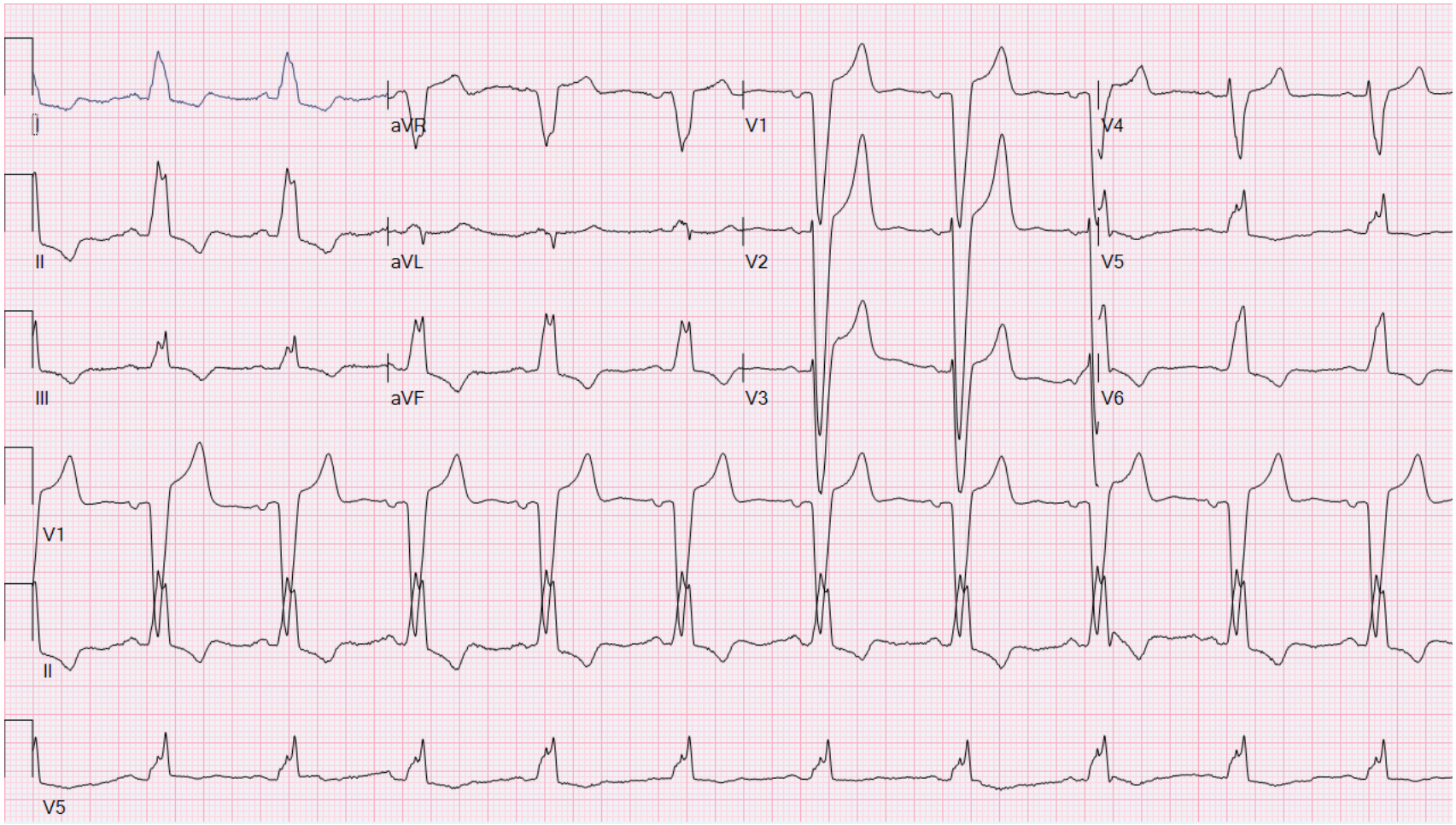


LBTB vs. CRT


LBTB
15 09:03:29
V
5
10
15
60
3:106HR
CRT
05/09/2016 13:48:30
FPS: 53
V
5
10
15

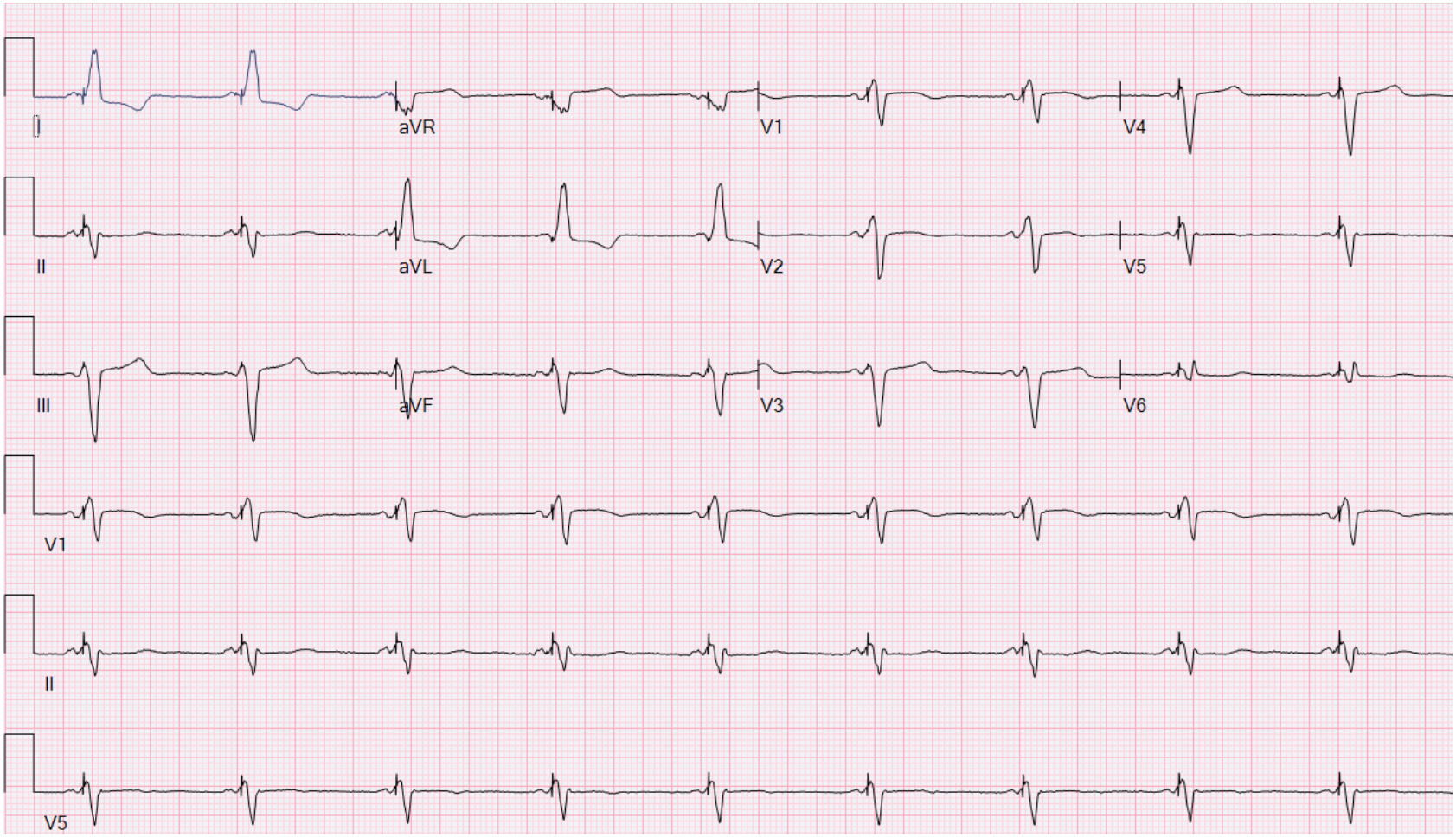
Wat wil je zien ná implantatie?

- Vrouw, 75 jaar
- dCMP
- LVEF 16%
- Dyssynchronie op echo cor



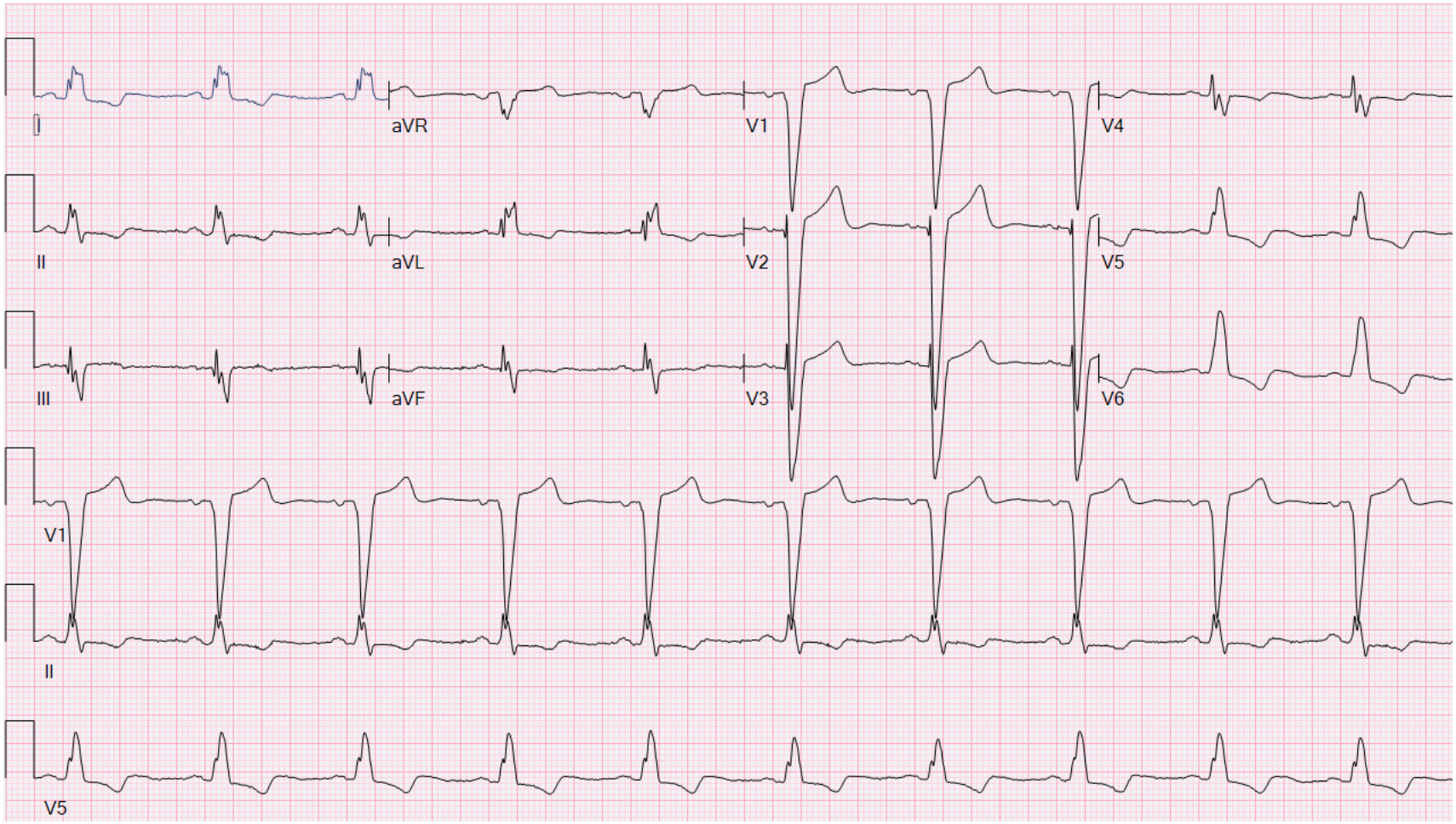
ECG Post-implantatie

- Vrouw, 75 jaar
- dCMP
- LVEF 16%
- Dyssynchronie op echo cor



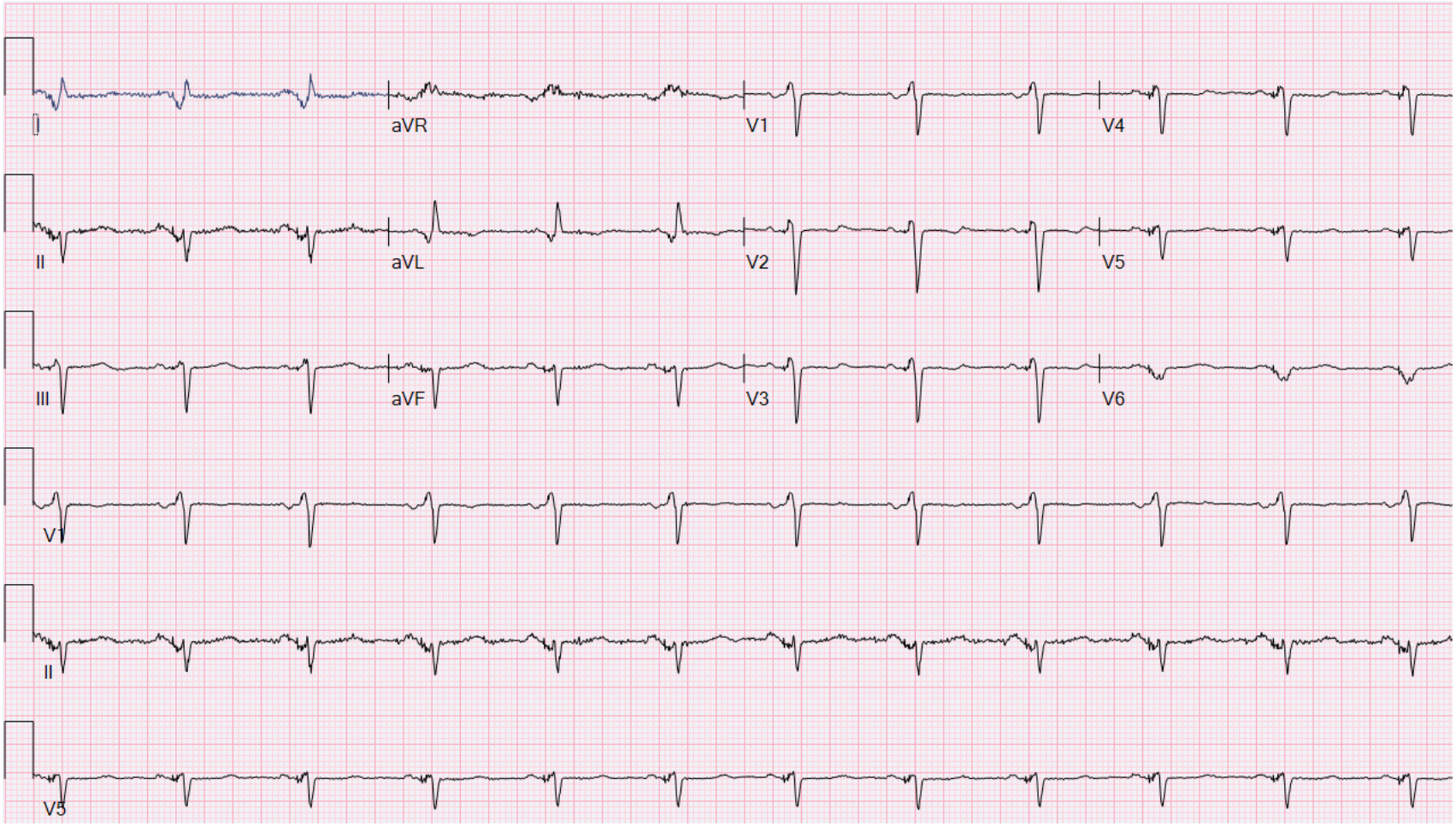
Wat wil je zien ná implantatie?

- Vrouw, 70 jaar
- iCMP
- LVEF 29%
- Dyssynchronie op echo cor



ECG Post-implantatie

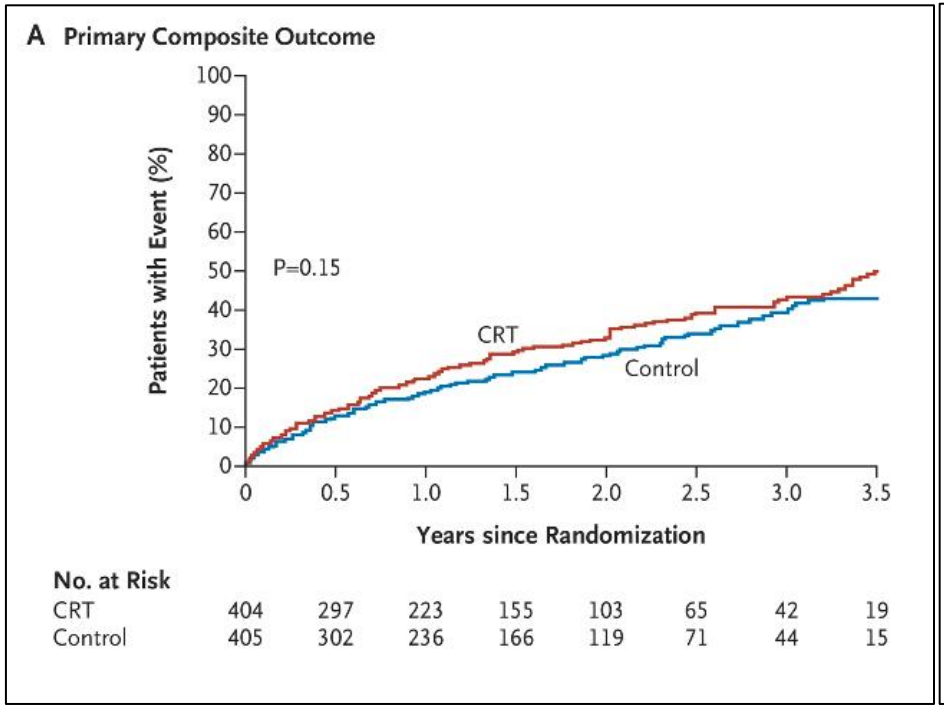
- Vrouw, 70 jaar
- iCMP
- LVEF 29%
- Dyssynchronie op echo cor

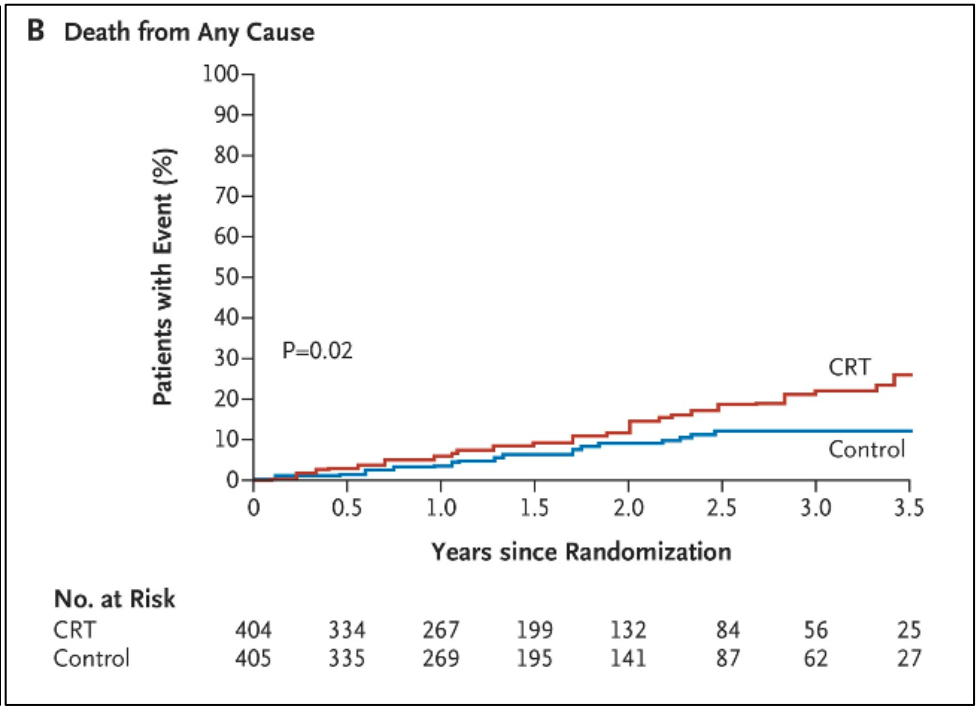


CRT bij smal QRS?

EchoCRT Study:

NYHA III or IV, LVEF ≤ 35%, indication for ICD, OMT, QRS ≤ 130 msec, LVEDD ≥ 55 mm, echocardiographic evidence of left ventricular dyssynchrony

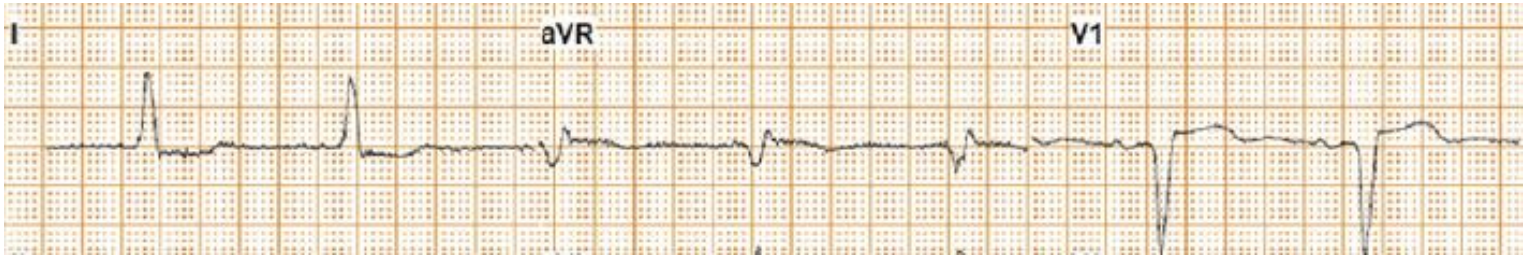




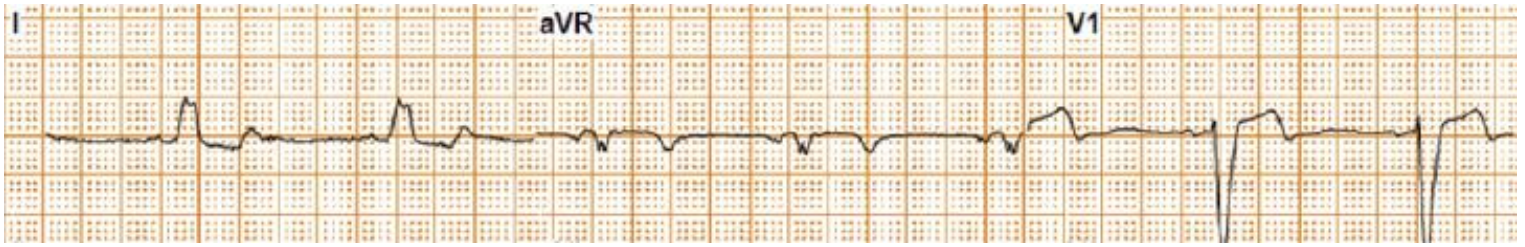
Sogaard M.D. ea. N Engl J Med 2013

Welke is het echte LBTB?

a.



b.



c.

d.