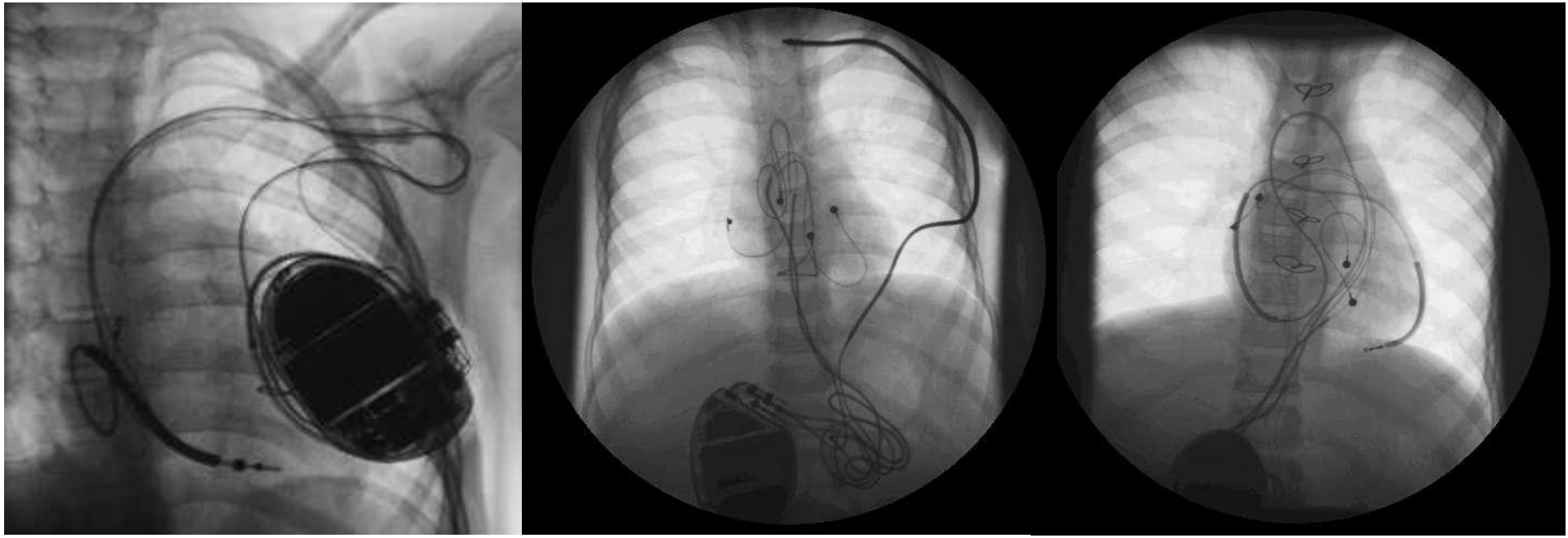
Pacemakers in congenital heart disease patients

Roman Gebauer

HERZZENTRUM
LEIPZIG

ICD/pacemaker in children



The experience in children is compare to adults still limited and accounts for less than 1% of all implanted devices

Pacing in CHD patients

- heterogenous group of heart defects
- uni-, biventricular physiology
- morphology of SV

simple recommendation/solution for pacing is not possible!

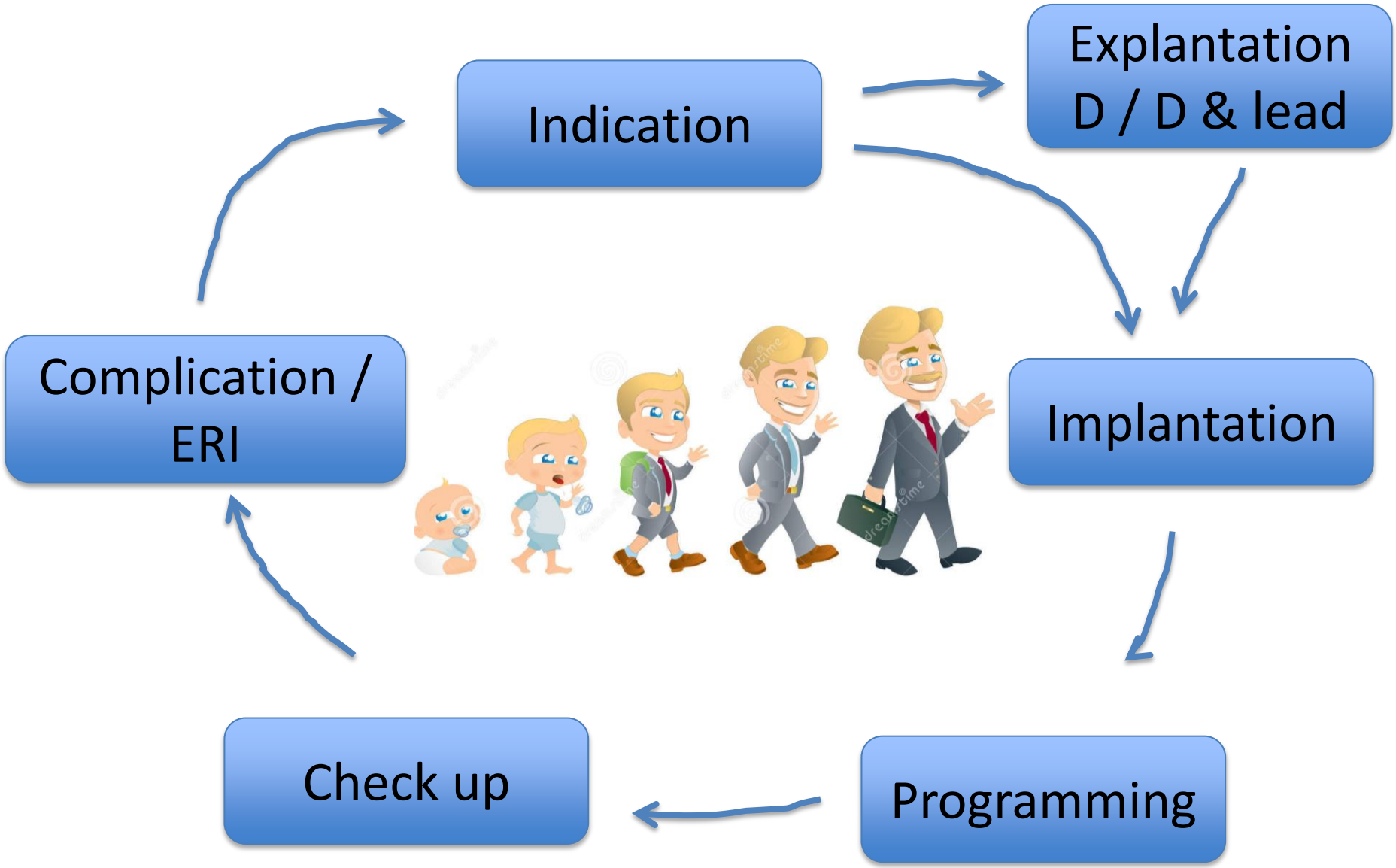
- ✓undefined
- variety of conduction system anatomy
  - ✓density of Punkinje fibers
  - ✓spontaneous conduction delay

CARDIAC PACING

- Appropriate HR
- Improvement of hemodynamics
  - ✓ Restoration of AV synchrony
  - ✓ Correction of intraventricular dyssynchrony
- Prevention of tachyarrythmias
- others …

- Pacing induced ventricular dyssynchrony
- Device/lead related complications/reoperations
  - ✓ Lead fracture
  - ✓ Thrombosis
  - ✓ Infection
  - ✓ Battery depletion
- …

Pacemaker's "Life-cycle"



Indication

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lack of prospective randomized studies

marked heterogeneity of the patients group

Society (PACES) and the Heart Rhythm Society (HRS). Endorsed by the governing bodies of PACES, HRS, the American Academy of Pediatrics (AAP), the American Heart Association (AHA), and the Association for European Pediatric and Congenital Cardiology (AEPC)

Josep Brugada[1]*, Nico Blom[2], Georgia Sarquella-Brugada[3], Carina Blomstrom-Lundqvist[4], John Deanfield[5], Jan Janousek[6], Dominic Abrams[7], Urs Bauersfeld[8†], Ramon Brugada[9], Fabrizio Drago[10], Natasja de Groot[11], Juha-Matti Happonen[12], Joachim Hebe[13], Siew Yen Ho[14], Eloi Marijon[15], Thomas Paul[16], Jean-Pierre Pfammatter[17], and Eric Rosenthal[18]

European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA).

Implantation

How?

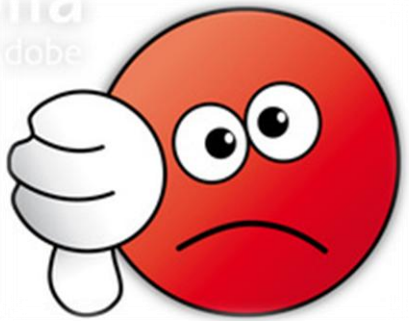
What?

Where?

Endocardial or Epicardial ???

- "easy" to implant in normal anatomy
- cosmetic factor
- lead potential adapt to growth

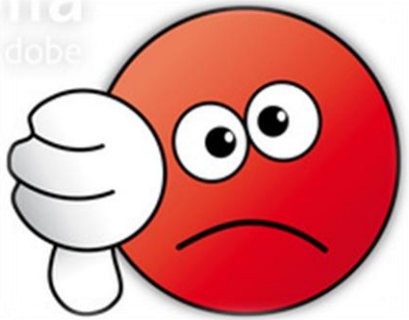
ENDOCARDIAL PACE



- "hard" to explant
- limited venous access to the heart (life long pacing)
- "optimal" pacing site not known
- venous occlusion
- thromboembolism
- IE
- AV valve damage

- in CHD pts without venous access to the heart
- "optimal" pacing site well defined (normal heart)
- mini-invasive implantation possible
- …

EPICARDIAL PACE



- partial sternotomy/thoracotomy
- risk of heart strangulation/coronary compression caused by growth
- lead failure
- MRI incompatibility

Cardiac pacing in paediatric patients with congenital heart defects: transvenous or epicardial?

Massimo Stefano Silvetti[1]*, Fabrizio Drago[1], Duccio Di Carlo[2], Silvia Placidi[1], Gianluca Brancaccio[2], and Adriano Carotti[2]

- Retrospective analysis, single center, 1982 - 2008
- 287 pts with CHD, median age 5 yrs
- Indication for pacing: SND & CAVB
- ≥ 1 heart surgery in 97%
- Endocardial in 117, epicardial in 170 pts
- Follow-up (median) 5 years
- Failure of pacing system in 29% pts

13% Endo vs 40% Epi (p=0.0001)

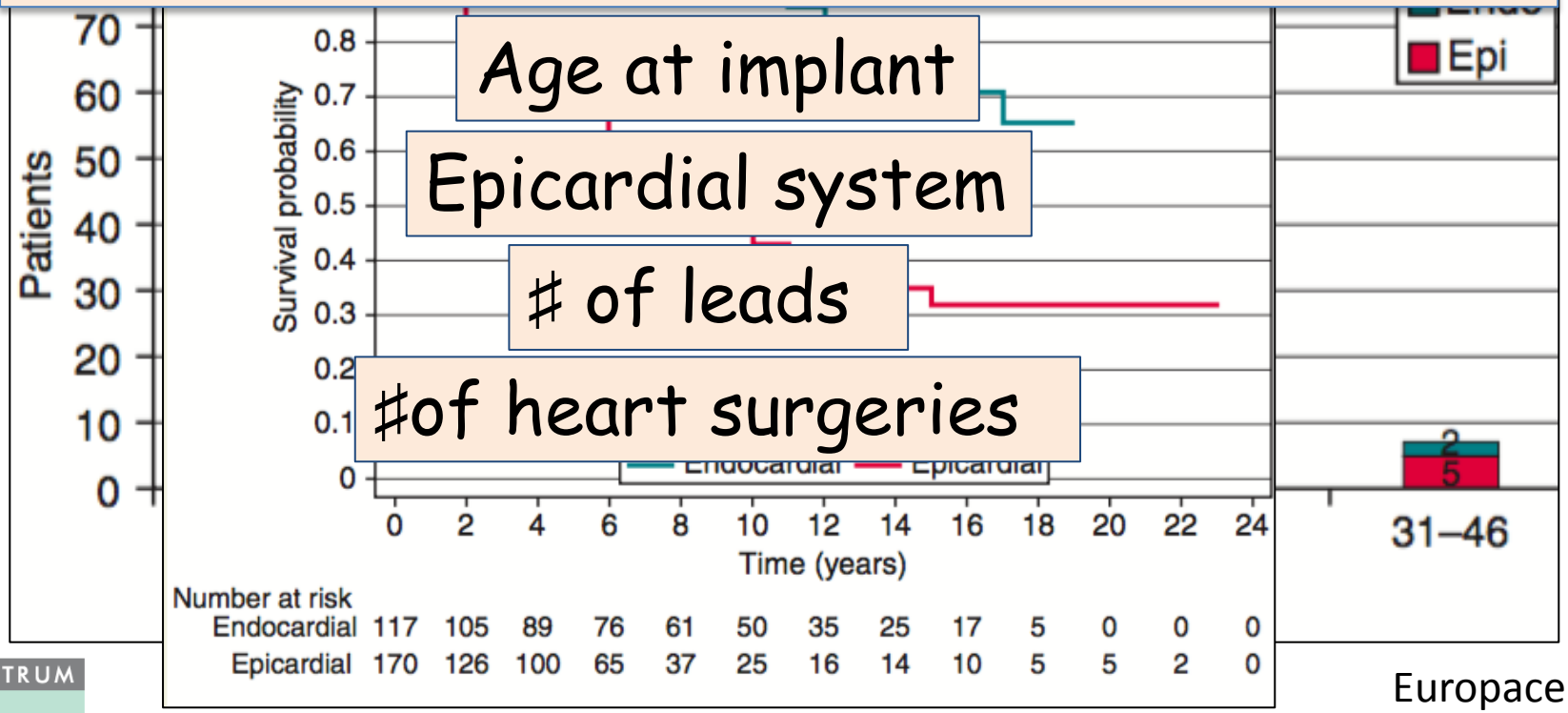
Europace 2013

Cardiac pacing in paediatric patients with congenital heart defects: transvenous or epicardial?

Massimo Stefano Silvetti[1]*, Fabrizio Drago[1], Duccio Di Carlo[2], Silvia Placidi[1], Gianluca Brancaccio[2], and Adriano Carotti[2]

Risk factors for failure of pacing system?

- Age at implant
- Epicardial system
- # of leads
- #of heart surgeries



Europace 2013

Original Article

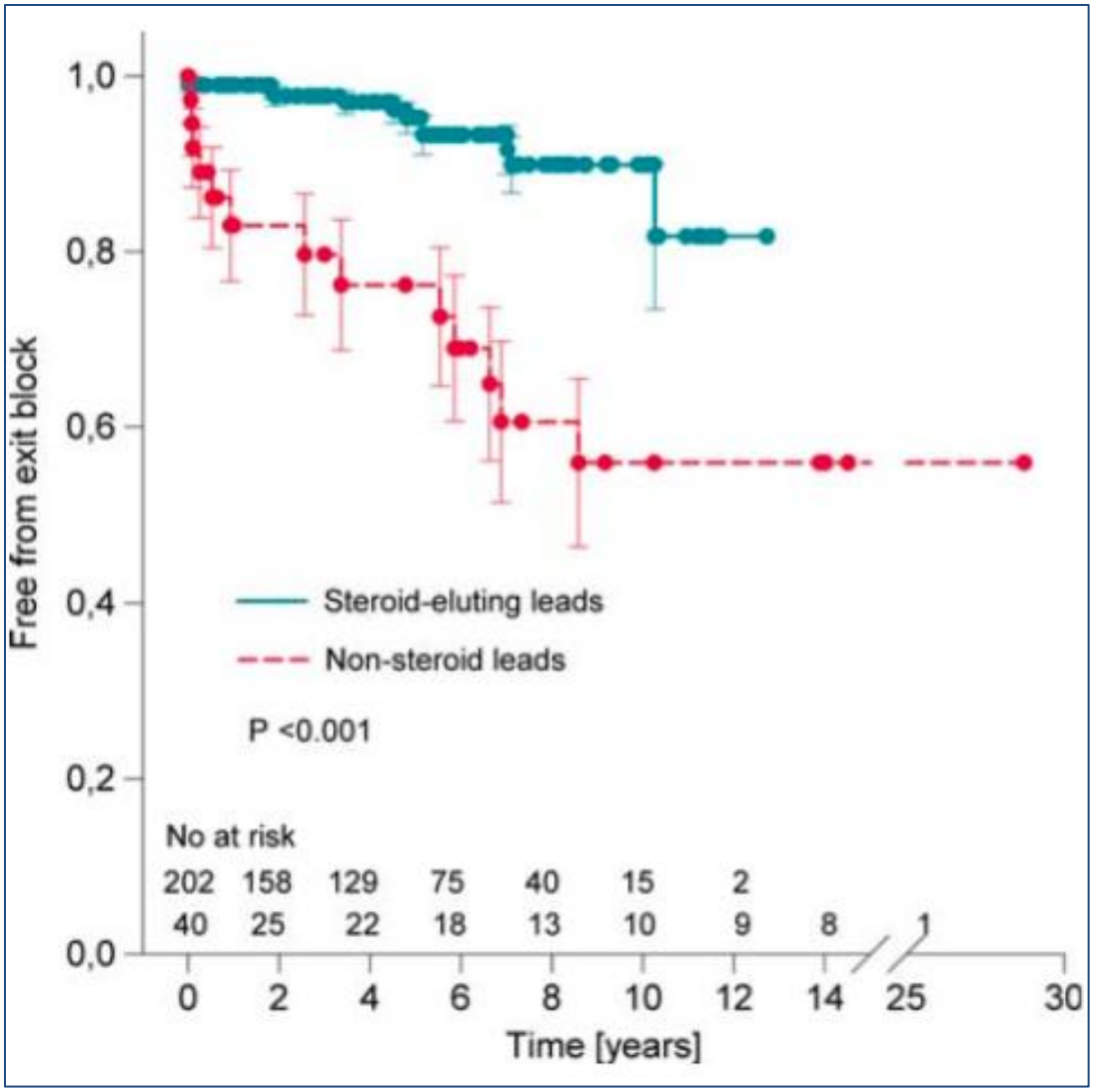
Twenty-Seven Years Experience With Transvenous Pacemaker Implantation in Children Weighing <10 kg

Laura Konta, MD, PhD; Mark Henry Chubb, MBBS, MA, MRCP, MRCPCH;
Julian Bostock, PhD; Jan Rogers, HNC; Eric Rosenthal, MD, FRCP

- Single center, 37 neonates and infants (1987 - 2003)
- Median age 6.7 months, weight 4.6 kg at implantation
- Follow-up median 17.2 yrs (in 28 pts)
- Subclavian vein occlusion
  - ✓ pts. < 5 kg: in 10 / 13 (77%)
  - ✓ pts. > 5 kg: in 2 / 13 (15%)

Circ Arrhythm Electrophysiol. 2016

The lead -
"Achilles heel" of the pacing system



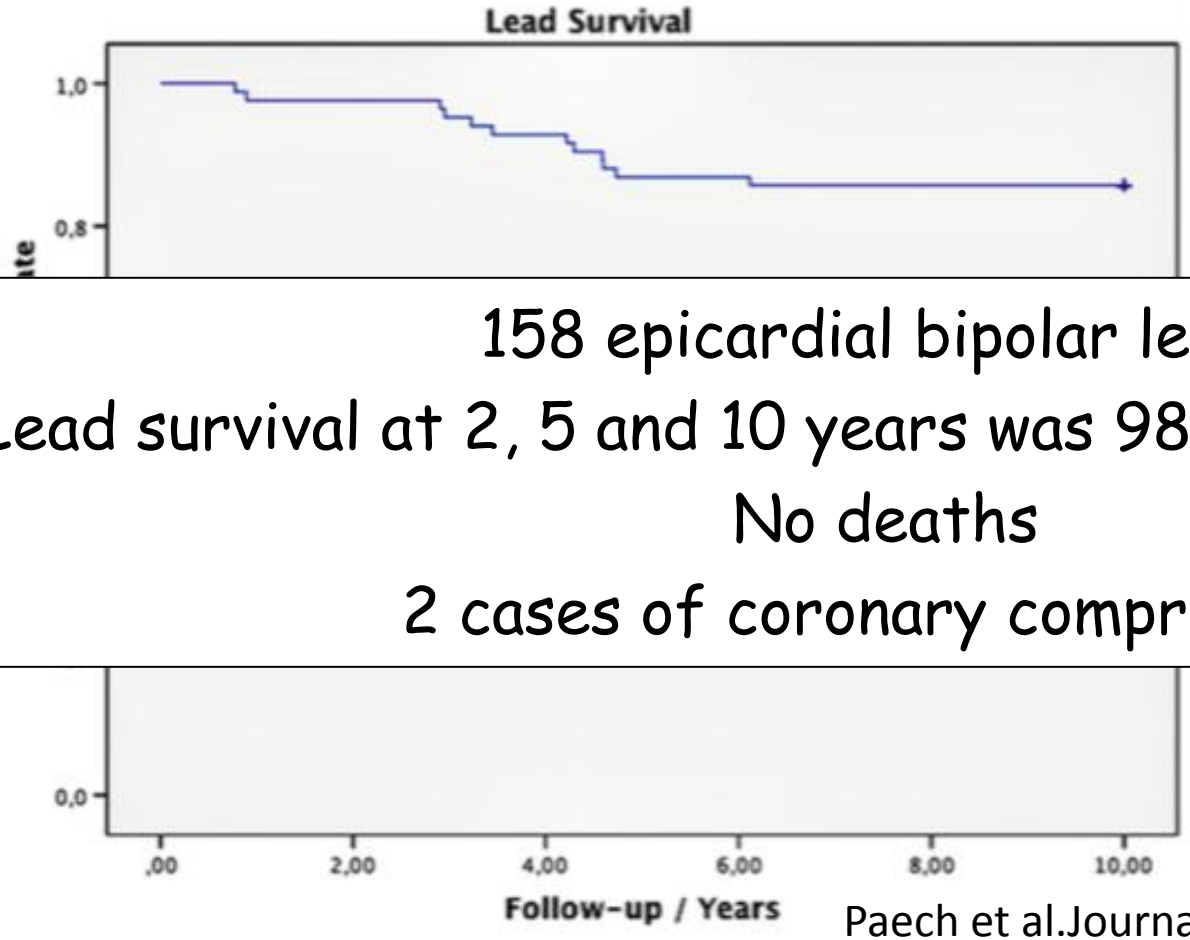
Risk factors for lead failure

- ✓ **Unipolar lead** (HR=2,7, p<0,001)
- ✓ **Height at the time of implantation** (HR 0.81, P=0.028 per each 10 cm increment)

Kubuš P et al. Europace 2011

RESEARCH ARTICLE Open Access

Performance of steroid eluting bipolar epicardial leads in pediatric and congenital heart disease patients: 15 years of single center experience



158 epicardial bipolar leads

Lead survival at 2, 5 and 10 years was 98.7%, 93% and 92.4%

No deaths

2 cases of coronary compression

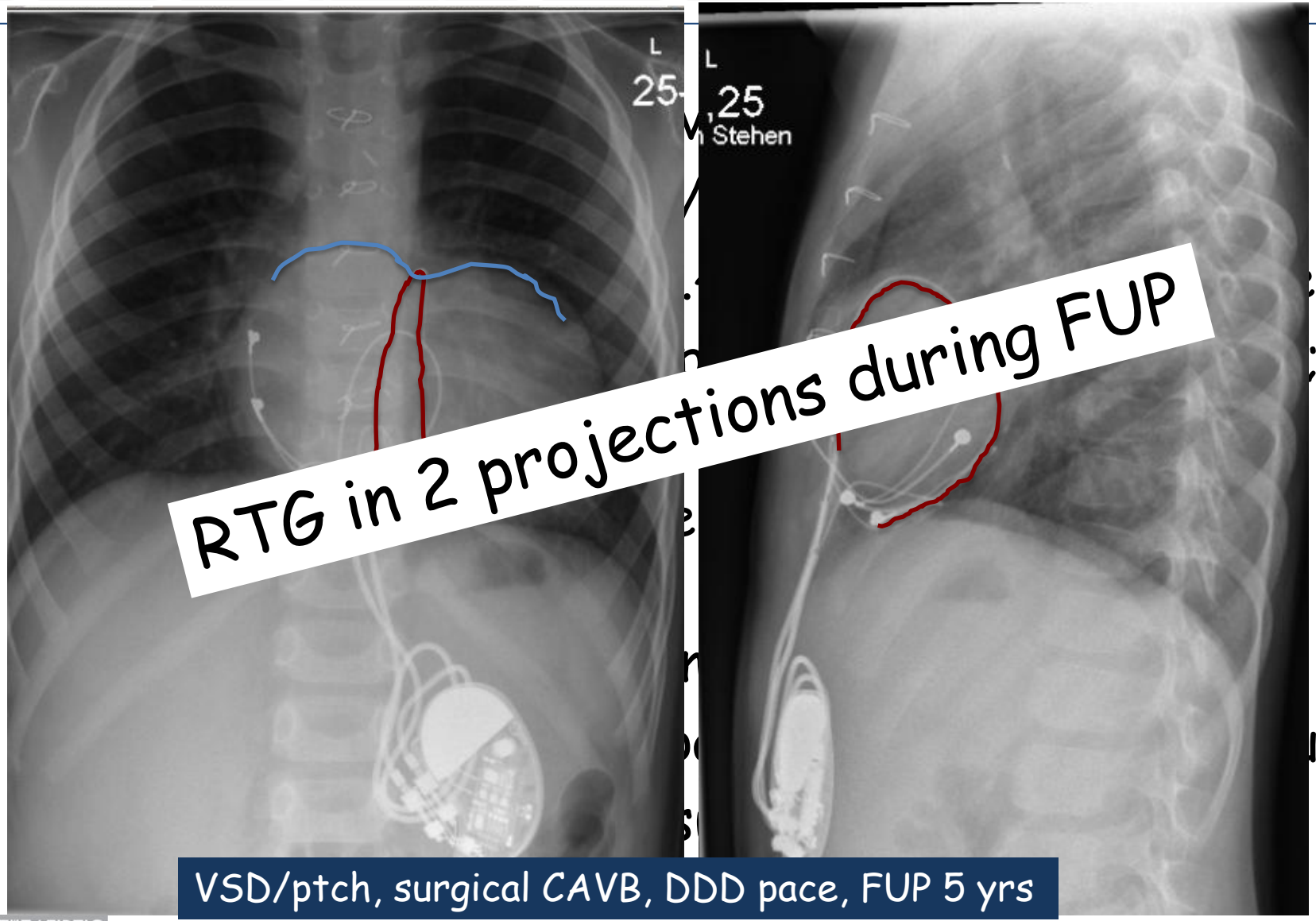
Paech et al.Journal of Cardiothoracic Surgery 2014

Heart Rhythm. 2018 Oct;15(10):1439-1447. doi: 10.1016/j.hrthm.2018.06.038. Epub 2018 Aug 13.

Coronary artery compression from epicardial leads: More common than we think.

Mah DY[1], Prakash A[2], Porras D[2], Fynn-Thompson F[3], DeWitt ES[2], Banka P[2].

- ars)
- e).



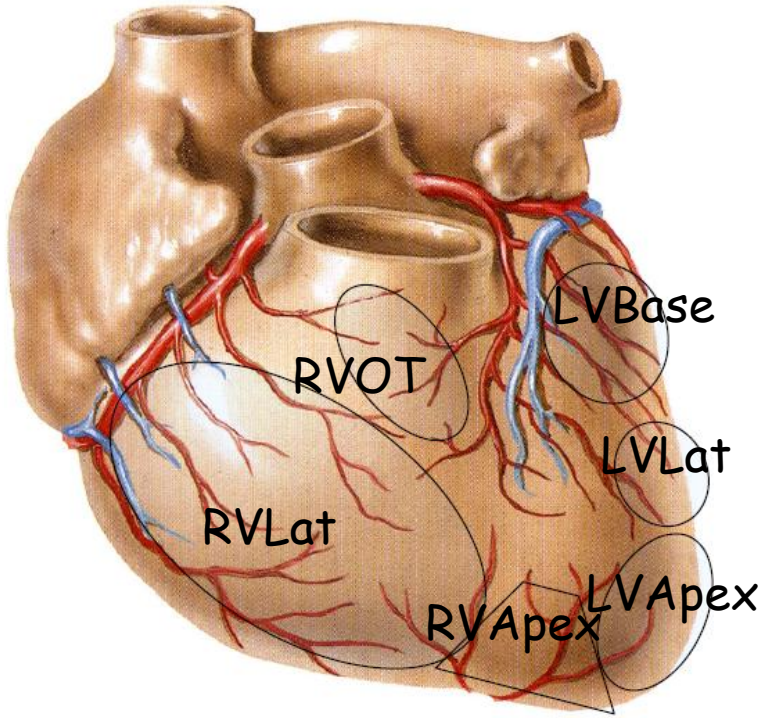
RTG in 2 projections during FUP

VSD/ptch, surgical CAVB, DDD pace, FUP 5 yrs

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association®

Permanent Cardiac Pacing in Children - Choosing the Optimal Pacing Site: A Multi-Center Study

- Cross-sectional study (N=178, 21 centers)
  - ✓CAVB, structurally normal heart
  - ✓Initially normal LVEF
  - ✓Pacing sites (pts)
    - ✓RV
      - RVOT (8), RV lat (44)
      - RVA (61), RV Septum (29)
    - ✓LV
      - LVA (12), LV lat (17)
      - LV Base (7)
  - ✓ Pacing duration 5.4 yrs



Janoušek et al. Circulation 2013

Circulation
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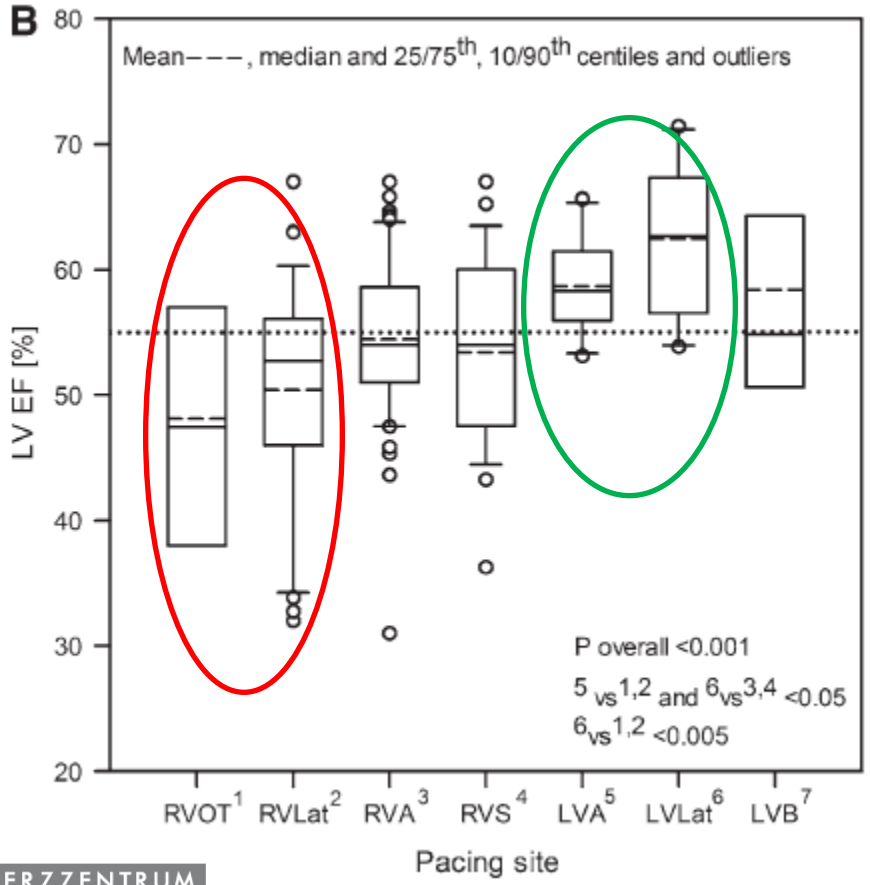
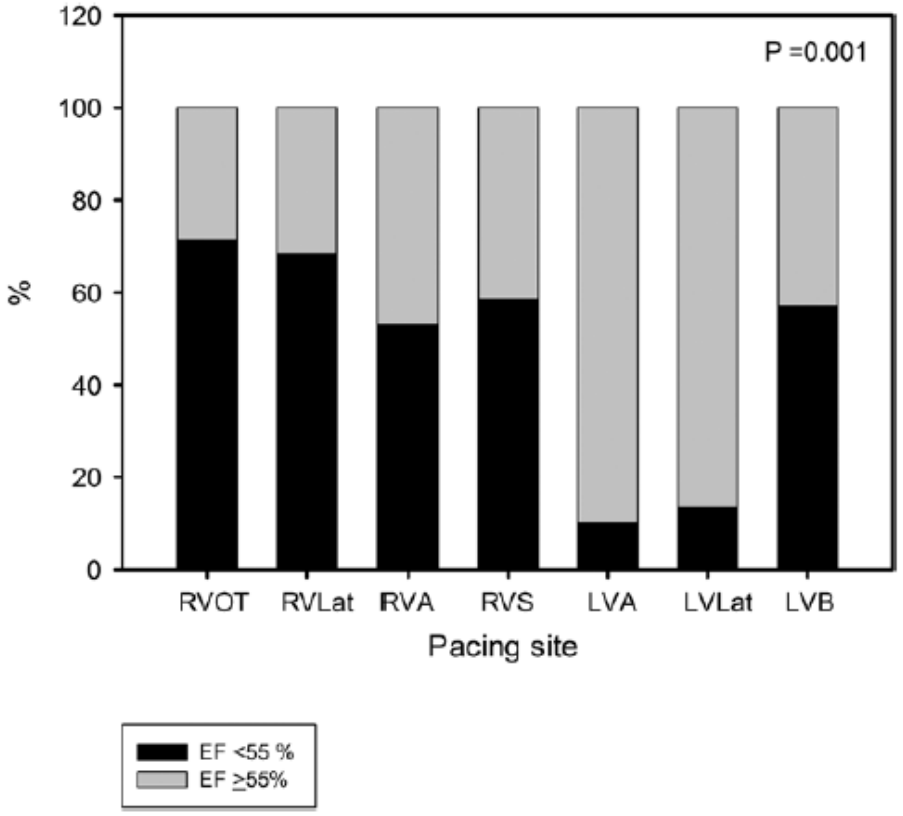
Permanent Cardiac Pacing in Children - Choosing the Optimal Pacing Site: A Multi-Center Study

LV ejection fraction at follow-up



Proportion of pts with LVEF<55 %



Janoušek et al. Circulation 2013

Circulation
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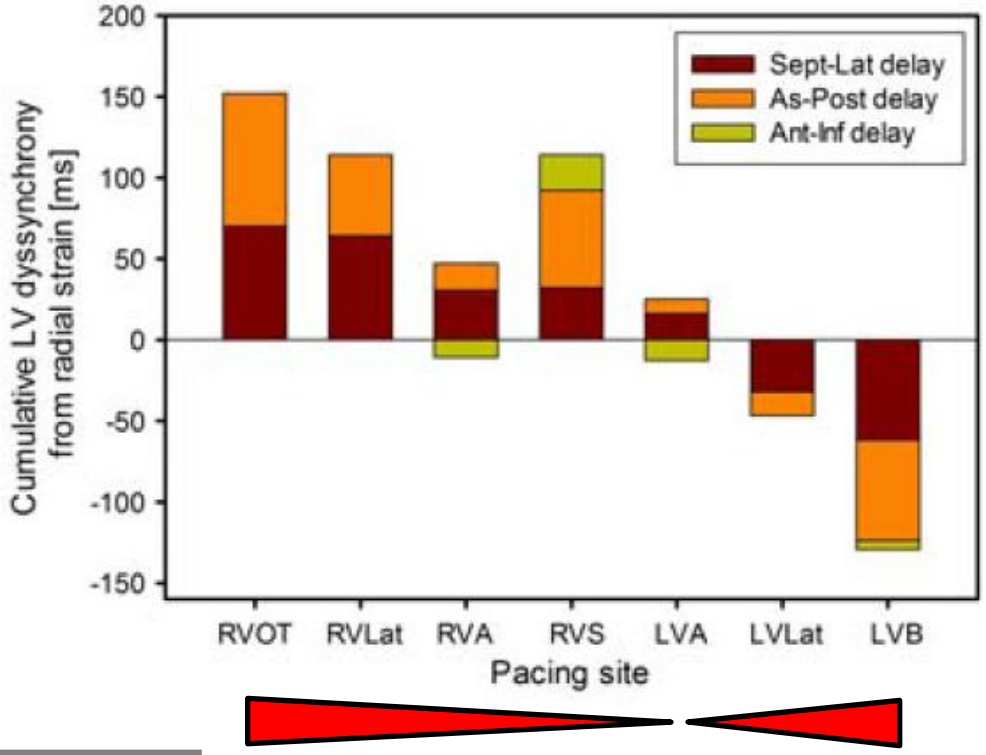
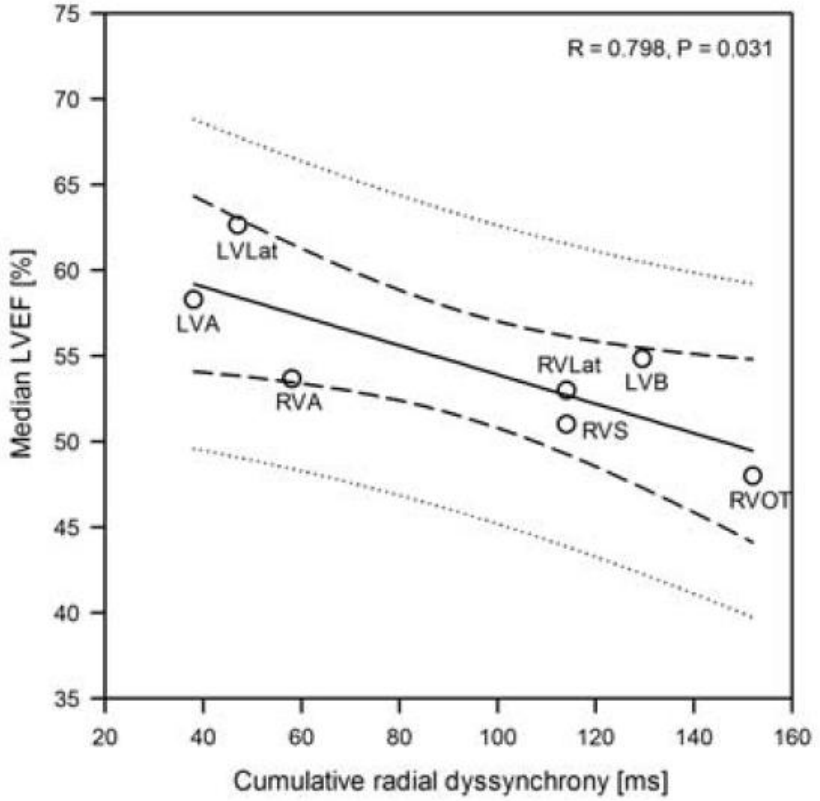
Permanent Cardiac Pacing in Children - Choosing the Optimal Pacing Site: A Multi-Center Study

Prevent conventional pacing associated cardiomyopathy by placement of the ventricular leads on LVA or LVlat wall

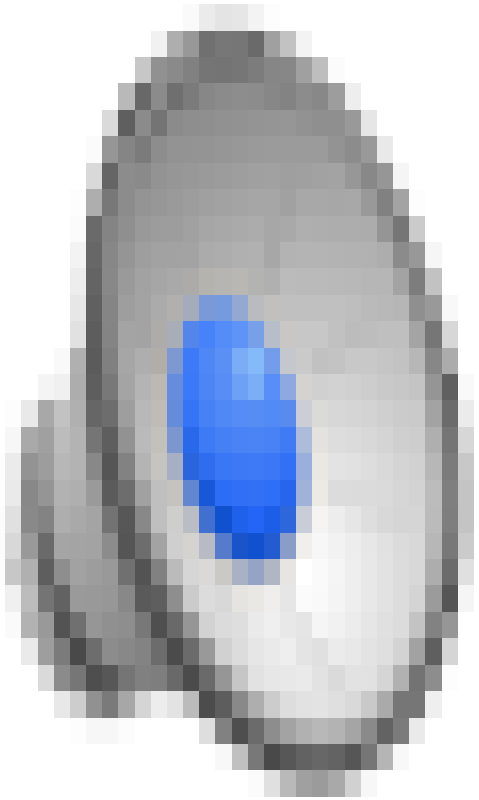
Cumulative LV dyssynchrony (from radial strain)



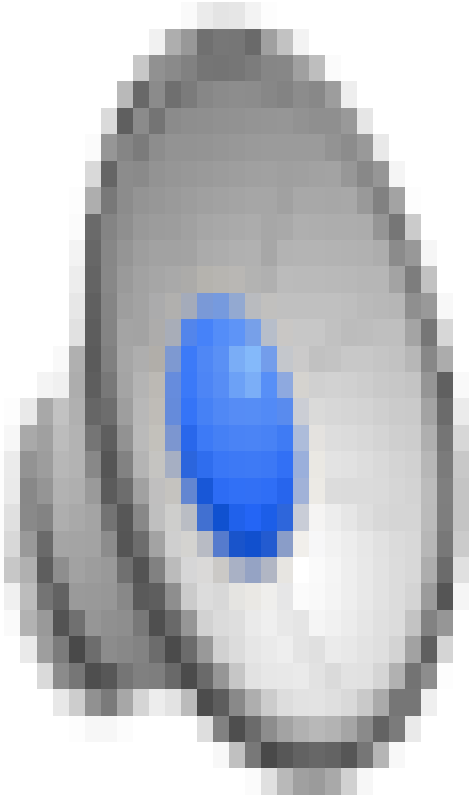
LVEF vs LV dyssynchrony



Janoušek et al. Circulation 2013



Dg. VSD, LVOTO, COA
1. COA/RES (11/2012)
2. Konno OP, VSD/ptch, surg. CAVB, VVIR PM implant. (06/2015)

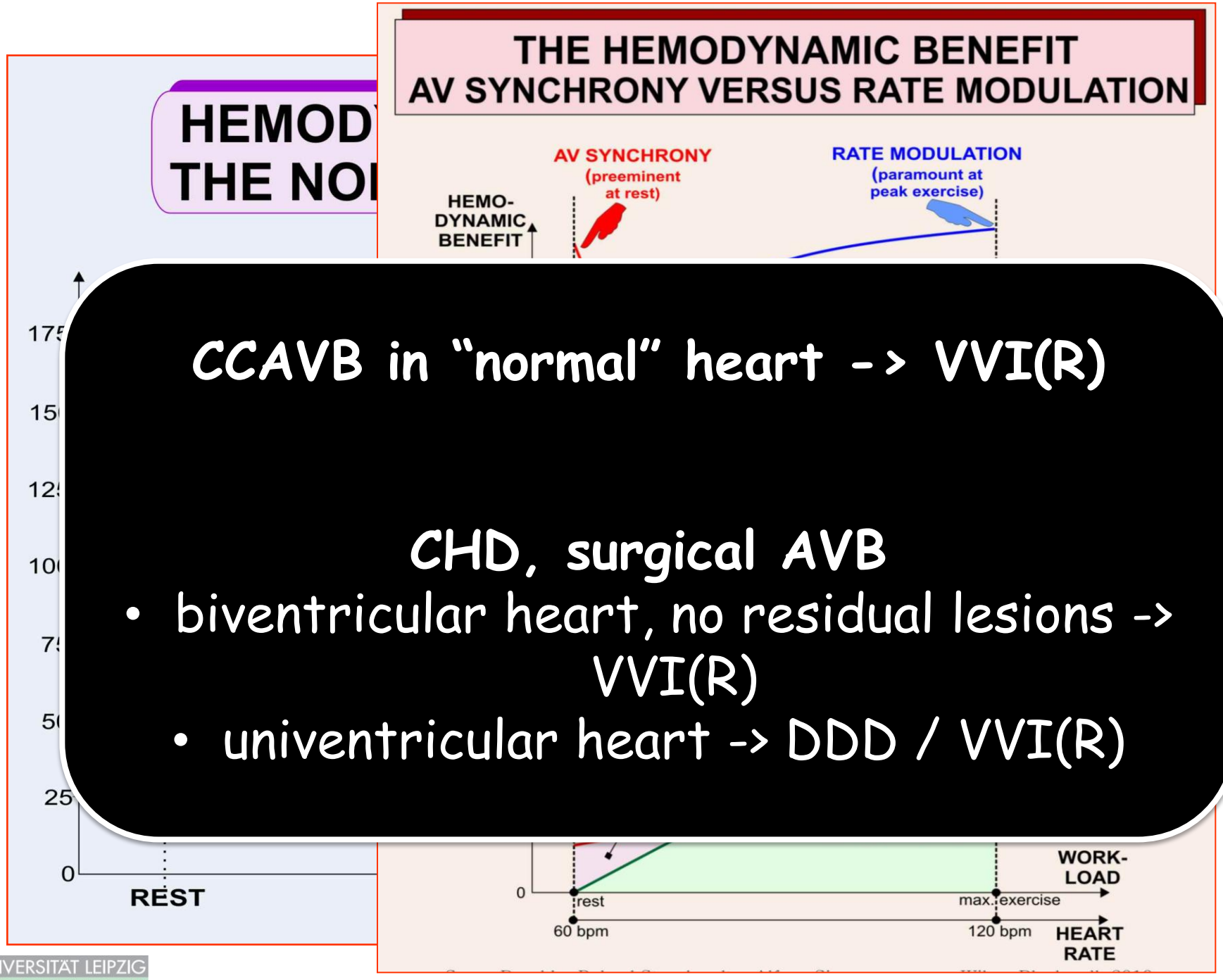


Dg. VSD, LVOTO, COA
1. COA/RES (11/2012)
2. Konno OP, VSD/ptch, surg. CAVB, VVIR PM implant. (06/2015)

DDD or VVI Pacemaker…?

fewer leads implanted

fewer complications


THE HEMODYNAMIC BENEFIT
AV SYNCHRONY VERSUS RATE MODULATION
AV SYNCHRONY
(preeminent
at rest)
RATE MODULATION
(paramount at
peak exercise)
HEMO-
DYNAMIC
BENEFIT
CCAVB in "normal" heart -> VVI(R)
CHD, surgical AVB
• biventricular heart, no residual lesions -> VVI(R)
• univentricular heart -> DDD / VVI(R)
175
150
125
100
75
50
25
0
REST
WORK-
LOAD
0
rest
max. exercise
60 bpm
120 bpm
HEART
RATE

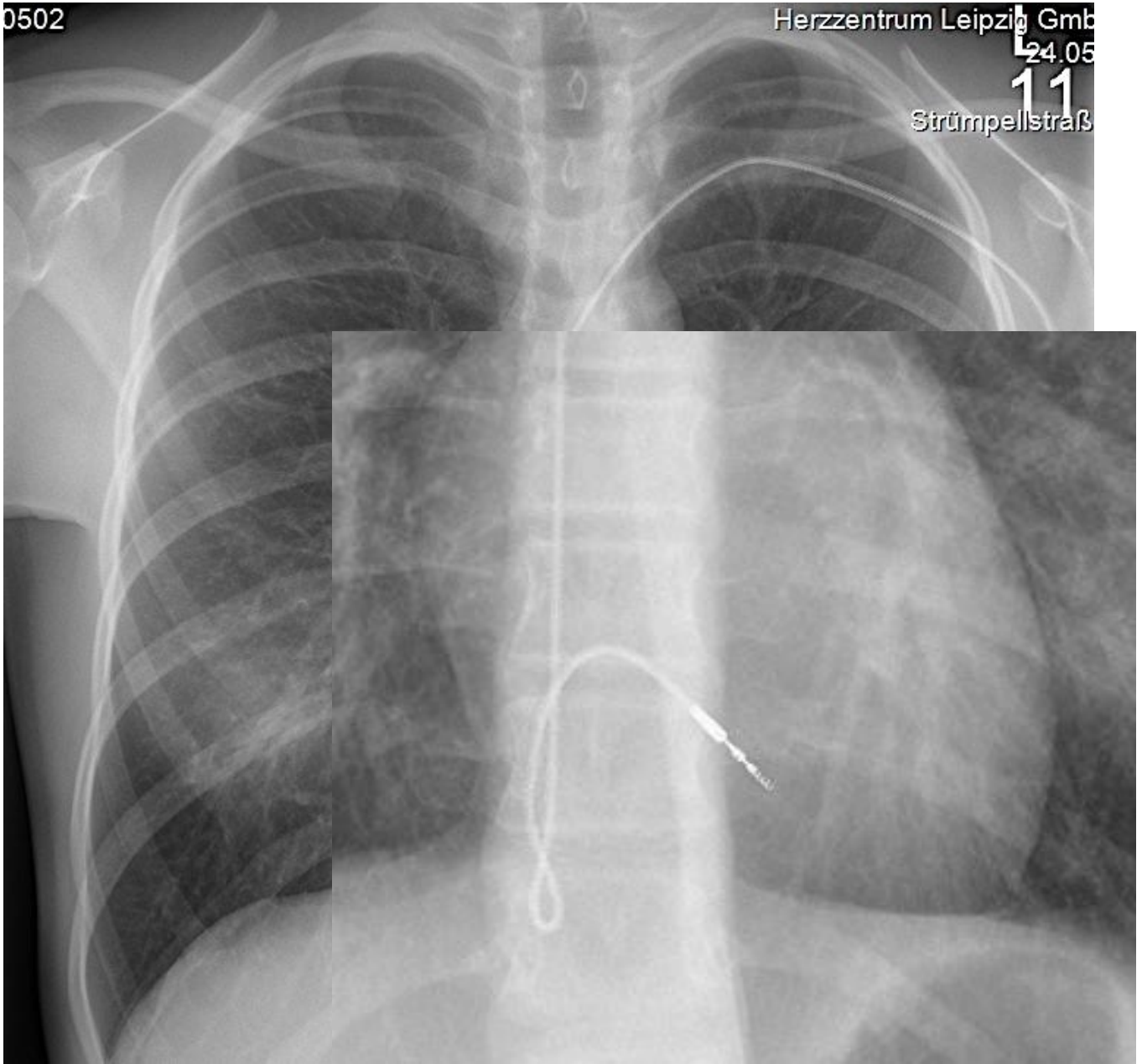
Pacemaker programming

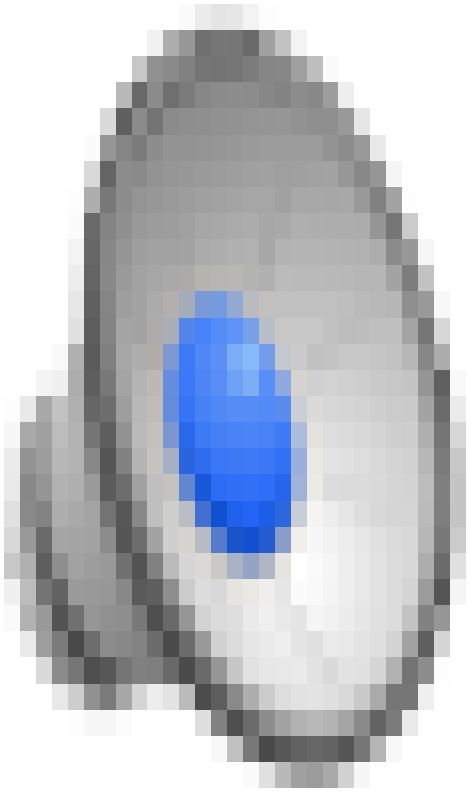
- Pacing rate
  - ✓ R mode
  - ✓ High maximal tracking rate in DDD
- Reduction of ventricular pacing
  - ✓ Fixed long AV delay
  - ✓ AV search hysteresis
  - ✓ Managed ventricular pacing
- Capture Management
  - ✓ Battery longevity

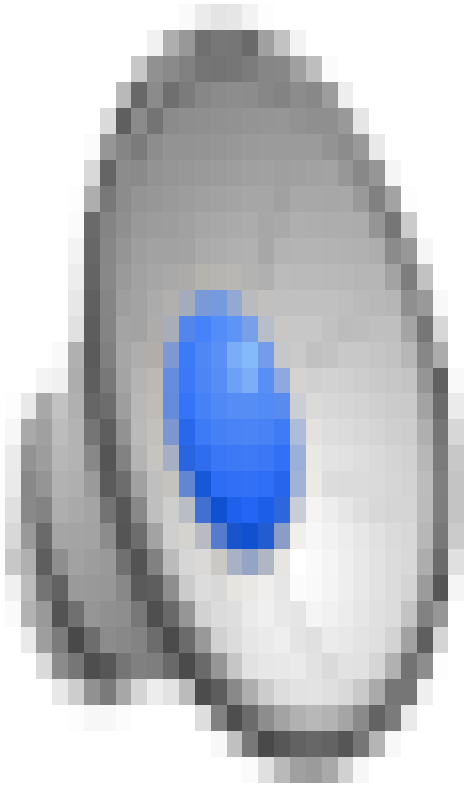
Lead extraction

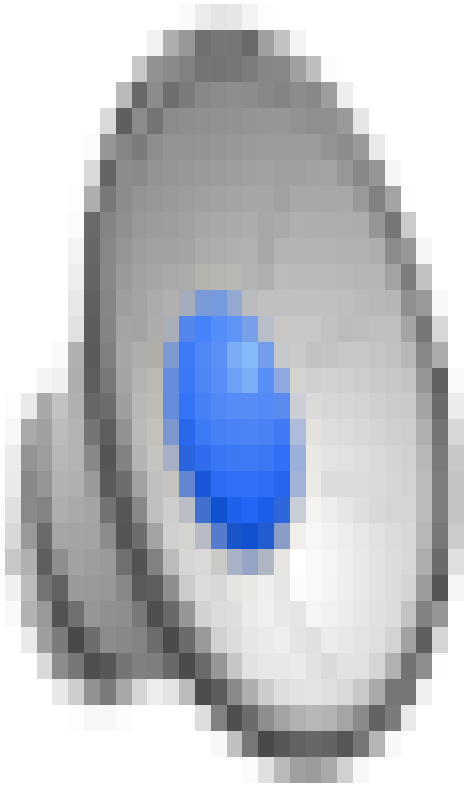
- be prepare for everything!
- surgery on call
- venous & arterial access in the groin
- additional wire(s) in SVC
- balloon catheter in OR
- …

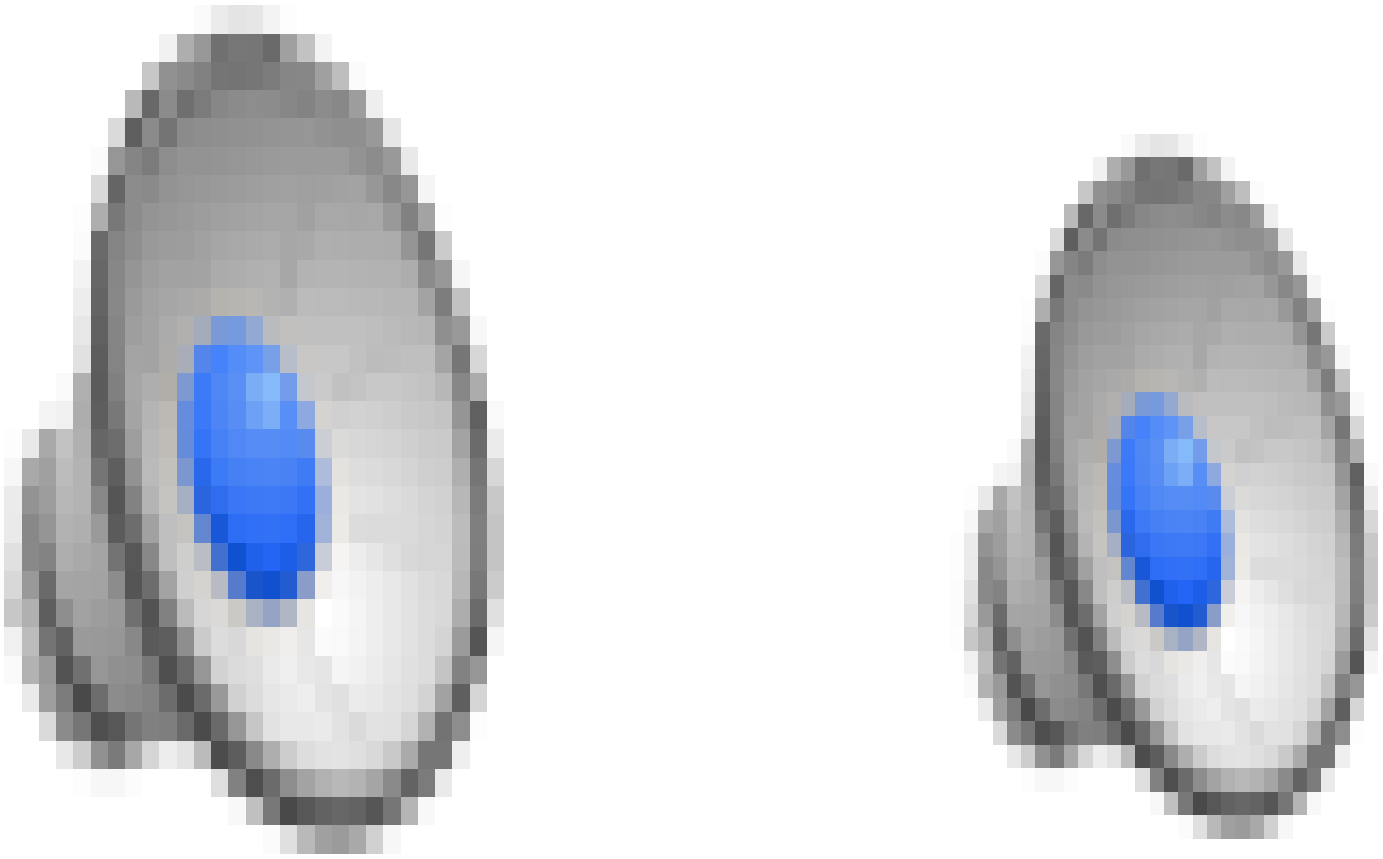
10 yrs. old, VVI pace at age of 2 yrs for asystole (another institution), ERI, lead malfunction, mild IVC obstruction (echo)

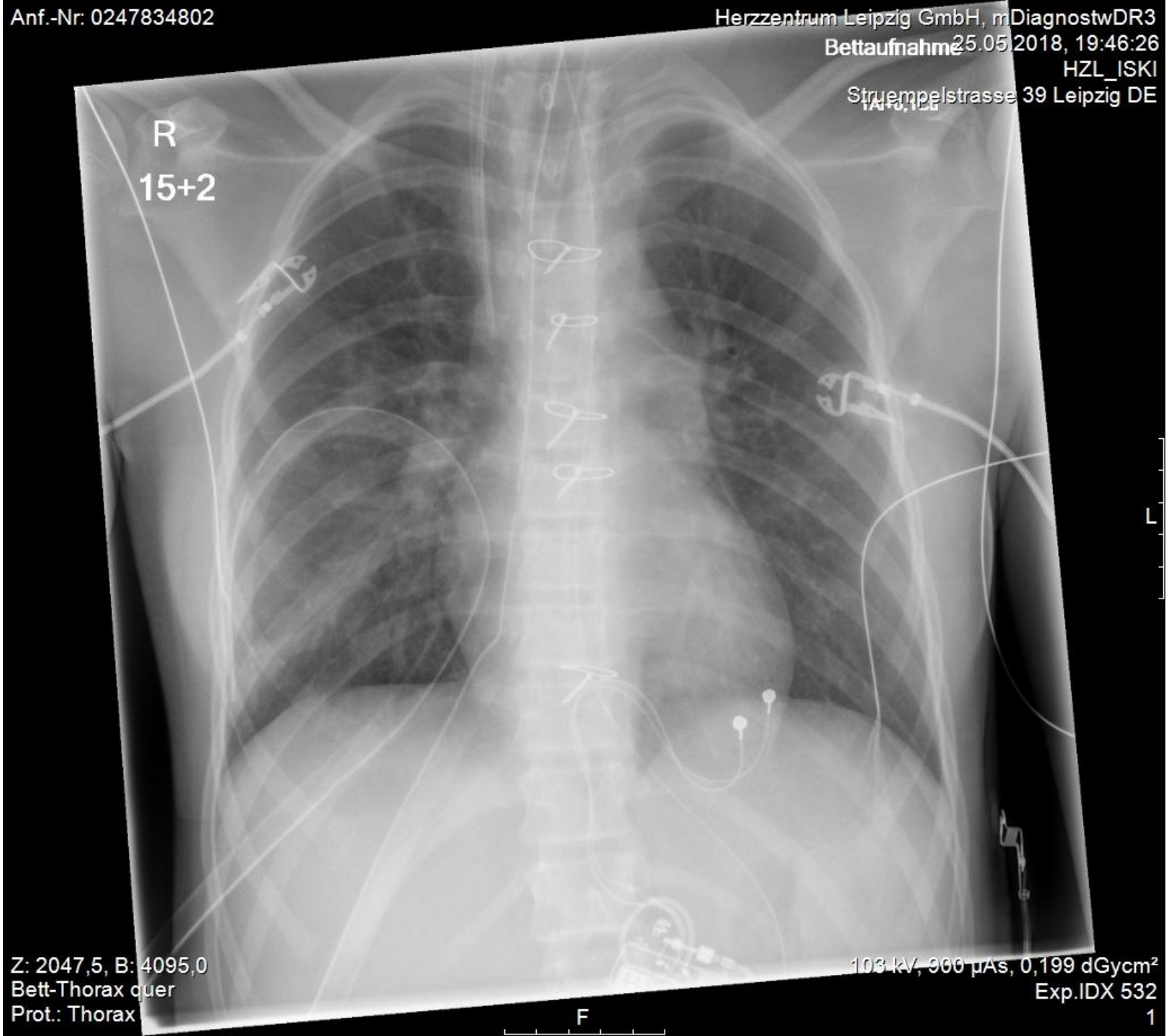








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Summary

- "to be paced" can be dangerou
  indication first ☺
- Endo vs Epi -> "*do this what you are familiar with & think over decades!*"
- keep it easy ☺
- if you implant endocardial lead, be prepare to extract it!!
- look at site with minimal "dyssynchrony potential" -> LVA, LV lat. wall


Thank you for attention!