CMR imaging to study biventricular pacing effects on the right ventricle in left bundle branch block patients

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Background: Cardiac resynchronization therapy (CRT) is an established treatment strategy for selected patients with symptomatic heart failure, left ventricular (LV) systolic dysfunction, and a left bundle branch block conduction abnormality. The effect of CRT on right ventricular (RV) function and possible reverse remodeling however, is less well understood and conflicting data are present. Moreover, the difficulty to accurately measure RV hemodynamics non-invasively may also hamper research on RV function in CRT patients.

Recent development of cardiac magnetic resonance (CMR) conditional CRT-devices allows for proper patient follow-up as BIV-pacing can be performed during the CMR exam. Therefore, this study assesses the effects of BIV-pacing on change in RV volumes and function using CMR.

Methods: Ten patients eligible for CRT-D implantation according to the ESC guidelines were prospectively enrolled in this study. All patients underwent CMR imaging at baseline including cine imaging for volume and function assessment. Six weeks after CRT-D implantation, patients received a follow-up CMR scan which consisted of a two-staged imaging protocol. First, patients were scanned during BIV-pacing and thereafter the CRT was turned off and patients were scanned during intrinsic rhythm. RV end systolic volume (ESV), end diastolic volume (EDV), and ejection fraction (RVEF) were assessed on cine images. RV volumes and function before and after device implantation are compared using paired samples T-tests and results are displayed in the figure.

Results: RV ESV, EDV, and RVEF were not different at CRT-on as compared to baseline (ESV: 94.0±20.3ml vs. 88.9±21.1ml, p=0.44, EDV: 182.4±29.5ml vs. 175.1±22.8ml, p=0.37, and RVEF: 48.6±6.6% vs. 49.6±8.1%, p=0.75). Also, an acute deterioration in RVEF was observed when switching CRT-off (48.6±6.6% vs. 41.1±5.7%, p=0.02). Moreover, RV function was significantly worse during CRT-off compared to baseline in terms of RVEF (41.1±5.7% vs. 49.6±8.1%, p<0.01) and higher volumes (ESV: 119.0±26.4ml vs. 88.9±21.1ml, p<0.001, EDV: 200.8±34.2ml vs. 175.1±22.8ml, p<0.01).

Conclusions: This study showed that RV hemodynamics did not benefit from CRT. Moreover, turning off CRT at follow-up had an instantaneous negative effect on RV function as compared to BIV-pacing, leading to even worse RV hemodynamics as compared to baseline measurements.
Right ventricular end systolic volume

**p < 0.001**

- ESV (ml)
  - Baseline: 100
  - CRT-on: 110
  - CRT-off: 120

**p = 0.44**

- Baseline: 150
  - CRT-on: 155
  - CRT-off: 160

**p = 0.03**

- Baseline: 200
  - CRT-on: 205
  - CRT-off: 210

Right ventricular end diastolic volume

**p = 0.005**

- EDV (ml)
  - Baseline: 200
  - CRT-on: 210
  - CRT-off: 220

**p = 0.37**

- Baseline: 250
  - CRT-on: 260
  - CRT-off: 270

**p = 0.01**

- Baseline: 300
  - CRT-on: 310
  - CRT-off: 320

Right ventricular ejection fraction

**p < 0.001**

- EF (%)
  - Baseline: 40
  - CRT-on: 45
  - CRT-off: 50

**p = 0.75**

- Baseline: 50
  - CRT-on: 55
  - CRT-off: 60

**p = 0.02**

- Baseline: 60
  - CRT-on: 65
  - CRT-off: 70