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奈良県立医科大学附属病院 Nara Medical University Hospital

High incidence of developing dilated cardiomyopathy with right ventricular inflow pacing in patients with congenital complete atrioventricular block

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Conflict of Interest

We have no disclosure.

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【Background】

The prognosis for children with congenital complete atrioventricular block (CCAVB) after pacemaker implantation (PMI) has been considered to be benign.

However, some develop dilated cardiomyopathy (DCM), with a reported prevalence of 5–30% majorly within one year from PMI.

Interestingly, the site of ventricular pacing has an impact on the mechanical synchrony and pump function of the left ventricle (LV)[1,2].

1) Janousek, J. et al. Circulation.

However, it is uncertain the exact relation with the ventricular pacing sites and the incidence of DCM in patients with CCAVB.

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【Purpose】

We aimed to evaluate and assess

(1) the DCM and/or heart failure death (HFD) incidence with or without PMI
(2) the relationship of ventricular pacing site with DCM/HFD incidence
(3) the effect on LV function of the pacemaker and pacing sites
(4) the clinical course of patients who developed DCM/HFD

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【Method-1】

Patients

A total of 38 patients (18 male, 20 female) with CCAVB
Followed up at National Cerebral and Cardiovascular Center, Japan
From October 1978 to June 2015
No structural anomaly of the heart.

Endpoints

① onset of DCM/HFD
② day of changing the pacing lead,
③ day of final medical consultation due to hospital transfer
④ last medical consultation until June 2015

DCM

Having 117% of the normal LV end-diastolic diameter (LVDd) and less than 45% of the LV ejection fraction (LVEF), as measured by transthoracic echocardiography (TTE).

Manolio, T. et al. *Am J Cardiol 1992;69:1458-1466.*

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【Method-2】

Clinical measuements

(1)the cardiothoracic ratio (CTR) on chest x-rays
(2)brain natriuretic peptide (BNP)
(3)QRS duration (QRSd) in 12-lead electrocardiogram (ECG)
(4)LVDd by TEE
(5)LVEF by TEE
(6)septal-to-posterior wall motion delay (SPWMD) by TTE

①immediately before PMI
②within one year of PMI
③at the endpoint

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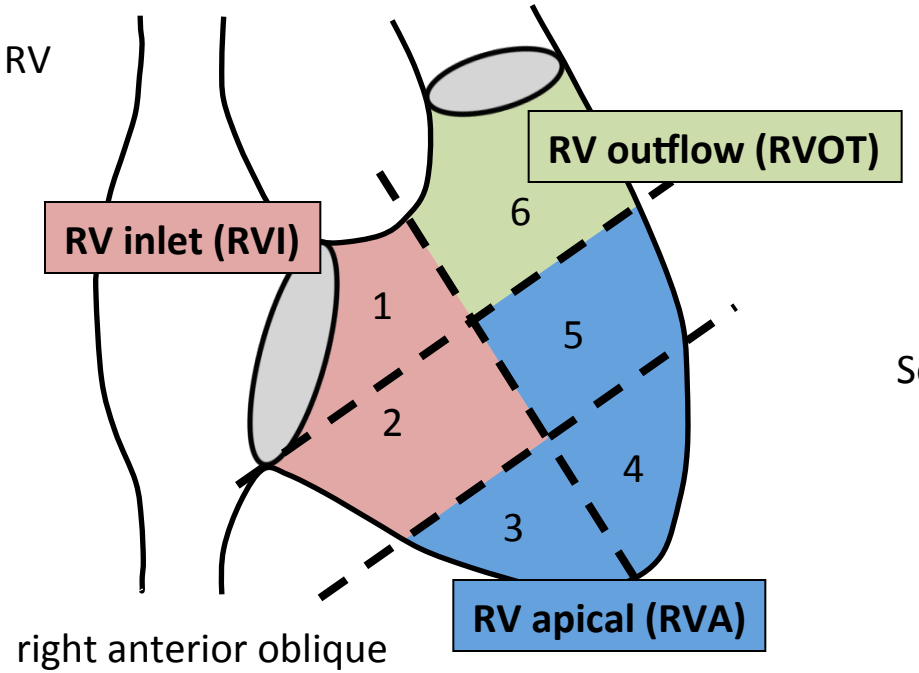
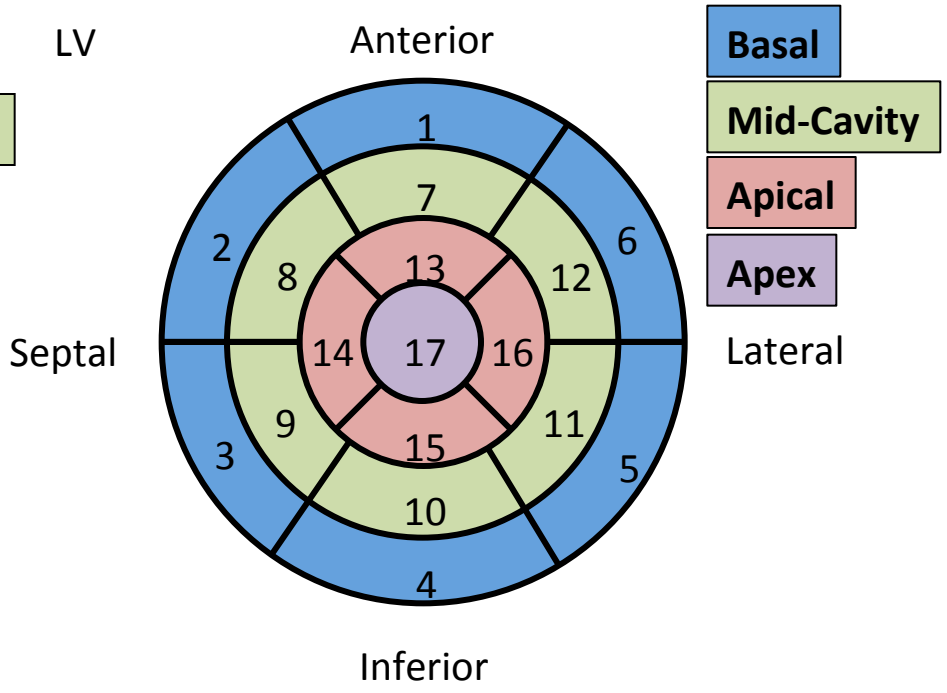
【Pacing sites】





①a line was drawn from the membranous septum to the apex to divide the septum into anterior and inferior halves

②further subdividing the base to apex length into three (basal, middle, and apical)

William D. et al. Moss & adams heart disease in infants, children, and adolescent. Philadelphia: Lippincott Williams & Wilkins, a Wolters Kluwer business, 2013, pp. 1-31.

Cerqueria, M. et al. Circulation. 2002; 105: 539-542

Assessed pacing sites from
＊biplane chest X-rays
＊ventriculographies
＊12-lead ECGs.

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【Result-①】

Patient characteristics

	n	total	PMI n DCM/HFD	n	non-DCM	n	non-PMI	p
Number		38	8 (25%)		24 (75%)		6	
Age at the end of follow up	38	6.8 (0.0-33.9)	8	2.4 (0.0-8.0)	24	***8.6 (3.5-33.9)	6	*12.0 (0.7-25.8)	0.001
Sex (men: female)	38	18:20	8	7:1	24	***10:14	6	*1:5	0.021
Maternal autoantibody	28	18 (64%)	7	4 (57%)	16	9 (56%)	5	5 (100%)	n.s.
Fetus bradycardia	37	35 (95%)	8	8 (100%)	24	22 (92%)	5	5 (100%)	n.s.
Fetal hydrops	38	2 (5.3%)	8	0 (0%)	24	2 (8.3%)	6	0 (0%)	n.s.
Gestational age on delivery (weeks)	37	38 (28-41)	8	37 (34-39)	24	38 (28-41)	5	38 (37-38)	n.s.
Own ventricular rate (bpm)	37	49 (35-75)	8	52 (45-75)	23	50 (35-73)			
Own atrial rate (bpm)	36	130 (55-187)	8	147 (97-187)	22	131 (70-170)			
Observation period from PMI (months)	32	69.3 (0.0-272.3)	8	17.0 (0.0-48.3)	24	***81.8 (20.6-272.3)			
Lower ventricular pacing rate	32	110 (60-130)	8	120 (80-120)	24	105 (60-130)			

*p<0.05 vs. DCM/HFD, ** p<0.05 vs. non-DCM, *** p<0.05 vs. DCM/HFD

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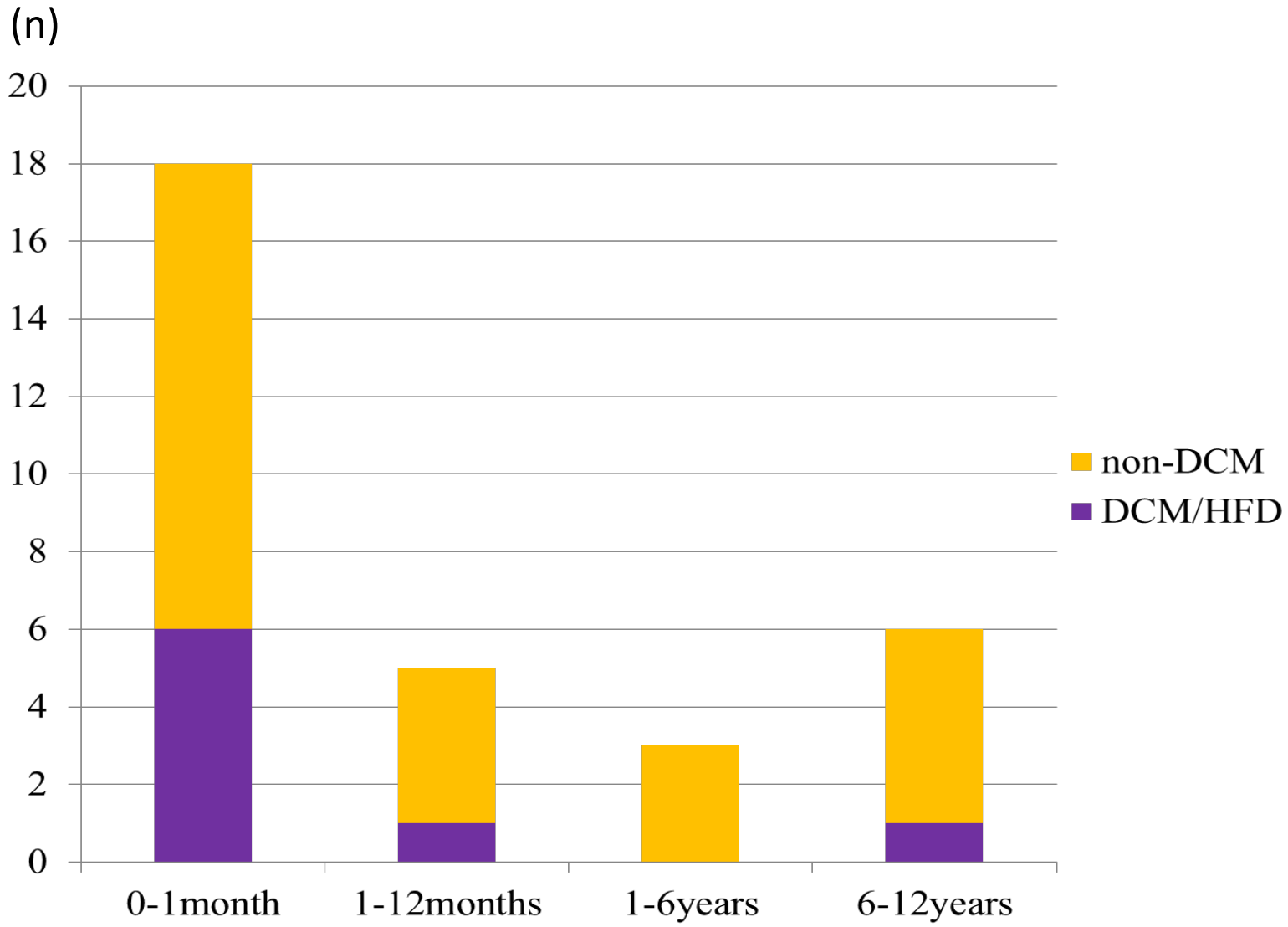
【Result-①】

Proportion of the age at the time of PMI



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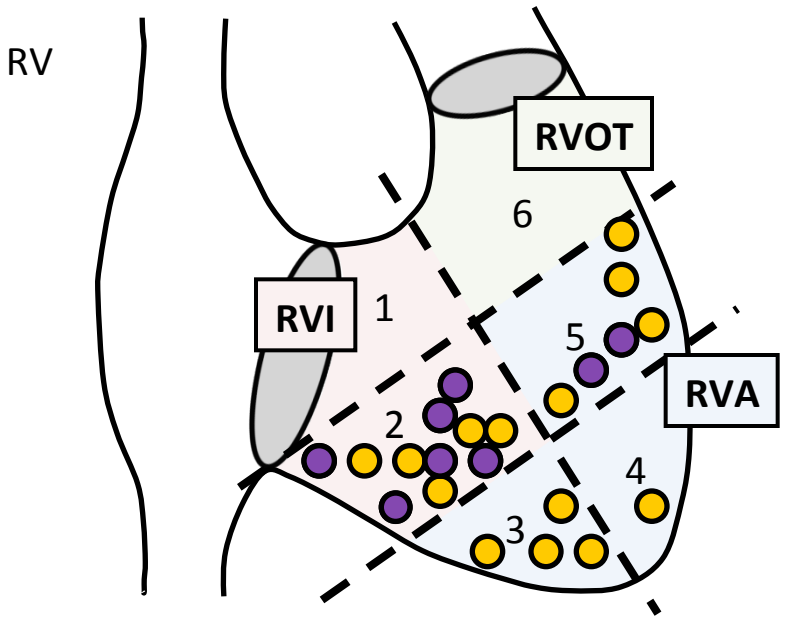
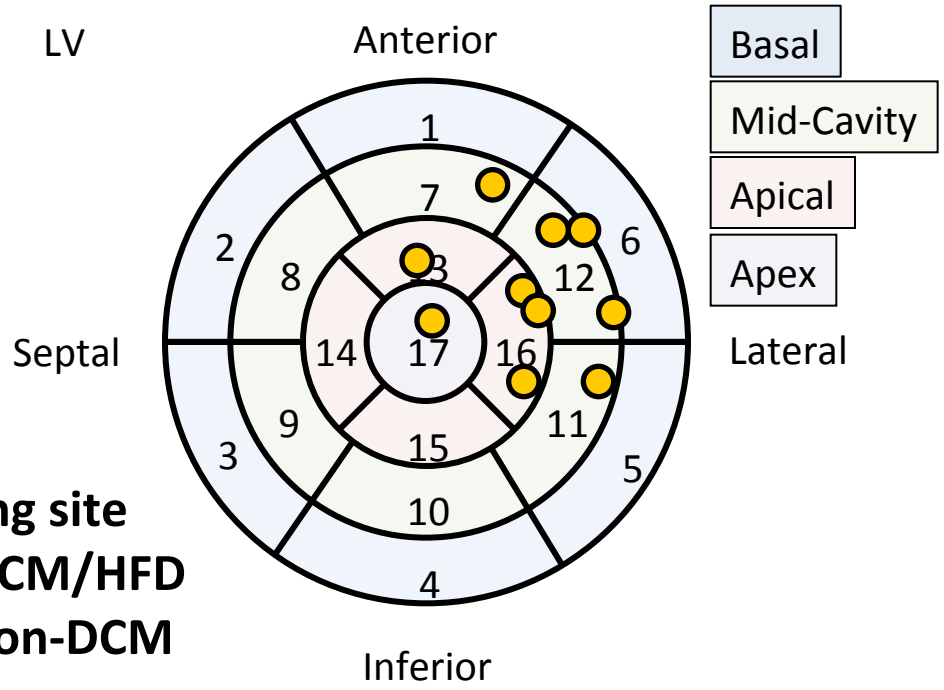
【Result-②】

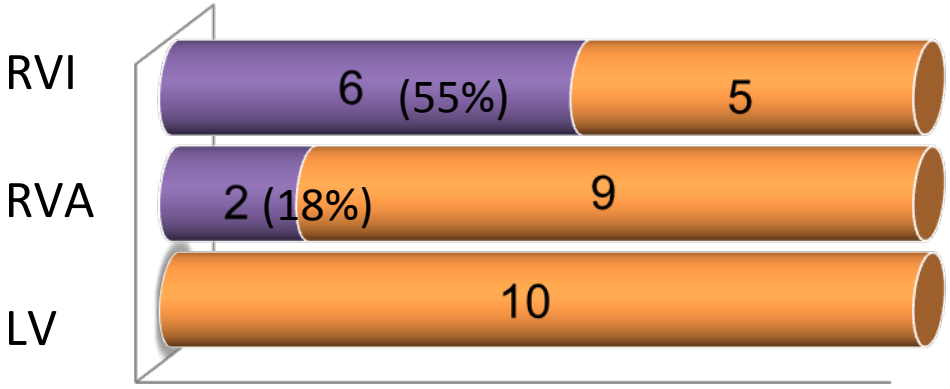
Pacing sites and development of DCM





pacing site

- **DCM/HFD**
- **non-DCM**



RVI vs. RVA vs. LV
p=0.013

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【Result-②】

Patient characteristics among patients with pacing from RVI, RVA, and LV

	n	RVI	n	RVA	n	LV	p
Number		11 (34%)		11 (34%)		10 (31%)	
Age at the end of follow up	11	4.0 (0.0-16.5)	11	6.6 (2.3-33.9)	10	**9.9 (3.5-26.1)	n.s.
Sex (men: female)	11	9:2	11	***4:7	10	**4:6	n.s.
Maternal autoantibody	8	4 (50%)	8	4 (50%)	7	5 (71%)	n.s.
Fetus bradycardia	11	11 (100%)	11	10 (91%)	10	9 (90%)	n.s.
Fetal hydrops	11	1 (9%)	11	0 (0%)	10	1 (10%)	n.s.
Gestational age on delivery (weeks)	11	37 (32-39)	11	38 (28-39)	10	37 (32-41)	n.s.
Own ventricular rate (bpm)	11	55 (45-75)	11	45 (40-73)	9	**40 (35-71)	n.s.
Own atrial rate (bpm)	10	147 (95-187)	11	***115 (70-150)	9	*155 (97-170)	0.015
Age of PMI (days)	11	4 (1-114)	11	***9 (0-4478)	10	**81 (0-2245)	n.s.
Observation period from PMI (months)	11	48.3 (0.0-198.0)	11	65.2 (3.6-272.3)	10	103.3 (42.0-249.6)	n.s.
Lower ventricular pacing rate	11	120 (90-130)	11	***110 (70-120)	10	120 (90-120)	n.s.

*p<0.05 vs. RVI, ** p<0.05 vs. RVA, *** p<0.05 vs. RVI

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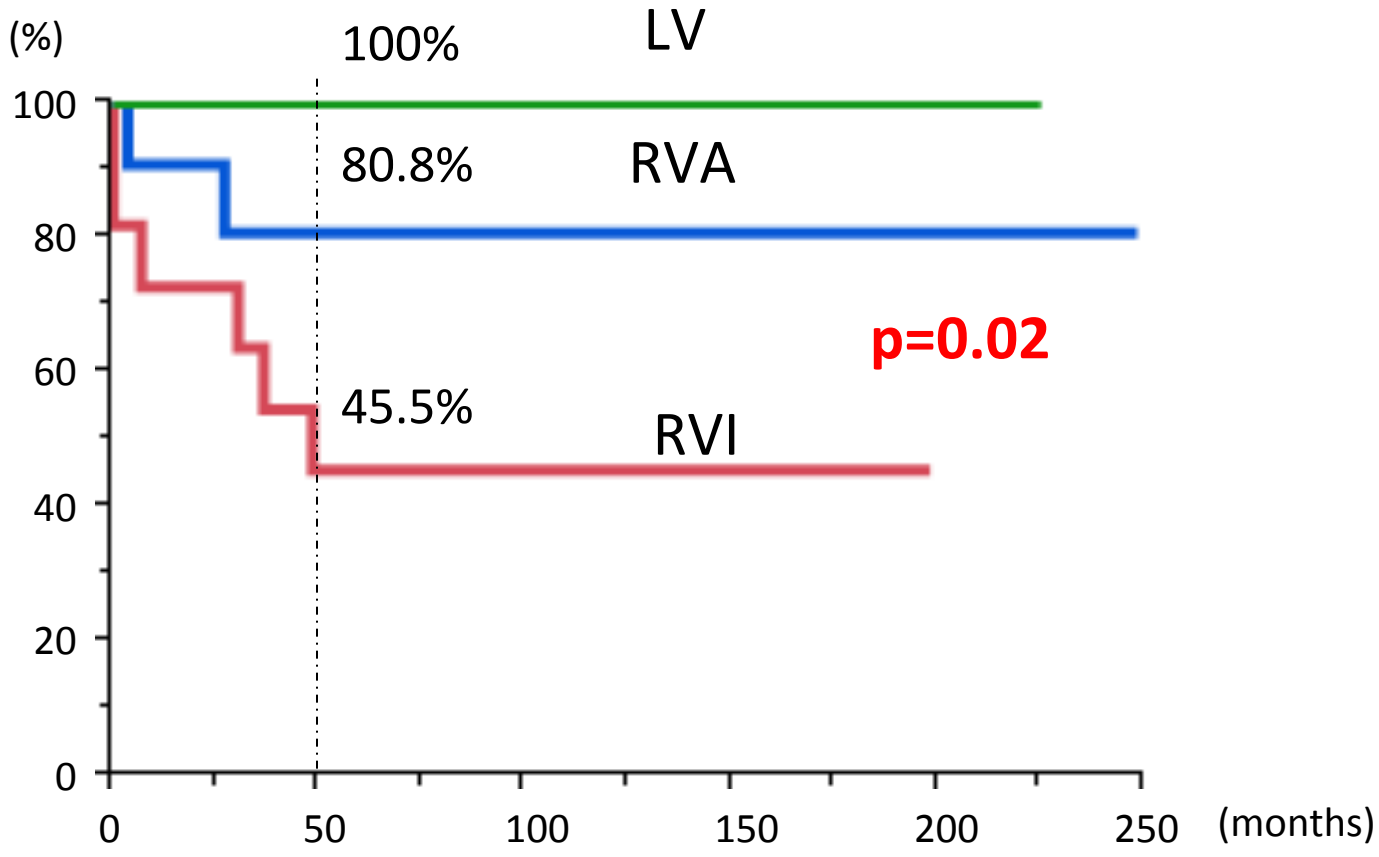
【Result-②】

The Kaplan–Meier survival curves against the development of DCM/ HFD in CCAVB patients after PMI



observation period

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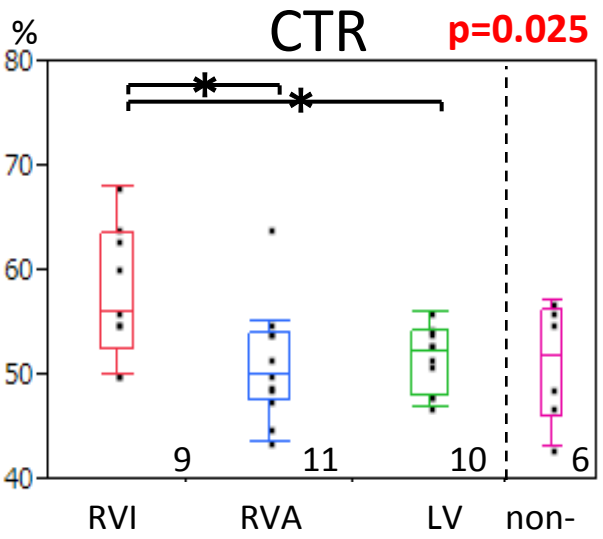
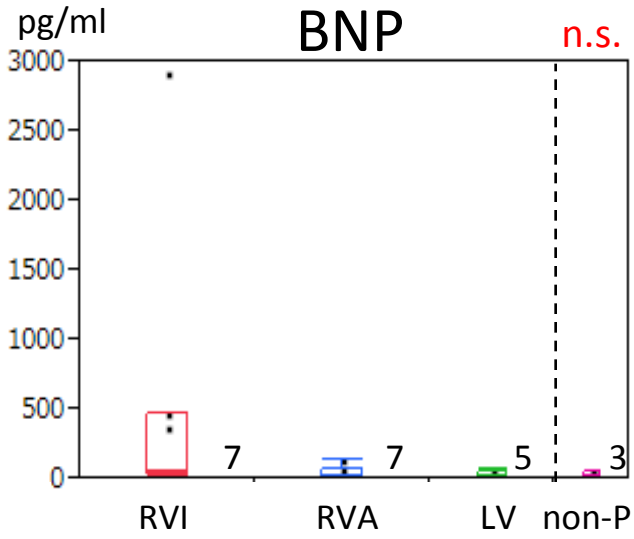
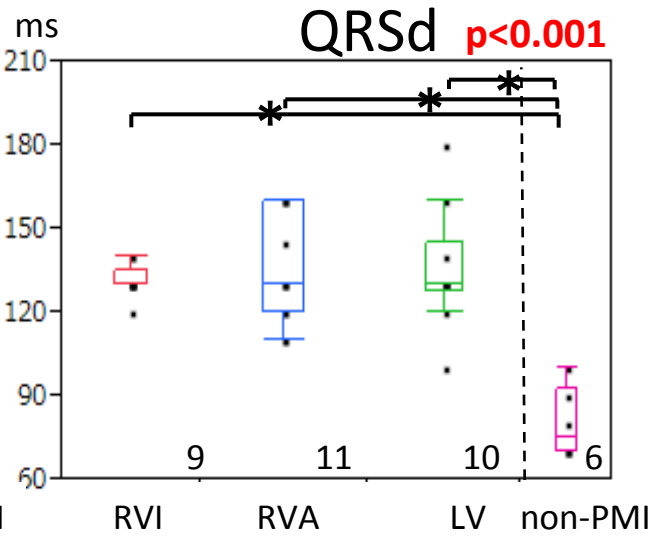
【Result-③】

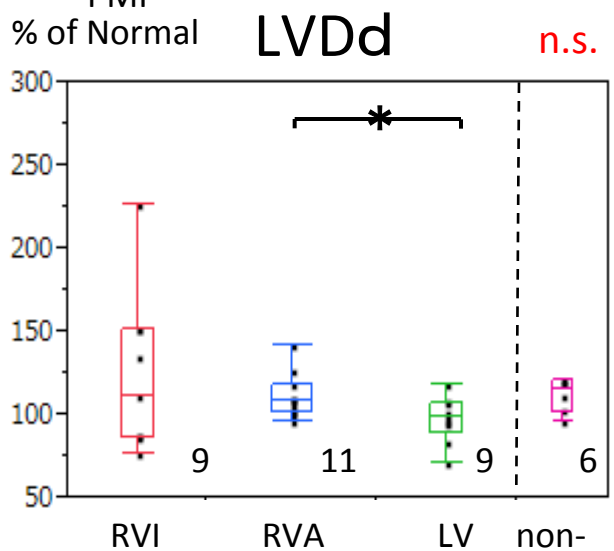
Relationship of pacing site with cardiac function and ventricular dyssynchrony -at endpoints-

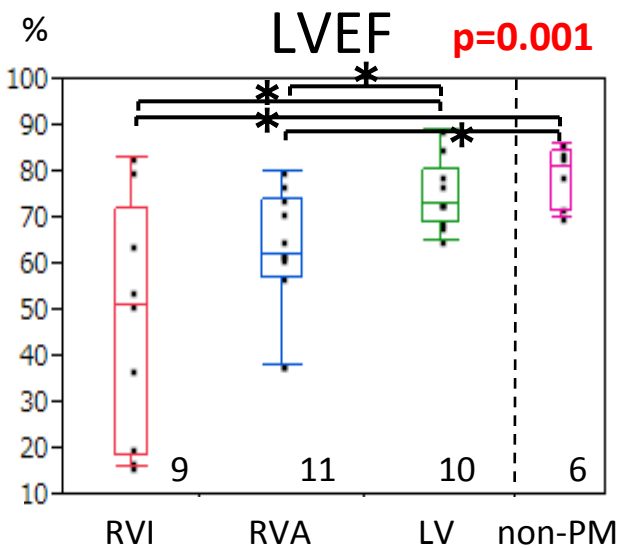
*p<0.05

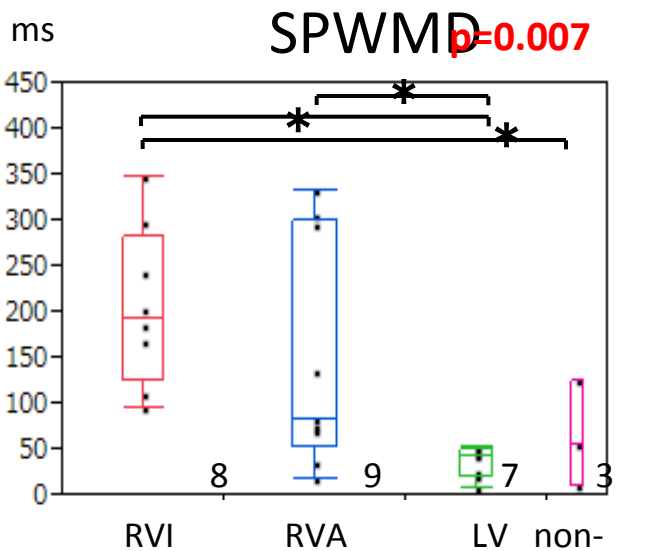












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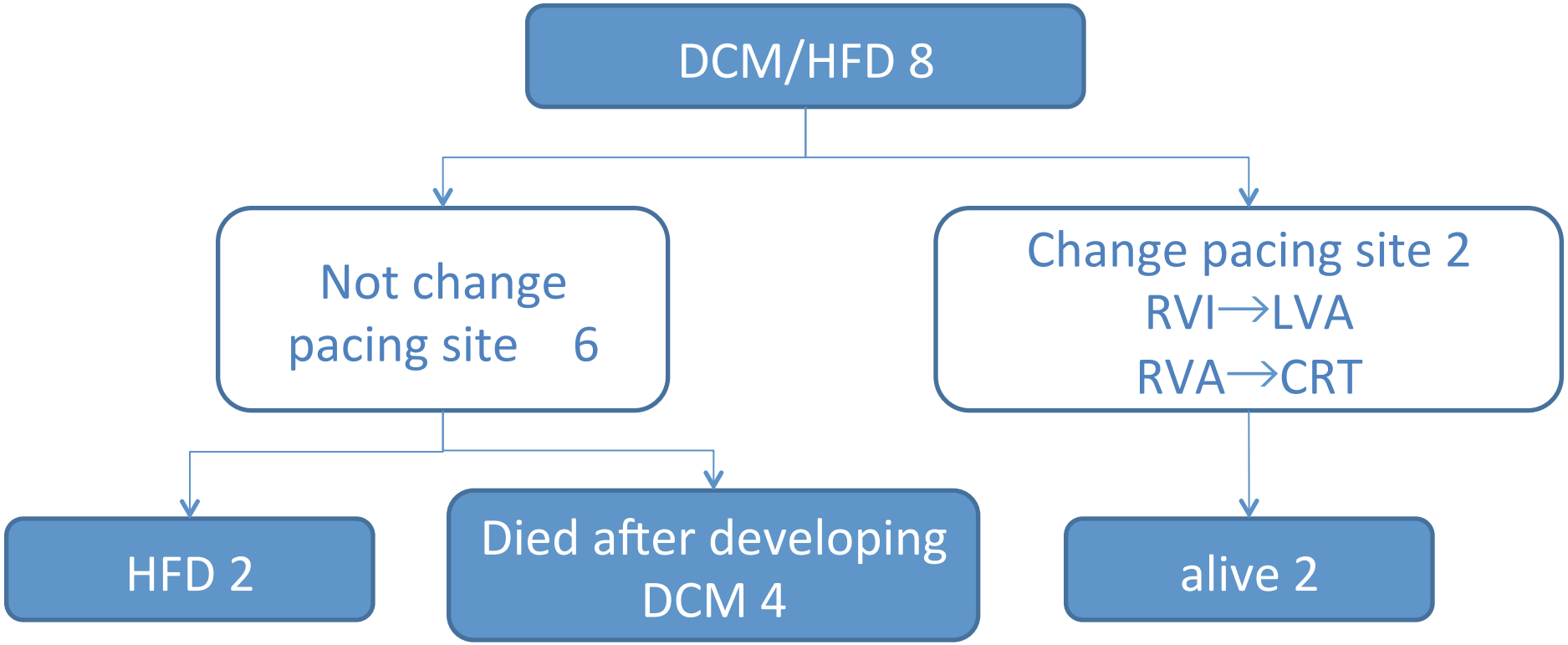
【Result-④】

The clinical course of eight patients who developed DCM/HFD after PMI



Both died 2 days after PMI (2 days old).

They died 27, 176, 189, 1130 days after developing DCM.

They have been alive after 7 and 8 years after changing pacing lead.

CRT; Cardiac Resynchronization Therapy

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【Summary】

- In the PMI group,twenty-five percent of patients with CCAVB developed DCM and/or HFD after PMI.
- There was a DCM/HFD incidence of 55% (6/11) with RVI pacing, 18% (2/11) with RVA pacing, and 0% (0/10) ($p = 0.013$) with LV pacing. The cumulative probability of avoidable DCM/HFD and survival at 50 months was 100% with LV pacing, 80.8% with RVA pacing, and 45.5% with RVI pacing ($p = 0.02$).
- At the endpoint, LVEF and SPWMD of patients with LV pacing were better than those for patients with other pacing sites. BNP and QRSd did not significantly differ among the pacing sites, although QRSd without pacing was shorter than that for any other pacing sites.
- Among the eight DCM/HFD patients, two in whom the pacing site was changed from RVI to LV apex or in whom therapy was upgraded to CRT remained alive with no heart failure symptoms, whereas the other six died of heart failure.

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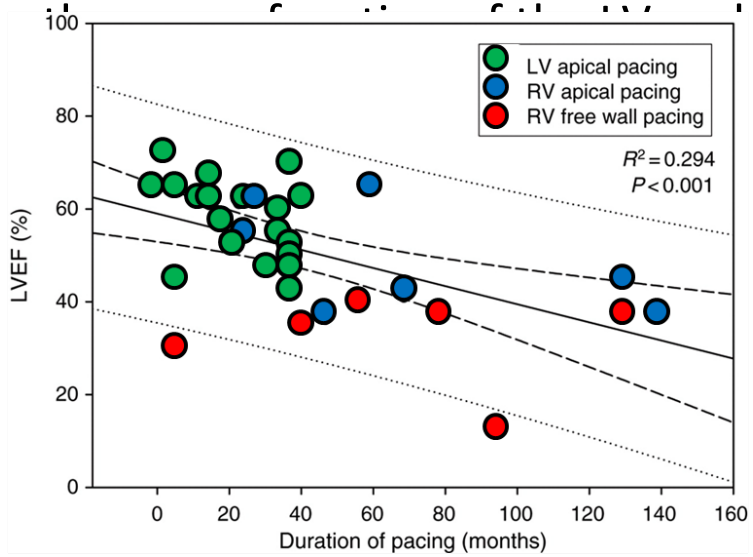
【Discussion】

- Previous reports of young patients with CCAVB showed relationships between the pacing site and LV function, pacing site and ventricular synchrony, and pacing duration and LV function. *Gebauer R A et al. Europace. 2009;11:1654-1659*
- Janousek et al. reported the site of ventricular pacing has an effect on the mechanical synchrony and pump function of the LV in children. *Janousek,J et al. Circulation. 2013;127:613-623*

→It is highly possible that ventricular dyssyn [illegible] ffects [illegible] the developm

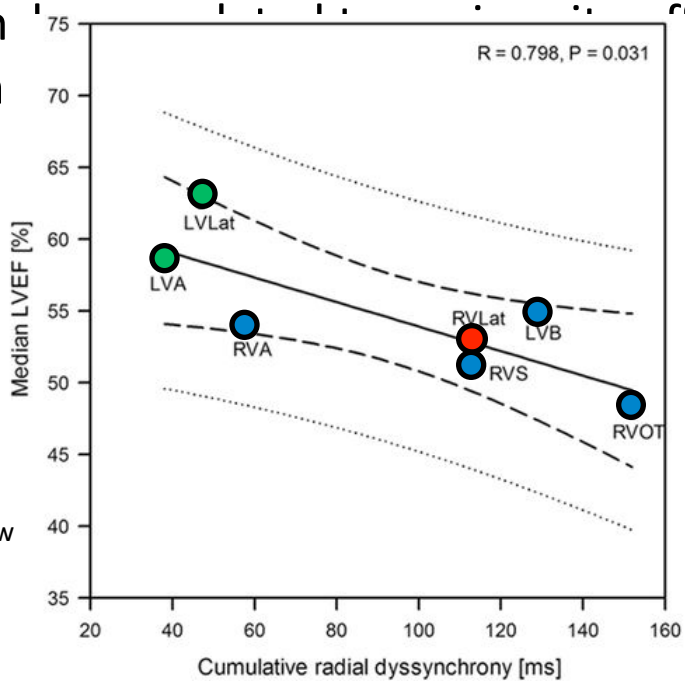


Gebauer R. A. et al. Europace 2009;11:1654-1659

RV Lat; RV lateral

RVA ; RV apex
RVS ; RV septal
RVOT ; RV outflow

LV Lat ; LV lateral
LVA ; LV apex
LVB ; LV basal



Janousek,J. et al. Circulation. 2013;127: 613-623

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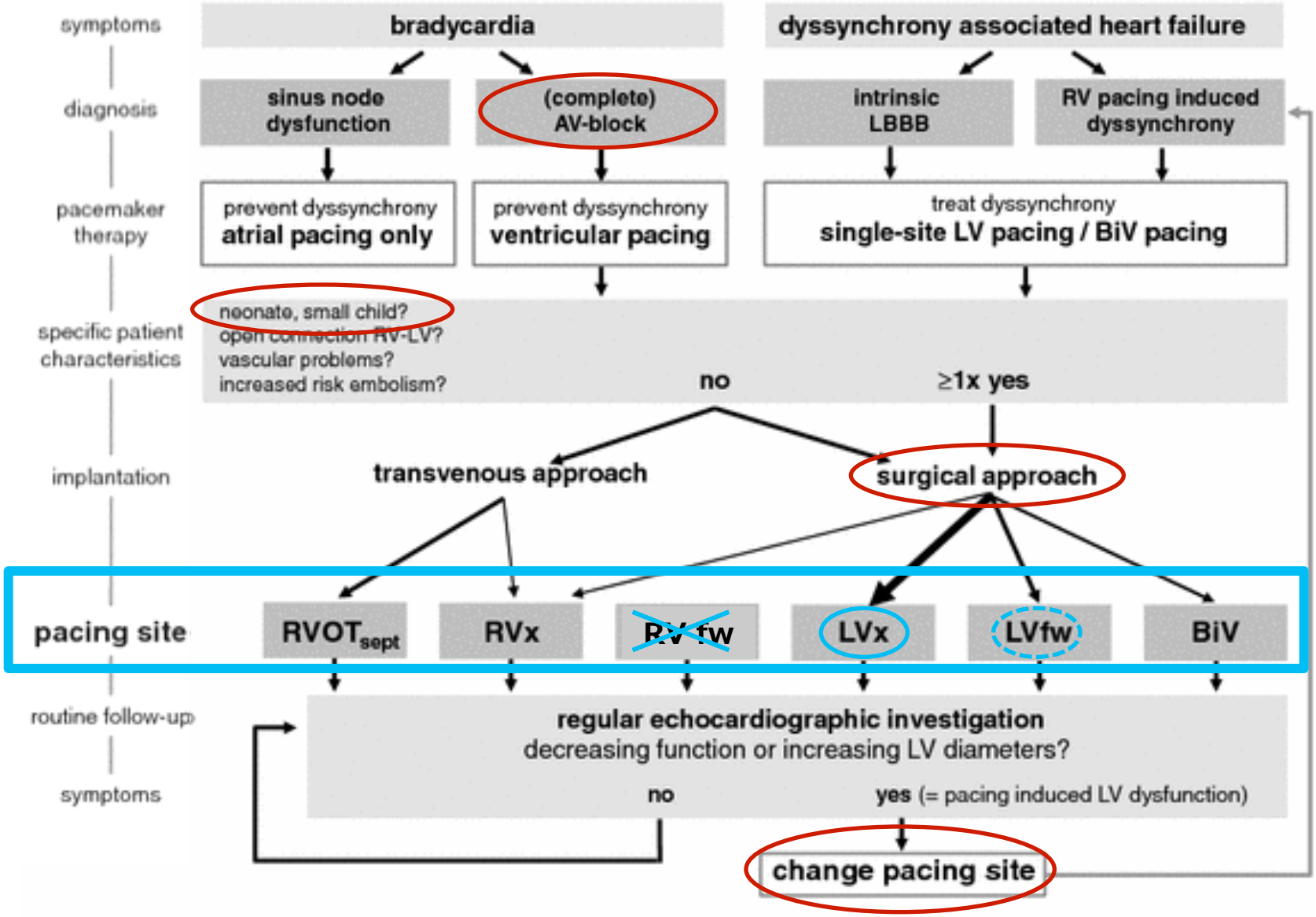
【Strategy for ventricular pacing in children with normal cardiac anatomy】



van Geldorp et al. Heart Fail Rev. 2011;16:305-314

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【Conclusion】

It is highly possible that ventricular dyssynchrony due to pacing site is one of the cause of DCM in CCAVB.

We strongly suggest that patients with CCAVB who need ventricular pacing should have PMI at the LV, not the RVI.

This research result is published in *Circulation Journal*.

Tsujii N, Miyazaki A, Sakaguchi H, Kagisaki K, Yamamoto T, Matsuoka M, Shima Y, Ichikawa H, Ohuchi H. High incidence of dilated cardiomyopathy after right ventricular inlet pacing in patients with congenital complete atrioventricular block. Circ J. 2016; 80:1251-1258.