CSP and the valves

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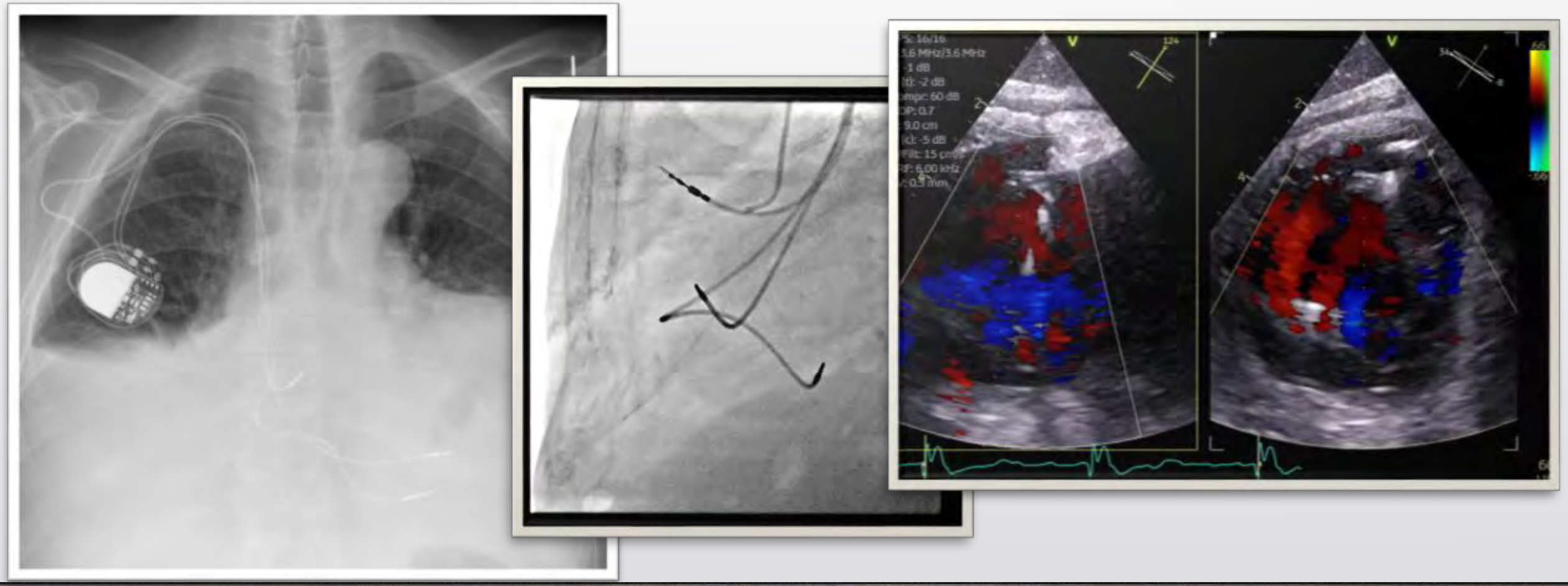
Conflicts of interest

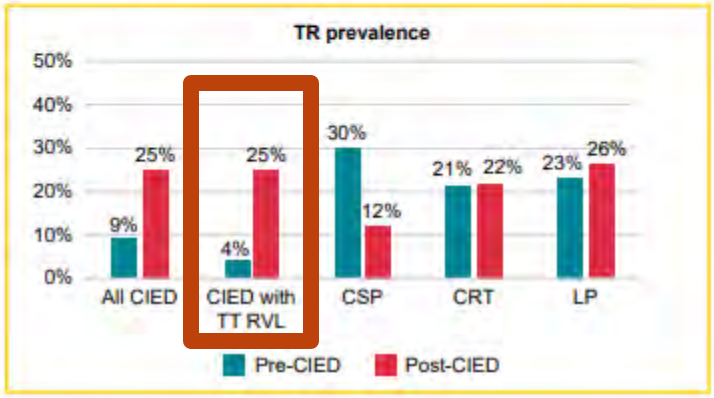
related to cardiac pacing

- Speaker honoraria from Biotronik
- Educational courses from Biotronik and Medtronic

You wake up in the middle of the night, heart pounding, the sheets damp with sweat… you've had a nightmare



Tricuspid regurgitation (TR)
(Defined as ≥ moderate)
57 studies *N* = 13 723 patients)

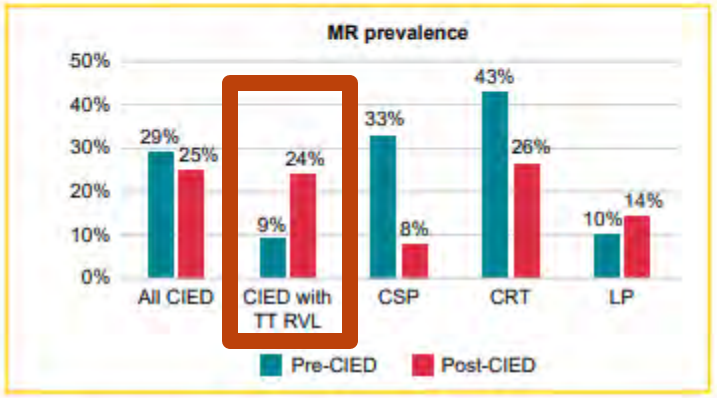


Pooled odds ratio (95% CI) of CIED-associated TR

All CIED: 2.46 (1.88–3.22), *P* < 0.001
CIED with TT RVL: 4.54 (3.14–6.57), *P* < 0.001
CSP: 0.37 (0.13–1.02), *P* = 0.05
CRT: 1.09 (0.55–2.17), *P* = 0.81
LP: 1.15 (0.83–1.59), *P* = 0.41

Pooled hazard ratio (95% CI) of all-cause mortality associated with CIED-associated TR = 1.64 (1.40–1.90), *P* < 0.001

Mitral regurgitation (MR)
(Defined as ≥ moderate)
90 studies *N* = 14 387 patients)



Pooled odds ratio (95% CI) of CIED-associated MR

All CIED: 0.74 (0.58–0.94), *P* = 0.02
CIED with TT RVL: 2.24 (1.18–4.26), *P* = 0.01
CSP: 0.15 (0.03–0.62), *P* = 0.001
CRT: 0.49 (0.40–0.61), *P* < 0.001
LP: 1.31 (0.72–2.39), *P* = 0.06

Pooled hazard ratio (95% CI) of all-cause mortality associated with persistent significant MR post-CRT = 2.00 (1.57–2.55), *P* < 0.001

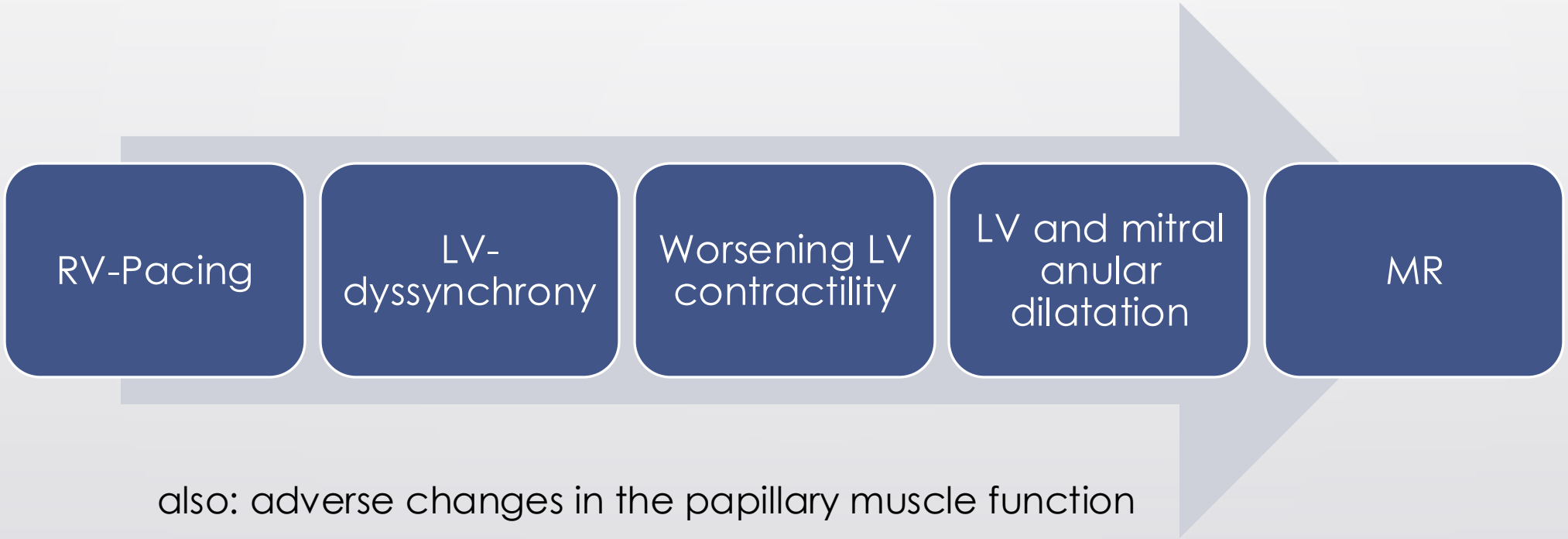
CIED: cardiac implantable electronic device
TT RVL: trans-tricuspid RV lead
LP: leadless pacing

M.F. Yuyun et al.; Europace (05/2024) 26, euae143
https://doi.org/10.1093/europace/euae143

What is the mechanism behind pacing-induced tricuspid regurgitation?

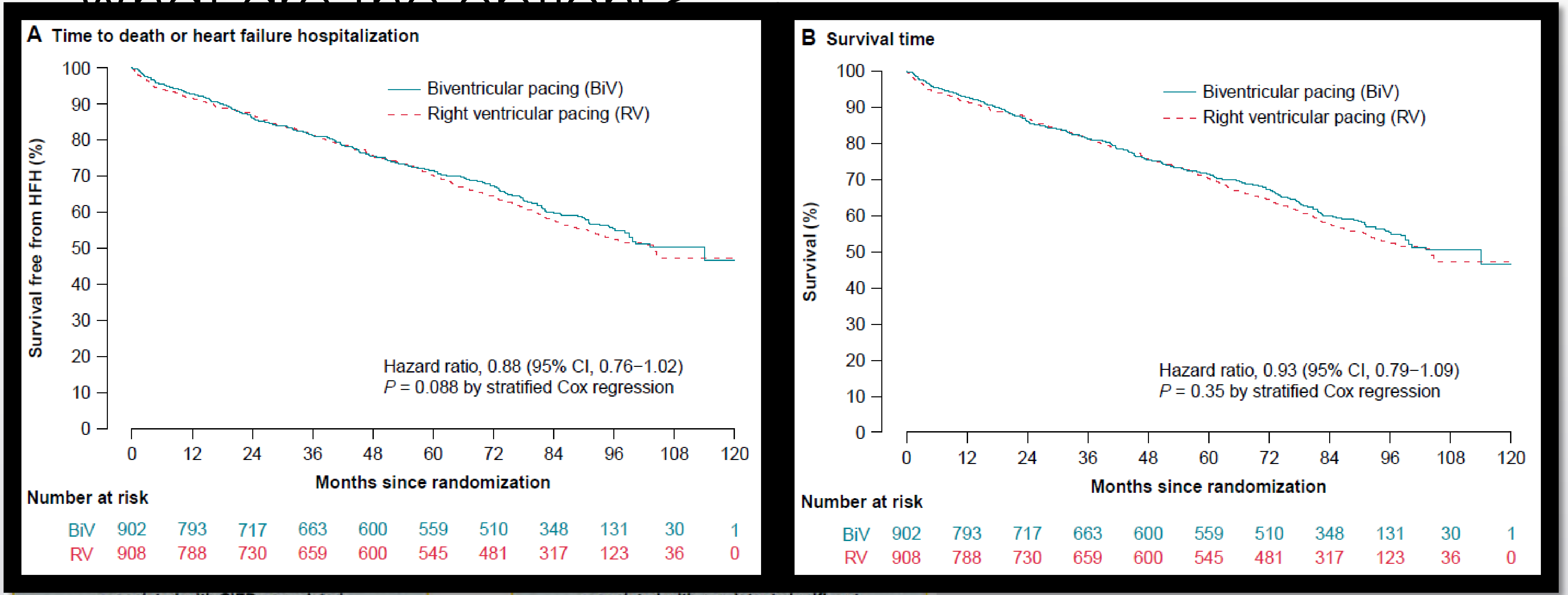
- Lead interference with leaflet mobility (lead impingement, adherence/fibrosis, lead entrapment, excessive lead slack)
- Leaflet perforation
- Number of leads
- Lead thrombosis
- Lead impact on sub-valvular apparatus
- Non-lead-related factors:
  - AV-, RV- or LV-dyssynchrony and LV-dysfunction
  - increased pulmonary artery systolic pressure
  - RV dilatation and dysfunction
  - tricuspid valve annular dilatation
  - leaflet tethering
  - mal-co-aptation

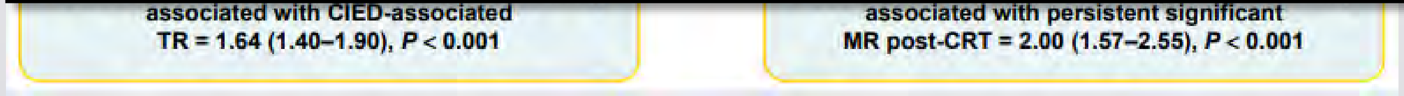
What is the mechanism behind pacing-induced mitral regurgitation?



also: adverse changes in the papillary muscle function

What are the options?



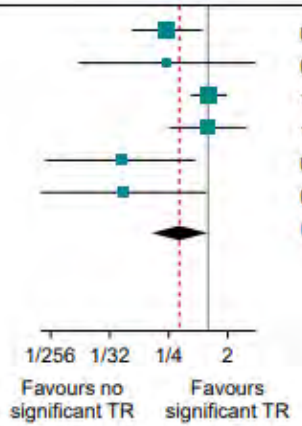


2025 ESC/EHRA Clinical Consensus Statement on Indications for CSP
Haran Burri; 06/2025 European Heart Journal
M.F. Yuyun et al.; Europace (05/2024) 26, euae143
https://doi.org/10.1093/europace/euae143

A Risk of tricuspid regurgitation post-conduction system pacing

Study	TR post-CIED Yes	TR post-CIED No	TR pre-CIED Yes	TR pre-CIED No	Odds ratio with 95% CI	Weight (%)
Grieco *et al.*, HBP, 2021	4	38	13	30	0.24 (0.07, 0.82)	22.45
Hasumi *et al.*, 2018	0	45	2	43	0.24 (0.01, 5.45)	7.97
HU *et al.*, 2022	32	59	31	60	1.05 (0.57, 1.93)	29.68
Mao *et al.*, LBBP, 2023	5	25	5	25	1.00 (0.26, 3.89)	20.82
Wang *et al.*, 2023	2	6	7	1	0.05 (0.00, 0.66)	10.22
Zhang *et al.*, 2023	0	29	7	22	0.05 (0.00, 0.94)	8.86
Overall					0.37 (0.13, 1.02)	

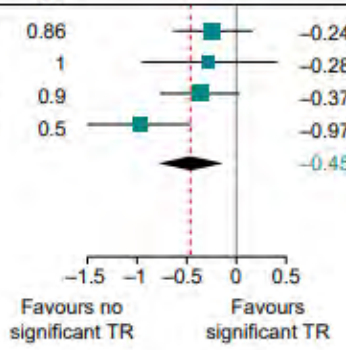
Heterogeneity: $\tau^2 = 0.80$, $I^2 = 59.54\%$, $H^2 = 2.47$
Test of $\theta_i = \theta_j$: Q (5) = 12.36, $P = 0.03$
Test of $\theta = 0$: $Z = -1.92$, $P = 0.05$



B Standardized mean difference tricuspid regurgitation post-conduction system pacing

Study	TR grade post-CIED N	TR grade post-CIED Mean	TR grade post-CIED SD	TR grade pre-CIED N	TR grade pre-CIED Mean	TR grade pre-CIED SD	SMD with 95% CI	Weight (%)
Chen *et al.*, LBBP, 2022	49	1	0.52	49	1.17	0.86	−0.24 (−0.63, 0.16)	30.42
Shan *et al.*, 2018	16	0.8	1.1	16	1.1	1	−0.28 (−0.96, 0.40)	16.12
Wu *et al.*, HBP, 2021	49	0.7	0.7	49	1	0.9	−0.37 (−0.77, 0.03)	30.28
Wu *et al.*, LBBP, 2021	32	0.7	0.7	32	1.3	0.5	−0.97 (−1.49, −0.46)	23.19
Overall							−0.45 (−0.78, −0.13)	

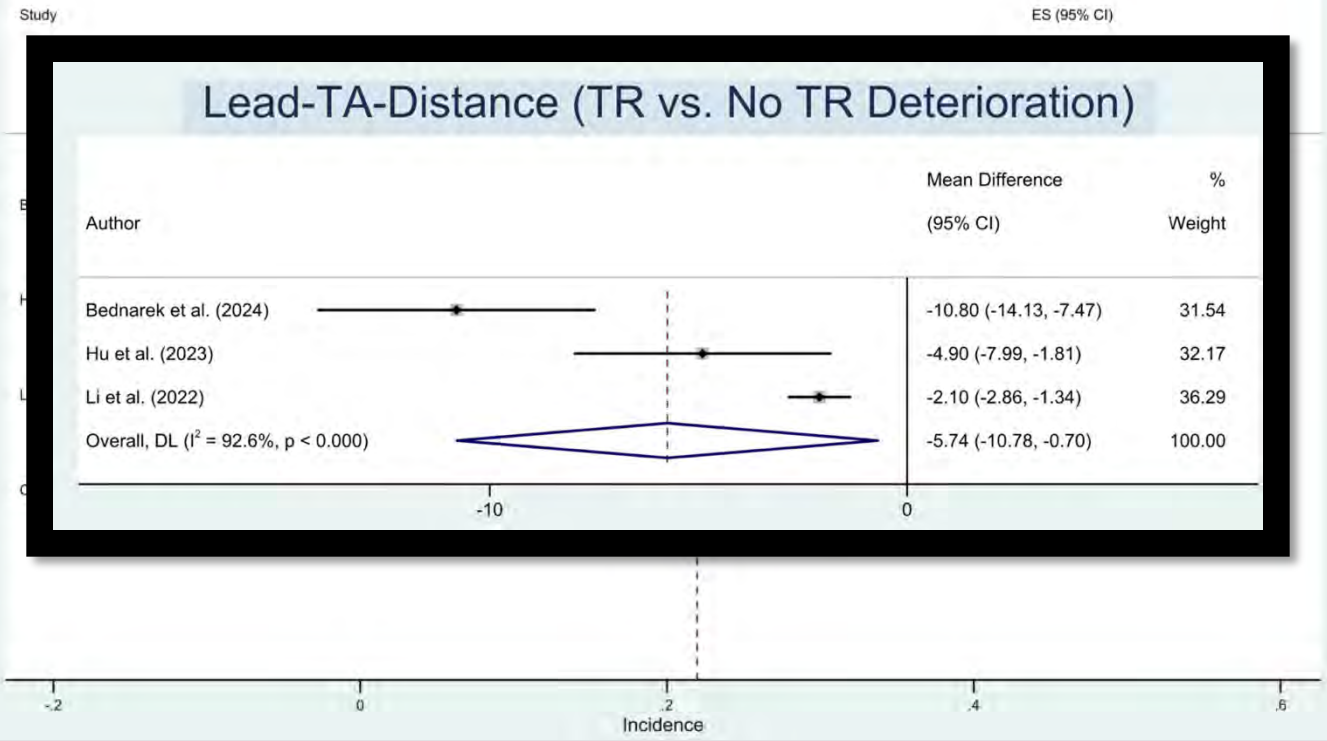
Heterogeneity: $\tau^2 = 0.05$, $I^2 = 45.75\%$, $H^2 = 1.84$
Test of $\theta_i = \theta_j$: Q (3) = 5.53, $P = 0.14$
Test of $\theta = 0$: $Z = -2.75$, $P = 0.01$



M.F. Yuyun et al.; Europace (05/2024) 26, euae143
https://doi.org/10.1093/europace/euae143

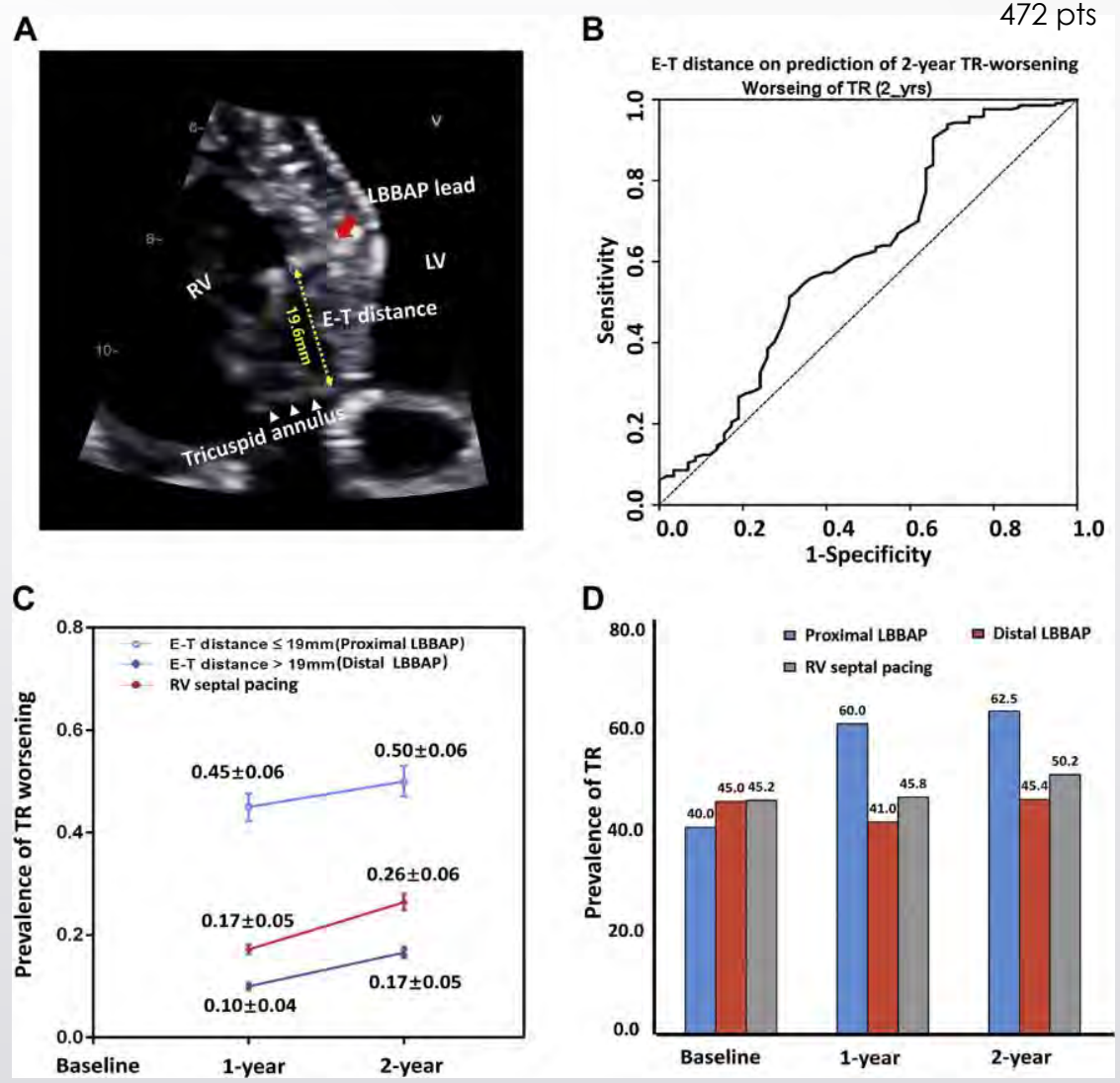
480 pts

Incidence of TR Deterioration

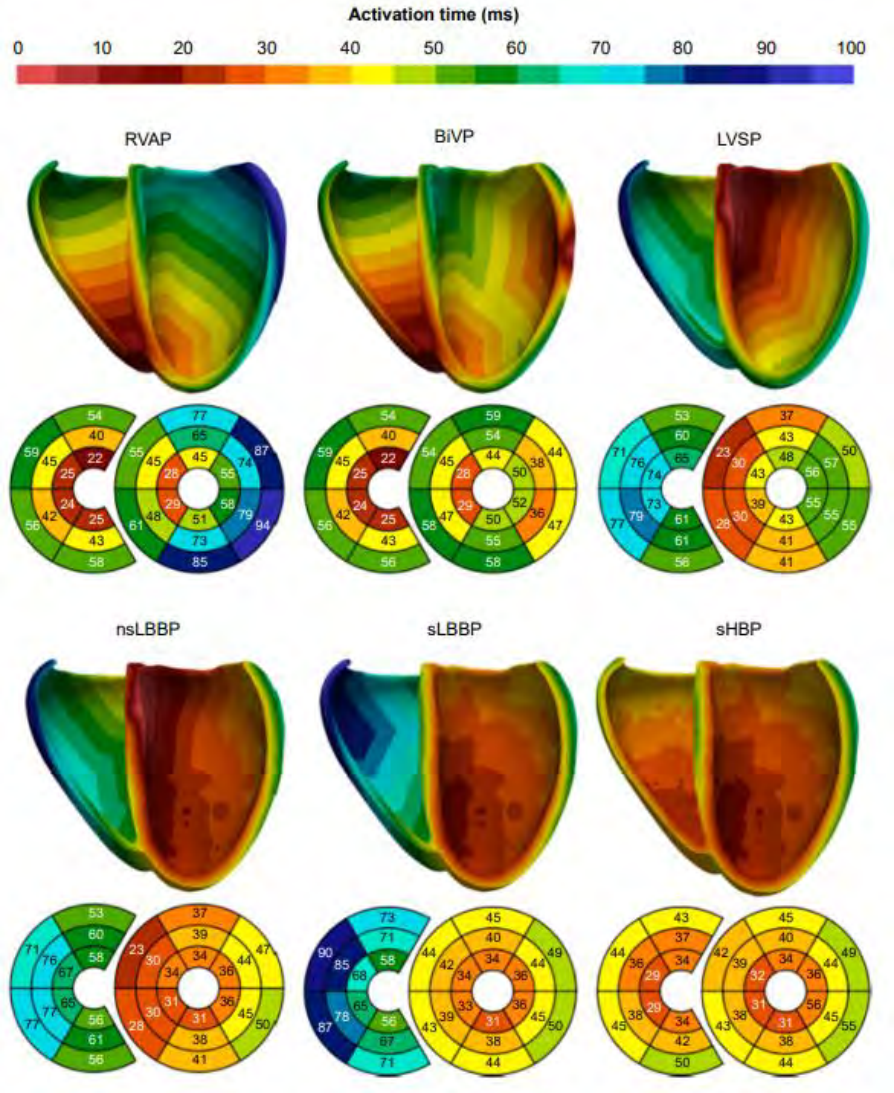


G. Karwiky et al.; J. of CV Electrophysiology; 09/2024
https://doi.org/10.1111/jce.16444

472 pts



X. Li et al.; Heart Rhythm; 07/2022
doi: 10.1016/j.hrthm.2022.03.005



CSP and the mitral valve

- Better left ventricular synchrony leading to more coordinated papillary muscle contraction
- Improved left ventricular ejection fraction and reduced left ventricular dimensions
- Preservation of the physiological activation sequence of the ventricles

M. Glikson et al.; ESC clinical consensus statement on indications for conduction system pacing;
Europace (2025) 27; https://doi.org/10.1093/europace/euaf050

Conclusion

- CSP offers significant advantages over traditional RV-Pacing in terms of cardiac valve function
- Implantation technique is crucial to reduce the risk for TR
- Long-term data is still limited -> large RCTs are needed and in the making

Thank you for your attention

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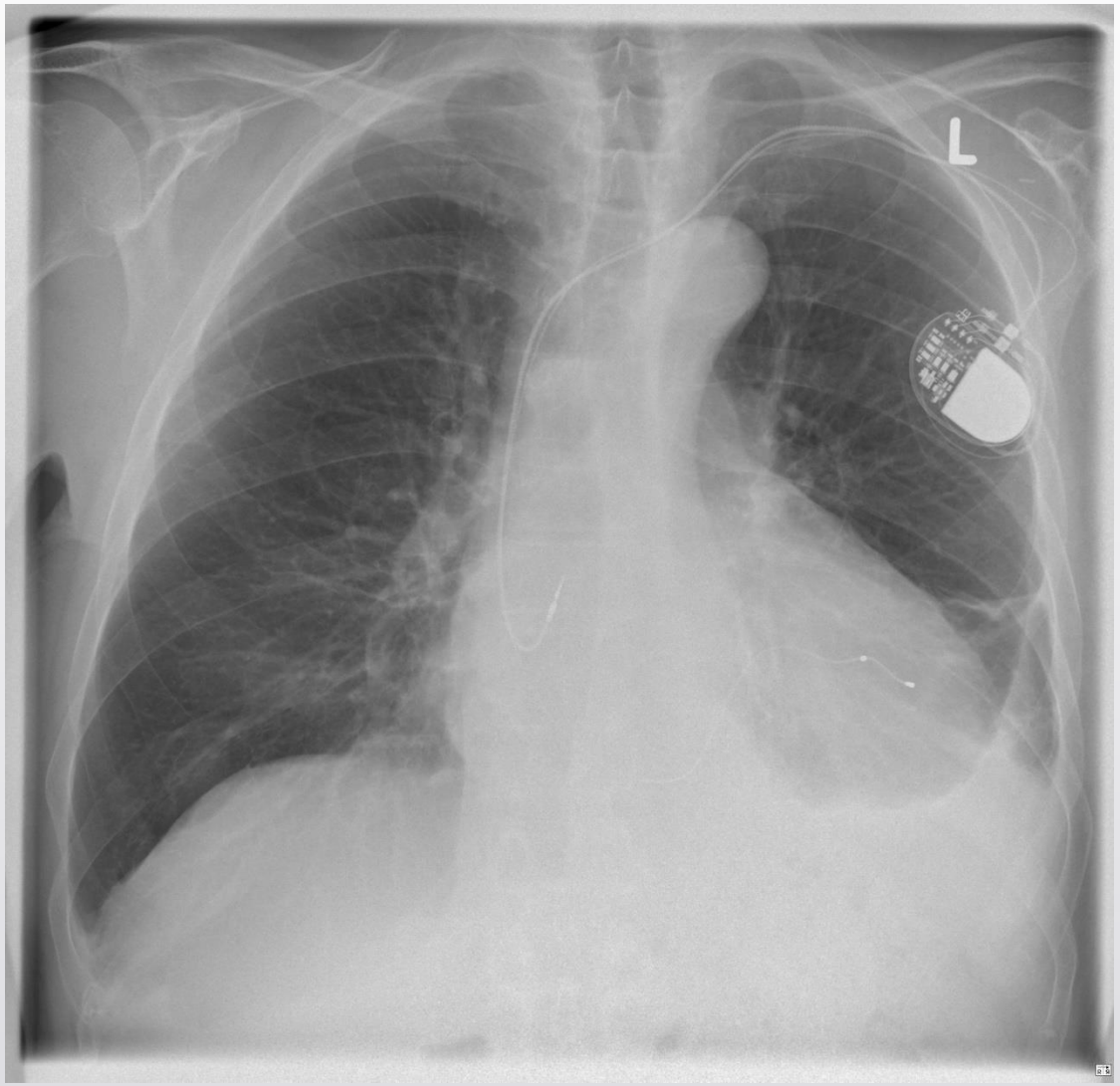
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