



ADRIS

ASSOCIATION DE RYTHMOLOGIE
INTERVENTIONNELLE & STIMULATION

Sonde endocavitaire et valve tricuspide

Les liaisons dangereuses

Objectifs de cette présentation

1

Quand suspecter une insuffisance tricuspide sur sonde

2

Comment prendre en charge cette valvulopathie

½ page sur 70 !

ty assurance pro-
e annual hospital
mplication rates,
he lowest (1 - 50
51 - 90 implanta-
-of-hours proce-
i rates.³⁵⁴ These
e performed by
olume.

tions due to dis-
sing or threshold
ions (2.4%) were
have a particular
nd coronary vein
y, LV leads (4.3%)
is compared with
ice (OR 3.3) and

cardiac

	%
	1.0 - 5.9
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	0.7 - 2.1
	0.1 - 0.4
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	5 - 15
	1 - 20
	0.1 - 1.5
	0.1 - 2.6
	5 - 15
	0.8 - 1.4

passive fixation RA lead (OR 2.2) were the most important risk predictors.

A meta-analysis of 25 CRT trials noted mechanical complications in 3.2% (including coronary sinus dissection or perforation, pericardial effusion or tamponade, pneumothorax, and haemothorax), other lead problems in 6.2%, and infections in 1.4%. Peri-implantation deaths occurred in 0.3%.³⁶⁹

10.2.2 Haematoma

Pocket haematoma is a frequent complication (2.1 - 9.5%), which can usually be managed conservatively. Evacuation, required in 0.3 - 2% of cases, is associated with an ~15 times increased risk of infection.⁶¹⁹ Moreover, patients developing pocket haematoma stay in hospital longer and have a higher in-hospital mortality rate (2.0% vs. 0.7%).⁷²⁴ Hence, appropriate precautions are critical, and reoperation should be limited to patients with severe pain, persistent bleeding, distension of the suture line, and imminent skin necrosis. Many haematomas can be avoided by careful haemostasis and optimal management of antiplatelet and anticoagulant drugs.

10.2.3 Infection

Infection is one of the most worrying CIED complications, causing significant morbidity, mortality, and healthcare costs.^{725,726} Infection rates are higher with device replacement or upgrade procedures,⁶⁹⁵ as well as CRT or ICD implants compared with simple pacemaker implantation.⁷²⁷ Olsen *et al*⁷⁰² reported the lifetime risk of system infection in patients with a pacemaker (1.19%), ICD (1.91%), CRT-P (2.18%), and CRT-D (3.35%). Specifically, patients undergoing reoperations, those with a previous device-related infection, men, and younger patients had a significantly higher risk of infection.

Similar findings have been reported in a large cohort of patients receiving an ICD, with infection rates of 1.4% for single, 1.5% for dual, and 2.0% for biventricular ICDs.⁷²⁸ In addition, early reintervention (OR 2.70), previous valvular surgery (OR 1.53), reimplantation (OR 1.35), renal failure on dialysis (OR 1.34), chronic lung disease (OR 1.22), cerebrovascular disease (OR 1.17), and warfarin use (OR 1.16) were associated with an increased risk of infection.⁷⁰² Infections also occur more frequently with use of temporary pacing or other procedures before implantation (OR 2.5 and 5.8, respectively), early reinterventions (OR 15), and lack of antibiotic prophylaxis (OR 2.5).^{639,729}

Further comprehensive information on how to prevent, diagnose, and treat CIED infections has been provided in a recent EHRA consensus document.⁶⁴²

10.2.4 Tricuspid valve interference

CIED leads may interfere with tricuspid valve function intraoperatively by causing damage to the tricuspid valve leaflets or the subvalvular apparatus, or chronically after operation or lead extraction. This damage has been linked to haemodynamic deterioration and an adverse clinical outcome.⁷³⁰ In fact, moderate to severe tricuspid regurgitation is generally associated with excess mortality.^{731,732} and occurs at a significantly higher rate in CIED patients.⁷³³ The prevalence of significant tricuspid regurgitation (defined as grade 2 or above) following CIED implantation varies between 10% and 39%. Most studies attribute a greater harm with ICD leads and in the

presence of multiple RV leads.^{45,46,49,445,642,685,697,709,728,730 - 732} The issue of lead interference with bioprosthetic tricuspid valves or after annuloplasty or repair is debated. Furthermore, there is no firm evidence supporting that pacing-induced RV dyssynchrony significantly contributes to tricuspid regurgitation. A recent study randomizing 63 patients to pacing lead positions in the RV apex, RVS, or LV pacing via the coronary sinus did not affect the development of tricuspid regurgitation.⁷³⁴ The diagnostic work-up of CIED lead-related tricuspid regurgitation based on clinical, haemodynamic, and in particular echocardiographic (2D, 3D, and Doppler) evaluation is often challenging.⁷³⁵ While clear guidance for the management of tricuspid regurgitation in the presence of CIED leads is still lacking, a high level of clinical suspicion is required, not discounting the possibility that worsening HF may be a consequence of the mechanical effect on tricuspid leaflet mobility or coaptation.⁷³⁰ General treatment options include medical therapy aiming to relieve congestion and lead extraction with careful replacement, or use of alternative pacing strategies, such as LV pacing via the coronary sinus or epicardial leads. However, transvenous lead extraction itself carries a risk of damage to the tricuspid valve and, hence, worsening tricuspid regurgitation. While leadless pacing eliminates the need for transvalvular leads, it may still negatively affect tricuspid valve function, potentially due to mechanical interference and abnormal electrical and mechanical ventricular activation.⁷³⁶ Indications for surgical valve repair or replacement in the context of CIED-induced tricuspid regurgitation follow current recommendations based on the presence of symptoms, severity of tricuspid regurgitation, and RV function. When considering tricuspid valve surgery, management of the RV lead should follow the recommendations outlined in section 8.2.3.⁷³⁷ Methods for percutaneous tricuspid repair have recently gained major attention, but evidence in favour of such interventions in the context of lead-related tricuspid regurgitation is still limited.⁷³⁸

10.2.5 Other

Increased complication risks have been observed in women (mainly pneumothorax and cardiac perforation) and in those with a low body mass index.^{354,739} Patients older than 80 years were also found to have a lower risk of lead-related reinterventions compared with patients aged 60 - 79 years (1.0% vs. 3.1%).³⁵⁴

Finally, suboptimal atrioventricular synchrony may lead to the pacemaker syndrome, giving rise to cannon waves caused by simultaneous atrial and ventricular contractions and symptoms of fatigue, dizziness, and hypotension (see section 5). Long-term RV pacing induces a dyssynchronous ventricular activation pattern that may promote progressive LV dysfunction and clinical HF. Strategies to avoid and resolve the adverse effect of RV pacing have been discussed above (section 6).

11 Management considerations

Integrated management of pacemaker and CRT patients, delivered by an interdisciplinary team in partnership with the patient and family, should be adopted in order to deliver comprehensive treatment across the continuum of healthcare (see section 12). The integrated-care approach is indicated in pacemaker and CRT patients to ensure a patient-centred approach and patient involvement in shared

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11.1 M patient

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TABLE 1 Frequency of CIED-Related Tricuspid Regurgitation

First Author (Ref. #)	Year	N	CIED	Timing of TR Assessment After Implantation	Assessment of Onset or Worsening of TR	Reported Frequency, %	Comments
Paniagua et al. (15)	1998	374	All PPM	NA	Onset	7	Severe TR was defined as 3 to 4+ TR
de Cock et al. (8)	2000	96	All PPM	Mean: 7.4 ± 2 yrs	Onset	21	Severity of TR was not specified
Seo et al. (16)	2008	87 (TR data available only in 82)	50 PPM, 17 ICD, 20 CRT	Range: 0 to 240 months	Onset	15	10 of the 12 patients who developed severe TR had nonsevere TR prior to CIED implantation
Kim et al. (12)	2008	248	174 PPM, 74 ICD	Range: 23 to 199 days	Worsening by at least 1 grade	24	21.2% of patients developed new, clinically significant TR (1.5 to 3+)
Webster et al. (17)	2008	123	All PPM	Median: 827 days	Worsening by at least 1 grade	25	Study population consisted of pediatric and congenital heart disease patients
Klutstein et al. (13)	2009	410	All PPM	Range: 1 to 3,549 days	Worsening by at least 2 grades	18	Improvement by at least 2 grades was observed in 4.4%
Höke et al. (11)	2014	239	191 ICD, 48 PPM	Within 1.5 yrs	Worsening to a grade ≥2	38	Significant TR was defined as grade ≥2
Fanari et al. (64)	2015	206	120 PPM, 86 ICD	Mean: 29 ± 19 months	Worsening by at least 1 grade	45	Post-implantation echocardiography was performed at least 6 months after lead insertion
Lee et al. (14)	2015	382	203 PPM, 179 ICD	Range: 1-1,200 days	Worsening by at least 2 grades	10	TR was assessed on a 6-point scale
Arabi et al. (6)	2015	41	7 PPM, 25 ICD, 9 CRT	1, 6, and 12 months	Worsening by at least 2 grades	17	TR was worsening by 1 grade in 71% of patients
Al-Bawardy et al. (5)	2015	1,596	611 PPM, 985 ICD	Range: 1 day-6.5 yrs	Prevalence of severe TR at 4 yrs	35	Prevalence of severe TR pre-implantation was 27%
Delling et al. (9)	2016	634	All PPM	NA	Onset	16	Significant TR was defined as ≥3+

CIED = cardiac implantable electronic devices; ICD = implantable cardiac defibrillation; NA = not available; PPM = permanent pacemaker; TR = tricuspid regurgitation.

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• Pourquoi un tel écart ?

• Design d'étude

- Observationnelle
- Sans groupe contrôle
- PM, DAI, CRT mélangés

• Imagerie : ETT 2D

- Visualisation complète de la sonde dans 15%
- 37% de surestimation de l'IT VS ETO

• Cardiopathie associée

- Dilatation VD → dilatation de l'anneau → IT fonctionnelle secondaire

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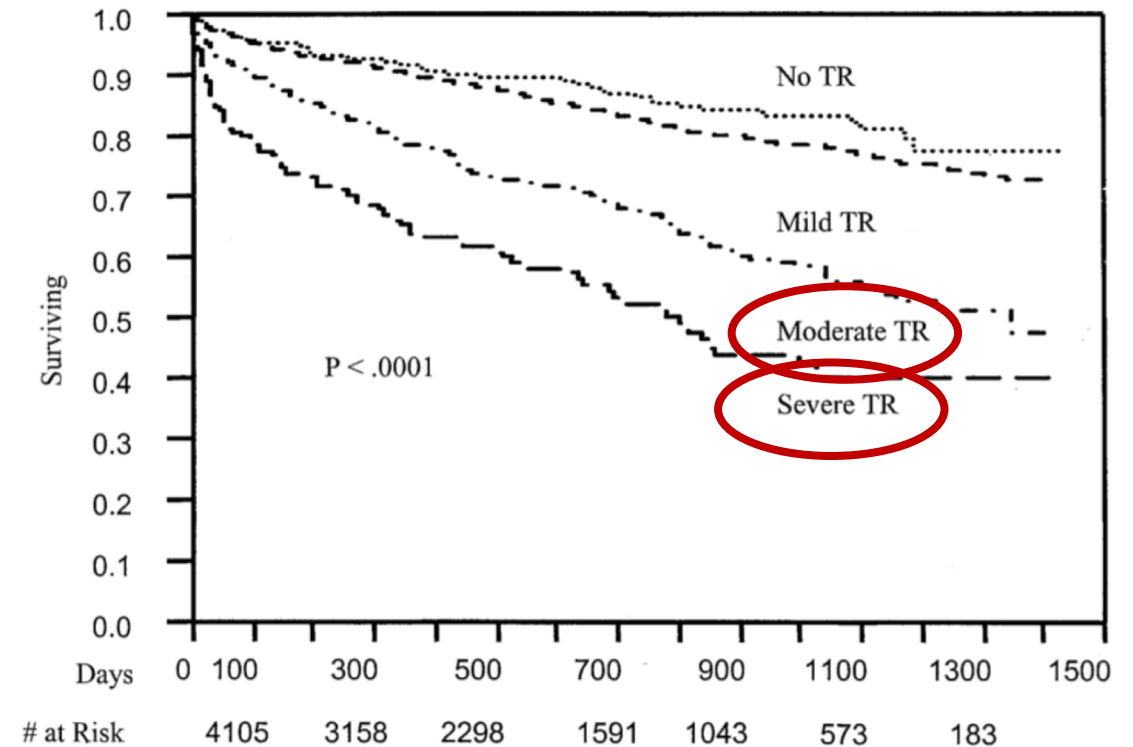
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- IT grade III et IV :

- ↗ de la mortalité

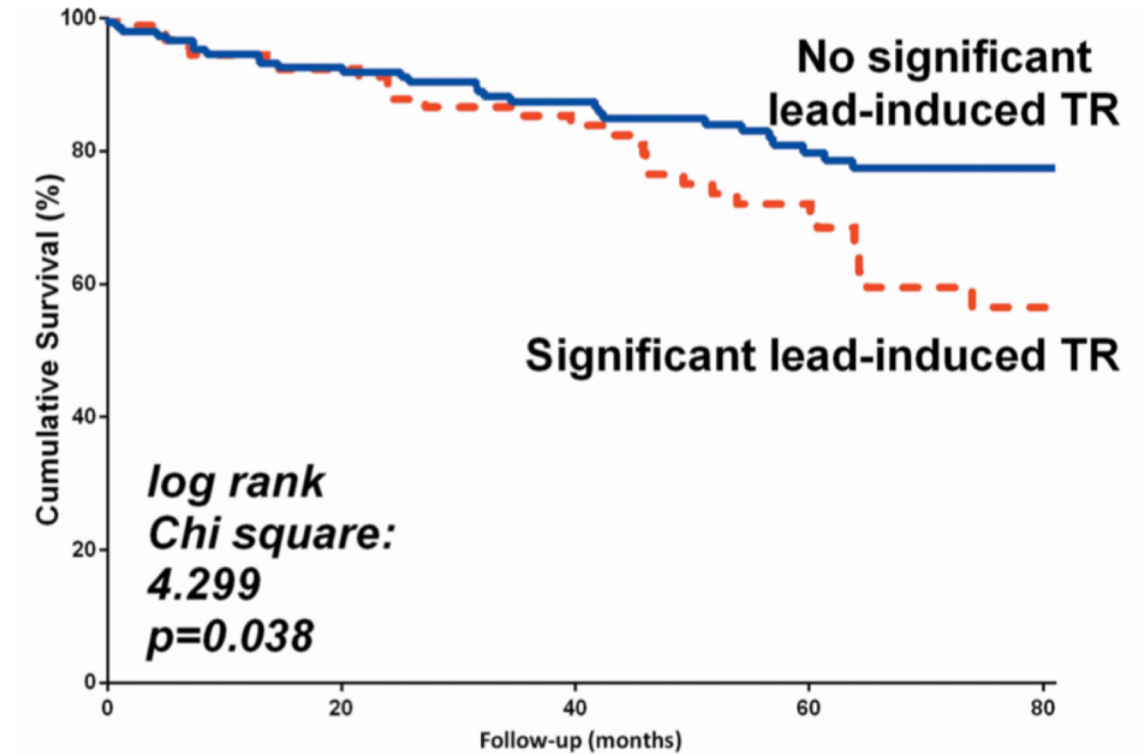
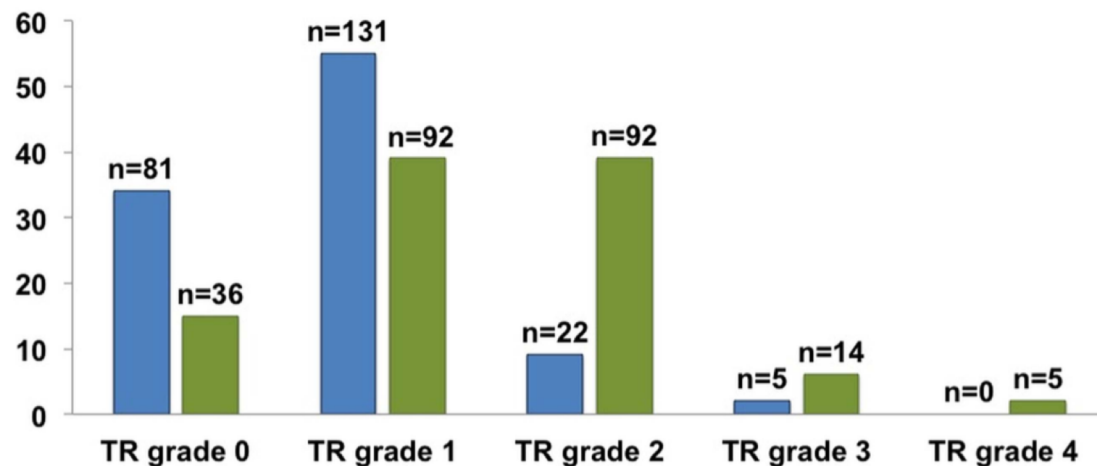
- Ajustée sur :

- Âge
- FEVG
- Diamètre VC inférieure
- Taille VD
- Fonction VD



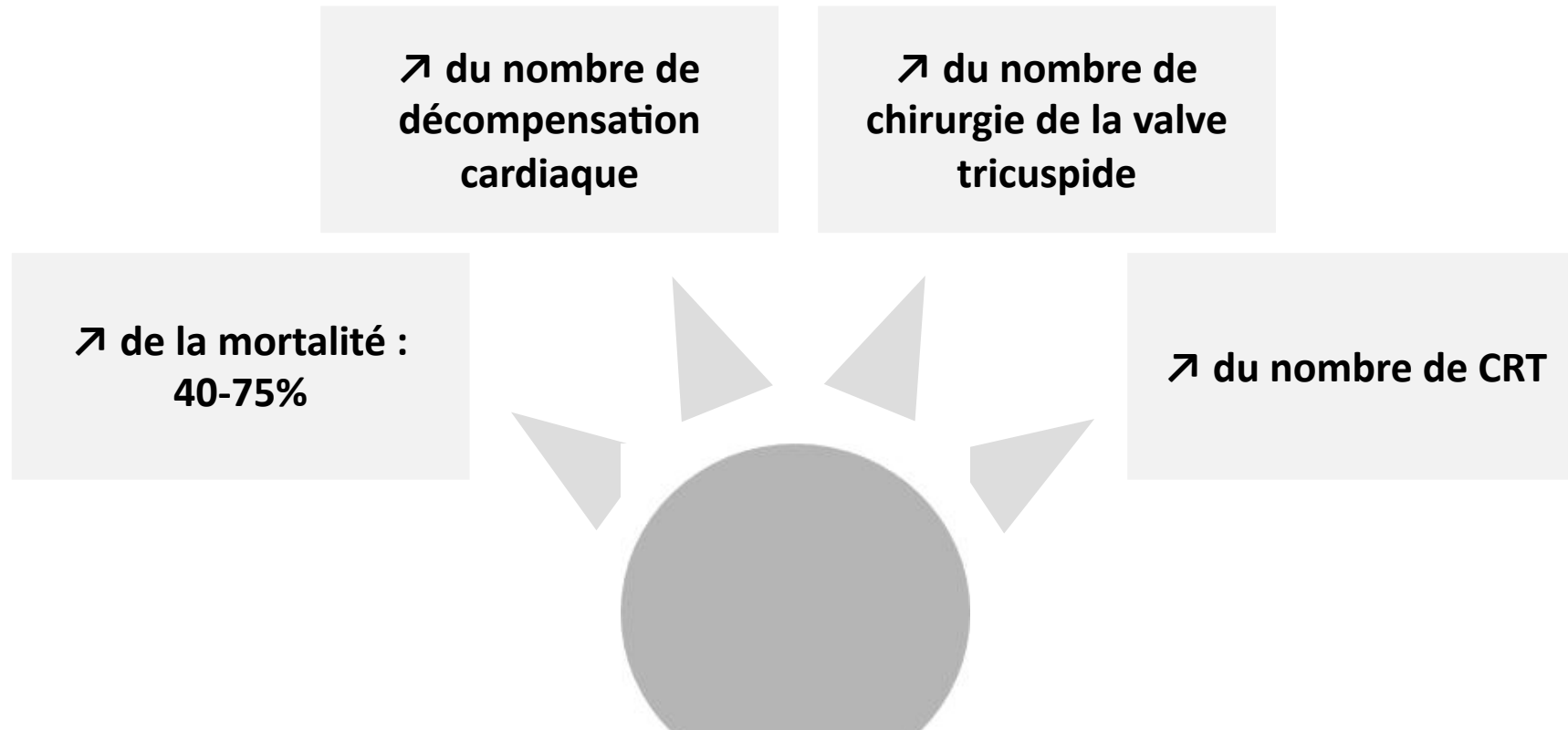
Impact of tricuspid regurgitation on long-term survival - JACC - 2004

- 239 patients (DAI 191, PM 48)
- 38% des patients ont aggravation significative de leur IT (1-1,5 ans)



Significant lead-induced tricuspid regurgitation is associated with poor prognosis at long-term follow-up - HEART - 2014

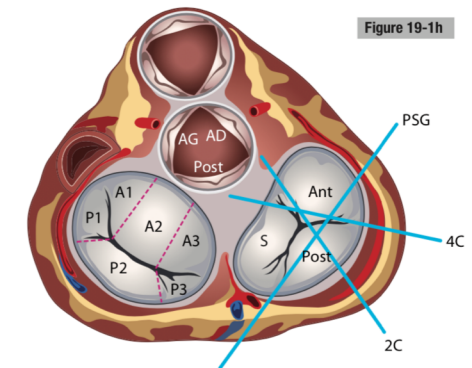
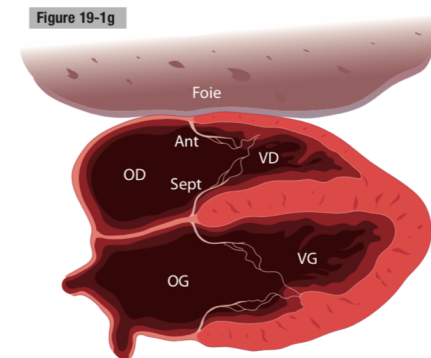
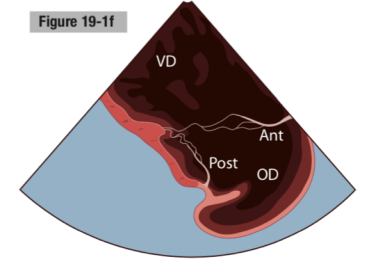
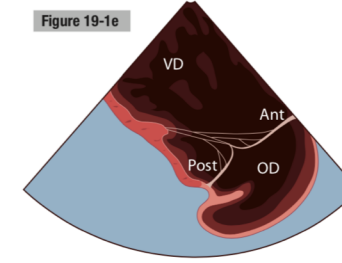
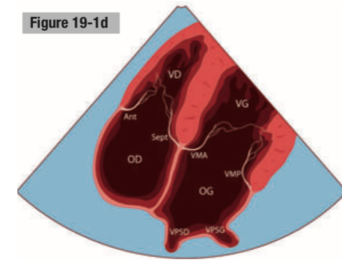
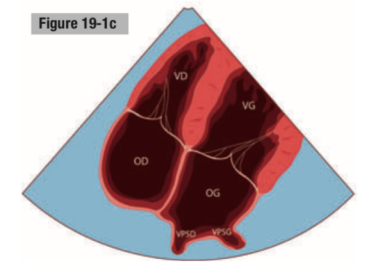
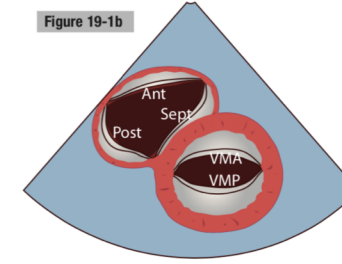
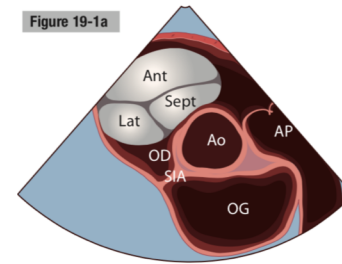
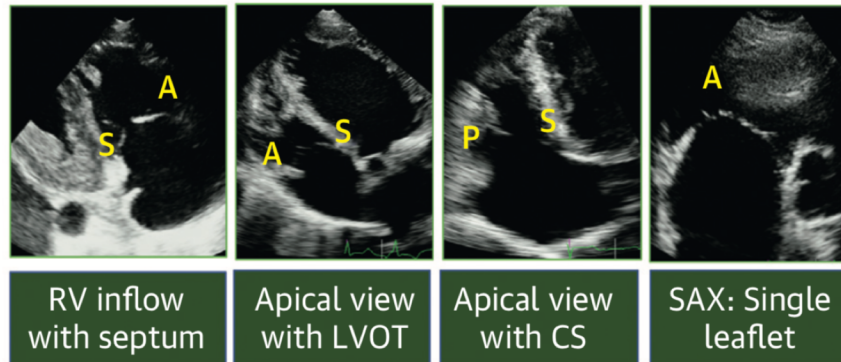
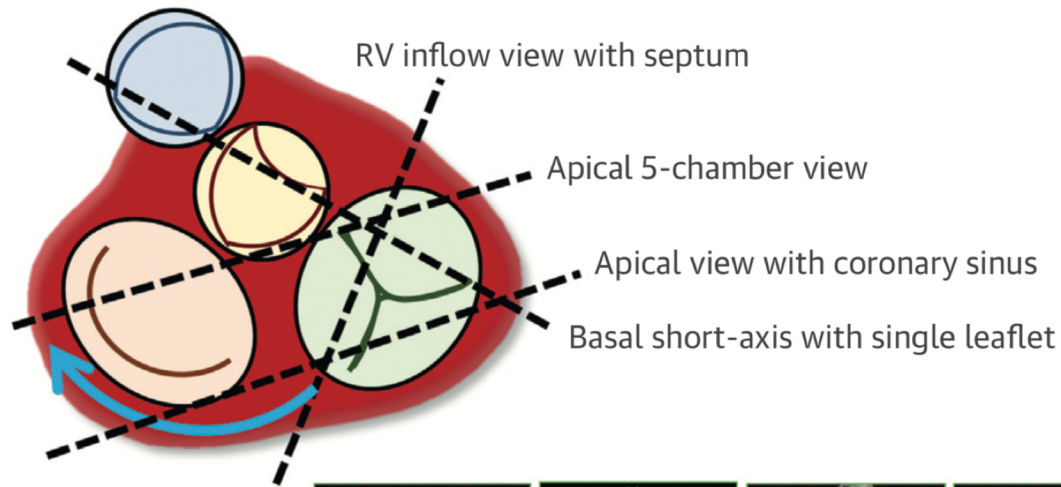
Pronostic de l'IT chez l'implanté



Sévérité d'une insuffisance tricuspide en ETT

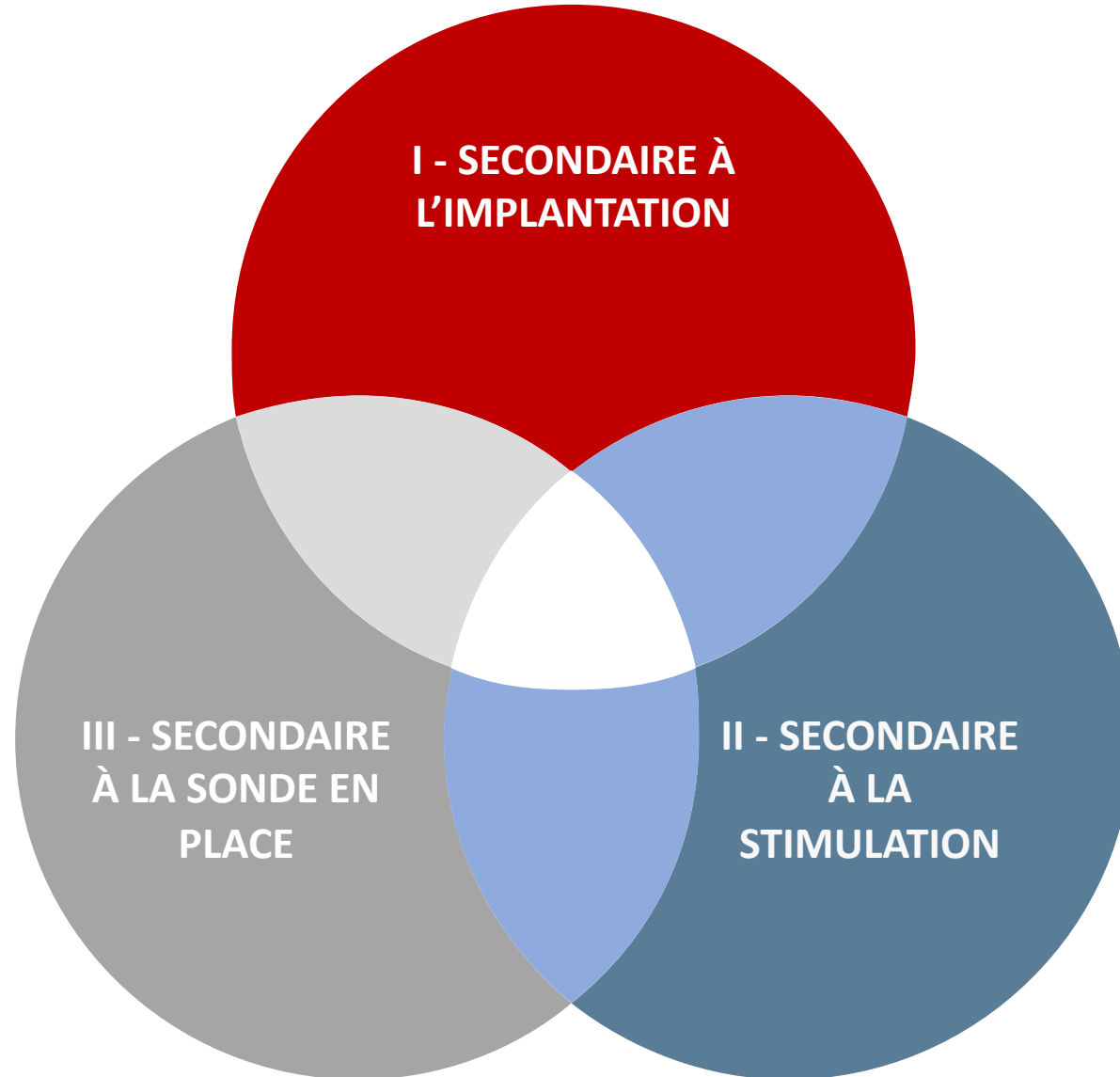
PARAMETRES	Modérée	Moyenne	Sévère
Quantitatifs			
SOR (mm ²)	Non définie	Non définie	> 40
VR (ml)	Non définie	Non définie	> 45
Semi-quantitatifs			
Vena-contracta (mm)	Non définie	< 7	> 7
Rayon de PISA (mm)	< 5	6-9	> 9
Flux des veines sus-hépatique	Dominance systolique	Emoussement systolique	Flux systolique inversé
Flux tricuspide en DP	Normal	Normal	Onde E dominante (> 1 m/s)
Qualitatifs			
Morphologie de la valve	Normal/anormal	Normal/anormal	Anormal/ large défaut de coaptation/capotage
Jet en doppler couleur	Petit, central	Intermédiaire	Jet central très large ou excentré
Jet en doppler continu	Pâle/parabolique	Dense/parabolique	Dense/triangulaire avec pic précoce (pic < 2 m/s dans les IT massives)

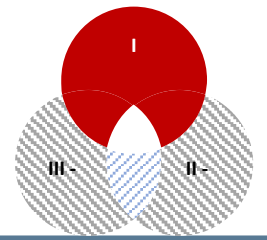
Les incidences échographiques



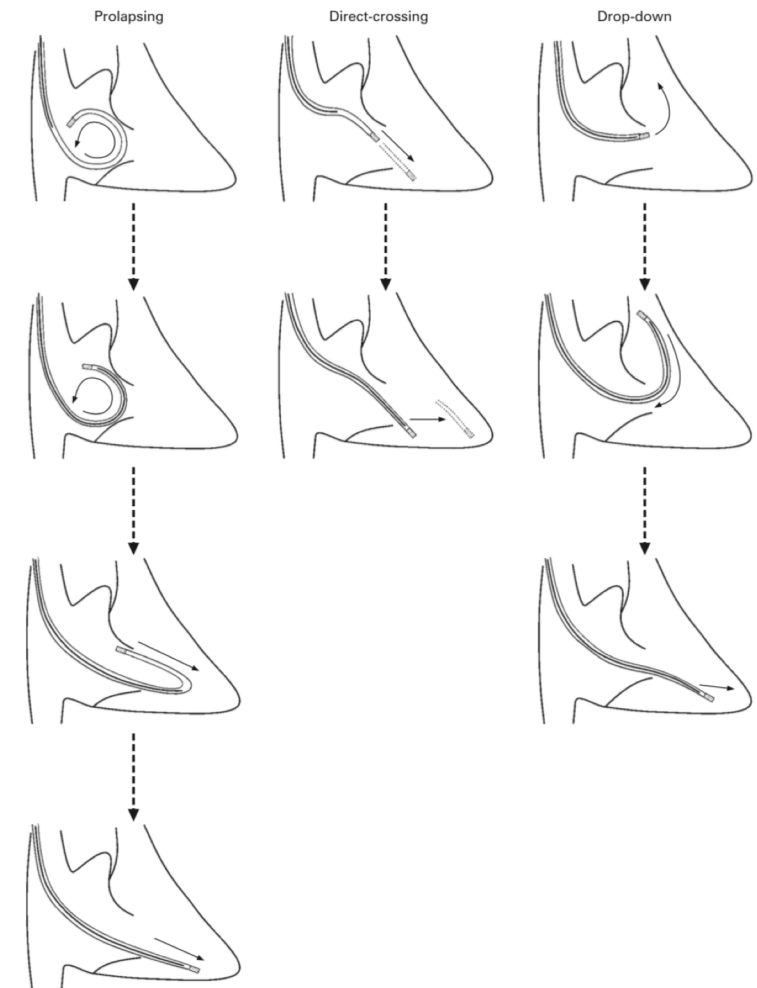
Cardiac implantable electronic device Lead-Induced Tricuspid Regurgitation - JACC CV Imaging - 2019

3 Etiologies de l'IT





- Lésion direct de la valve ou de l'appareil sous valvulaire :
 - « Direct-crossing » > « Prolapsing »
 - Le nombre de passages de la sonde à travers la valve
 - Le nombre de sondes à travers la valve
 - Sonde de DAI > sonde de PM
 - Sonde apicale > sonde chambre de chasse

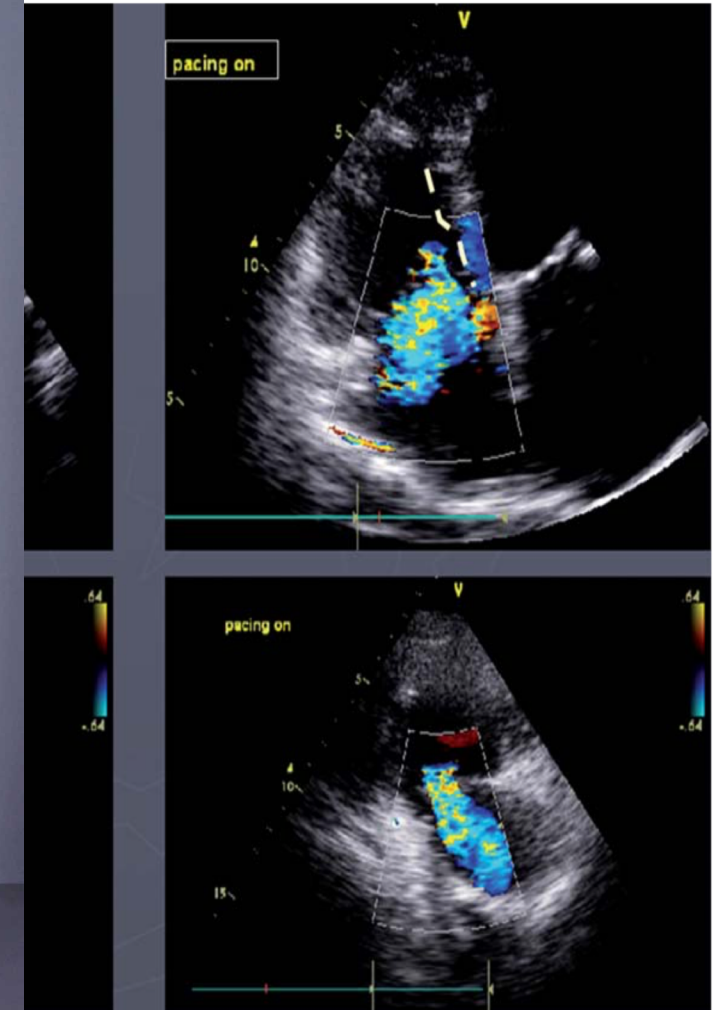


- Effet direct (débat)
 - Modification de l'activation du sé

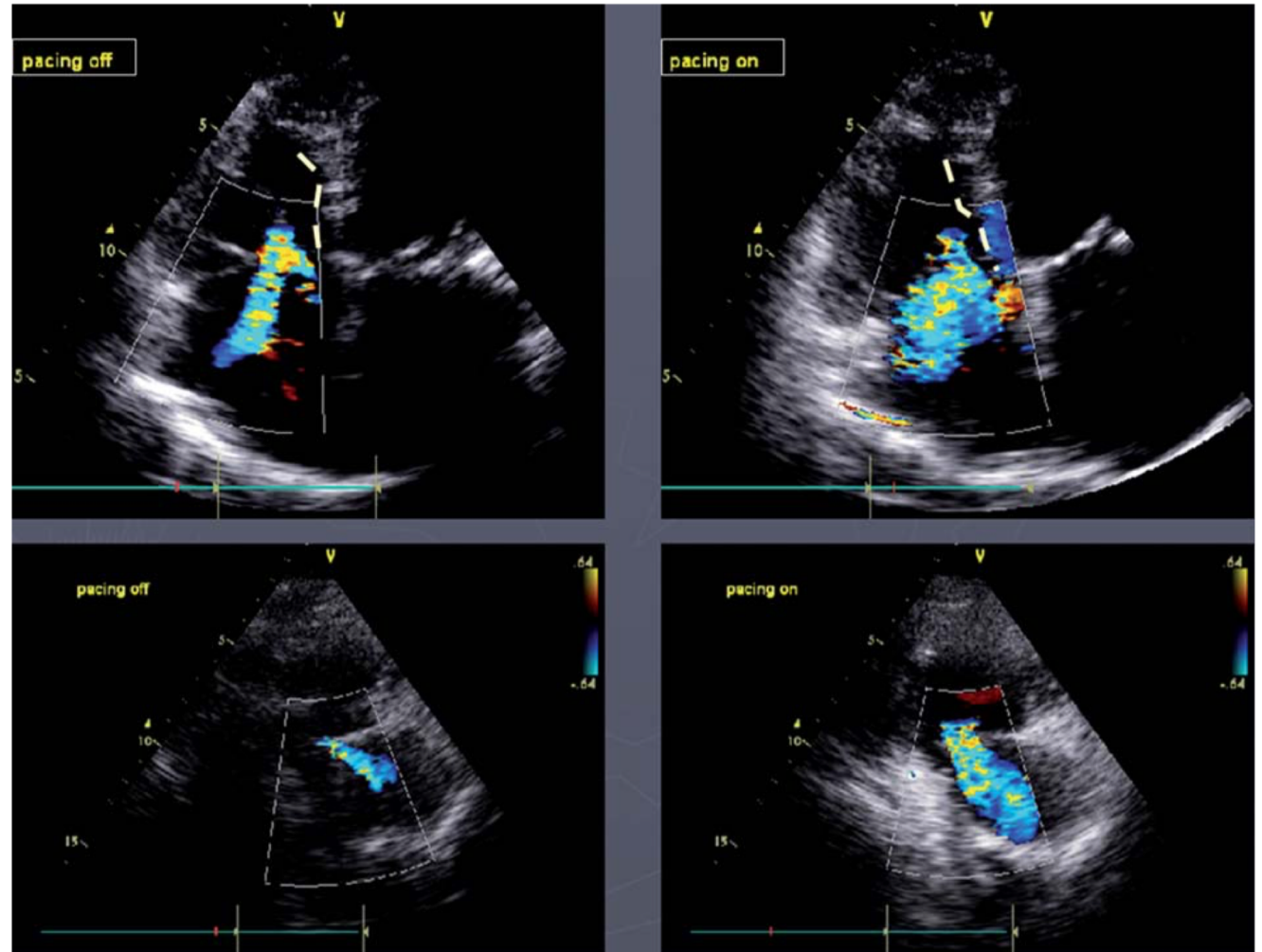
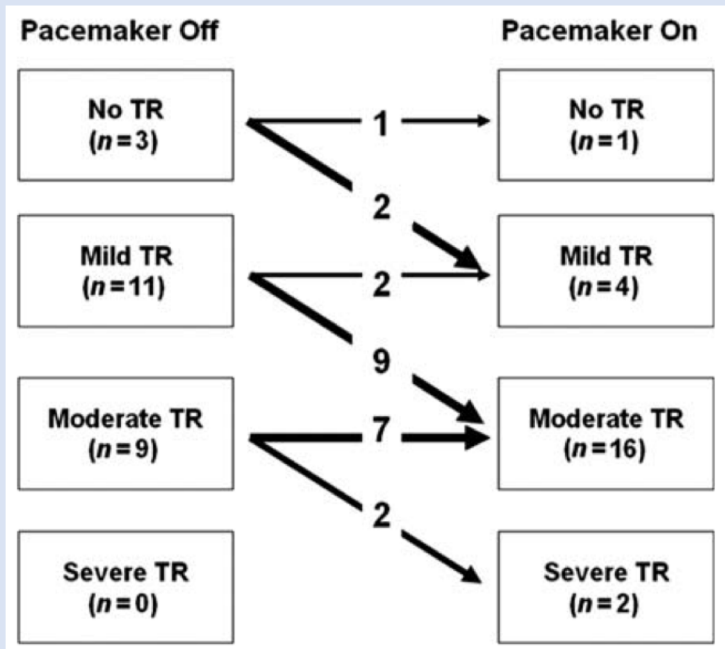


Pacemaker Off

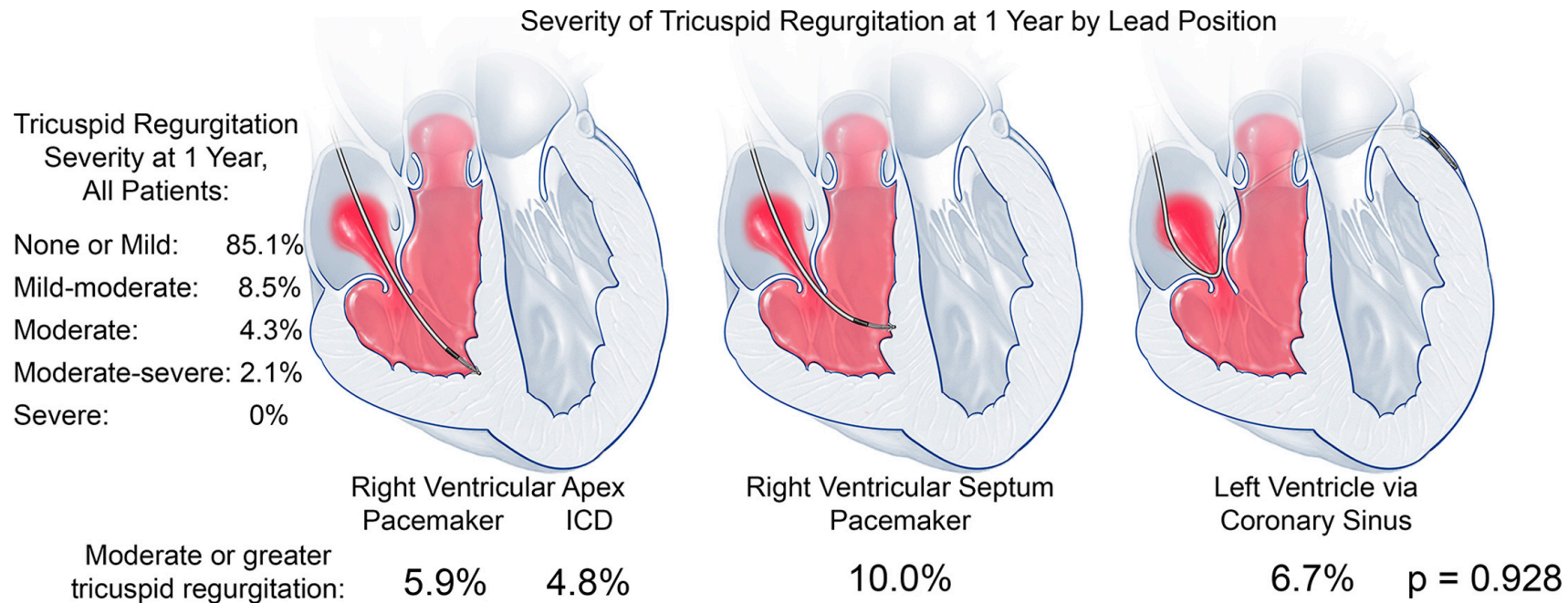
No TR (n=3)	1
Mild TR (n=11)	2
Moderate TR (n=9)	9
Severe TR (n=0)	7
	2

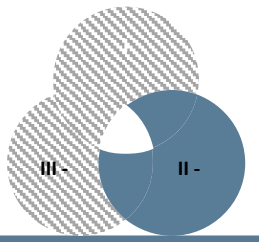


- Effet direct (débattu) :
 - Modification de la cinétique d'activation du septum

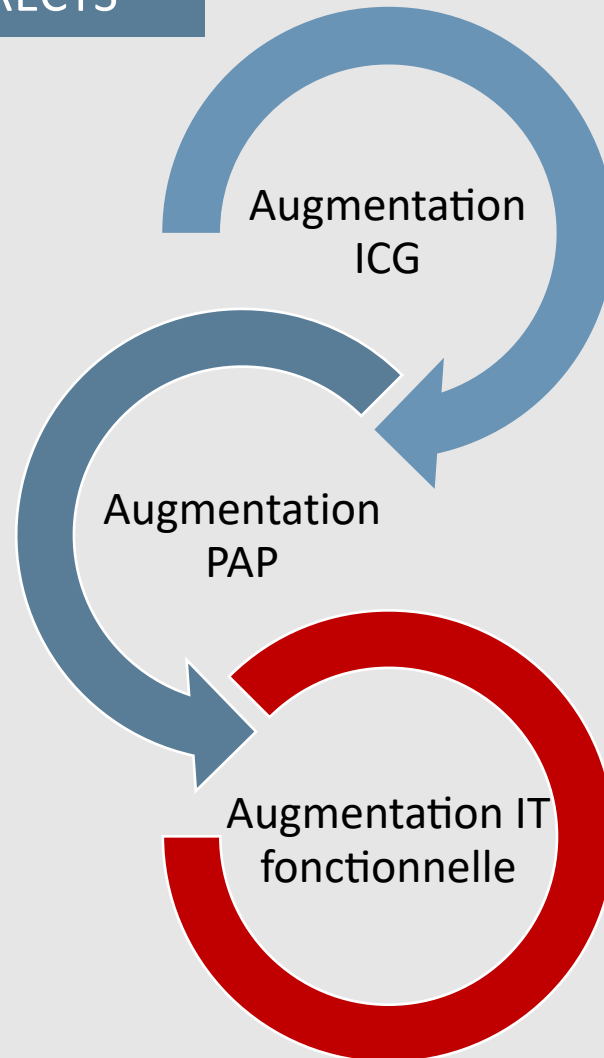


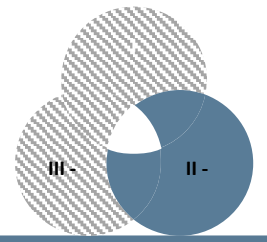
- Effet direct (débattu) :
 - 63 patients
 - Rando 1:1:1
 - Pas de différence selon la localisation de la sonde



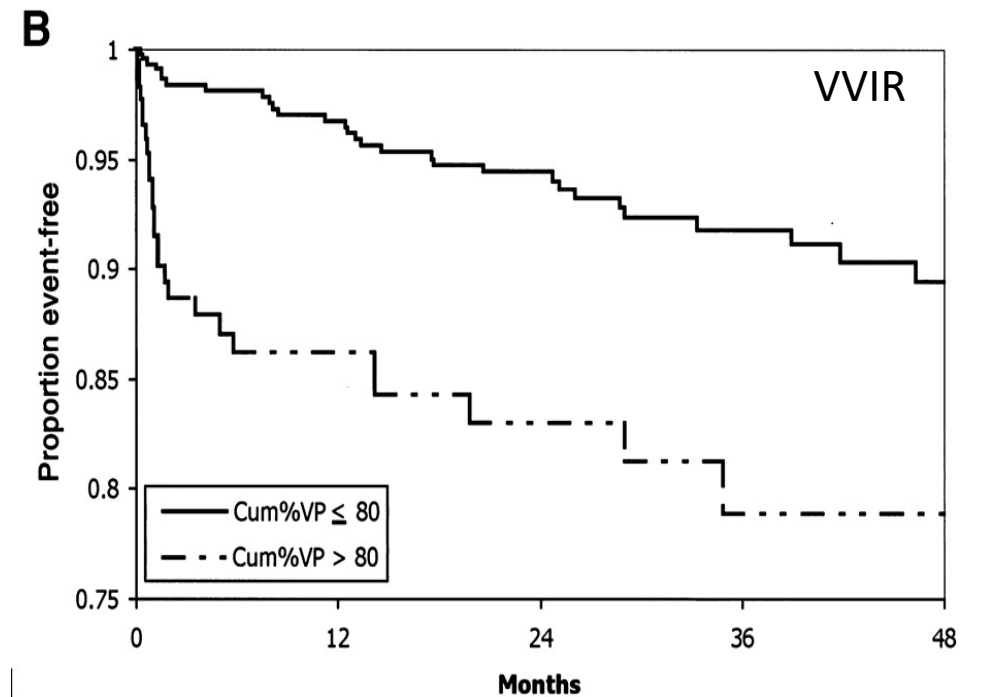
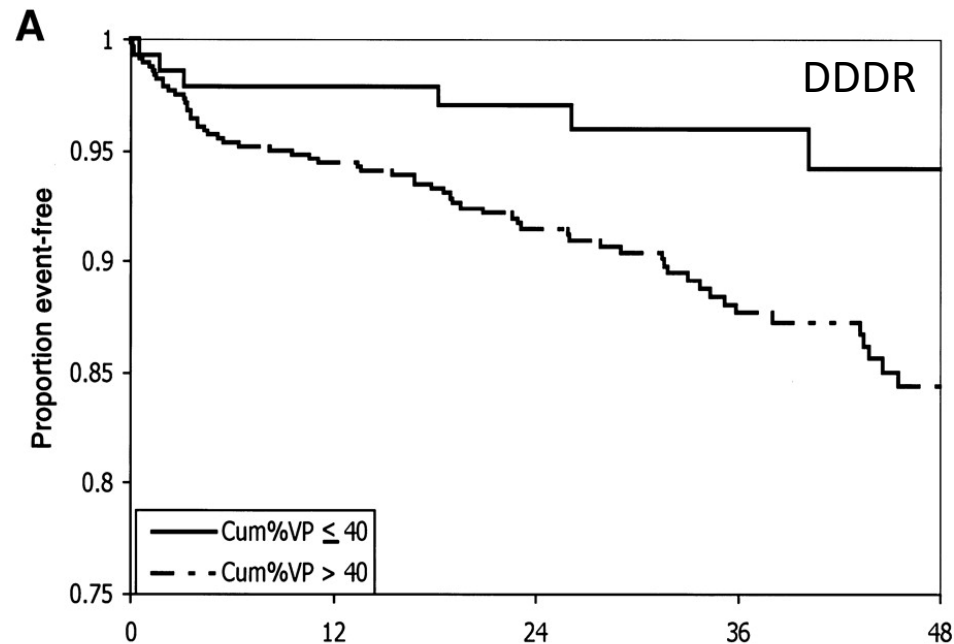


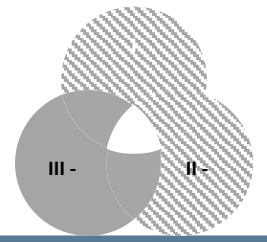
EFFETS INDIRECTS



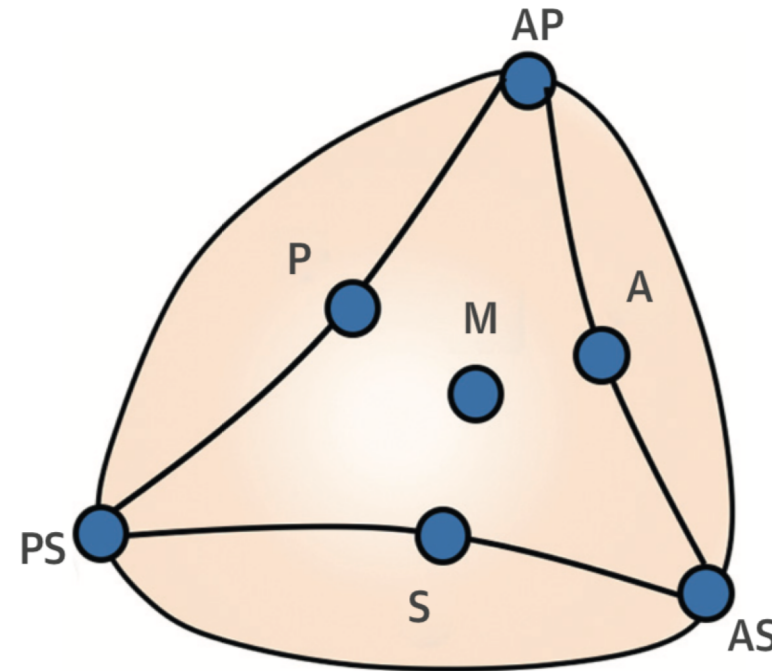


- Sous-analyse de MOST (VVI vs DDD)
- Dysfonction sinusale
- 2000 patients
- Hospitalisation pour insuffisance cardiaque

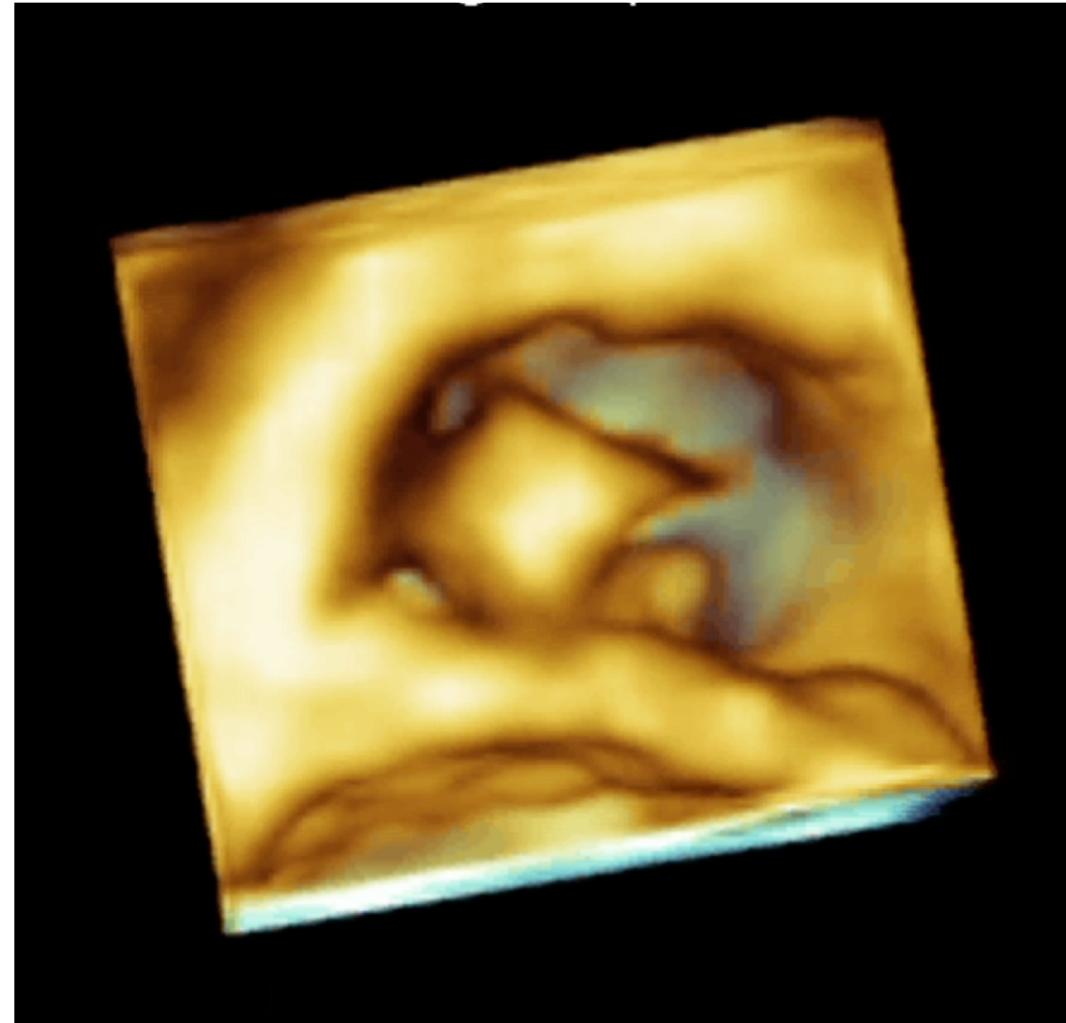
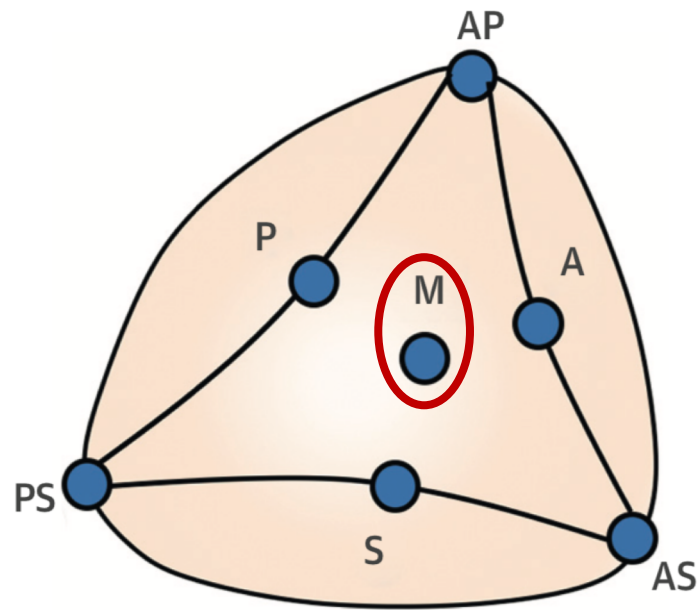
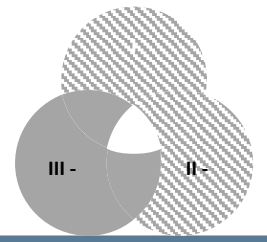


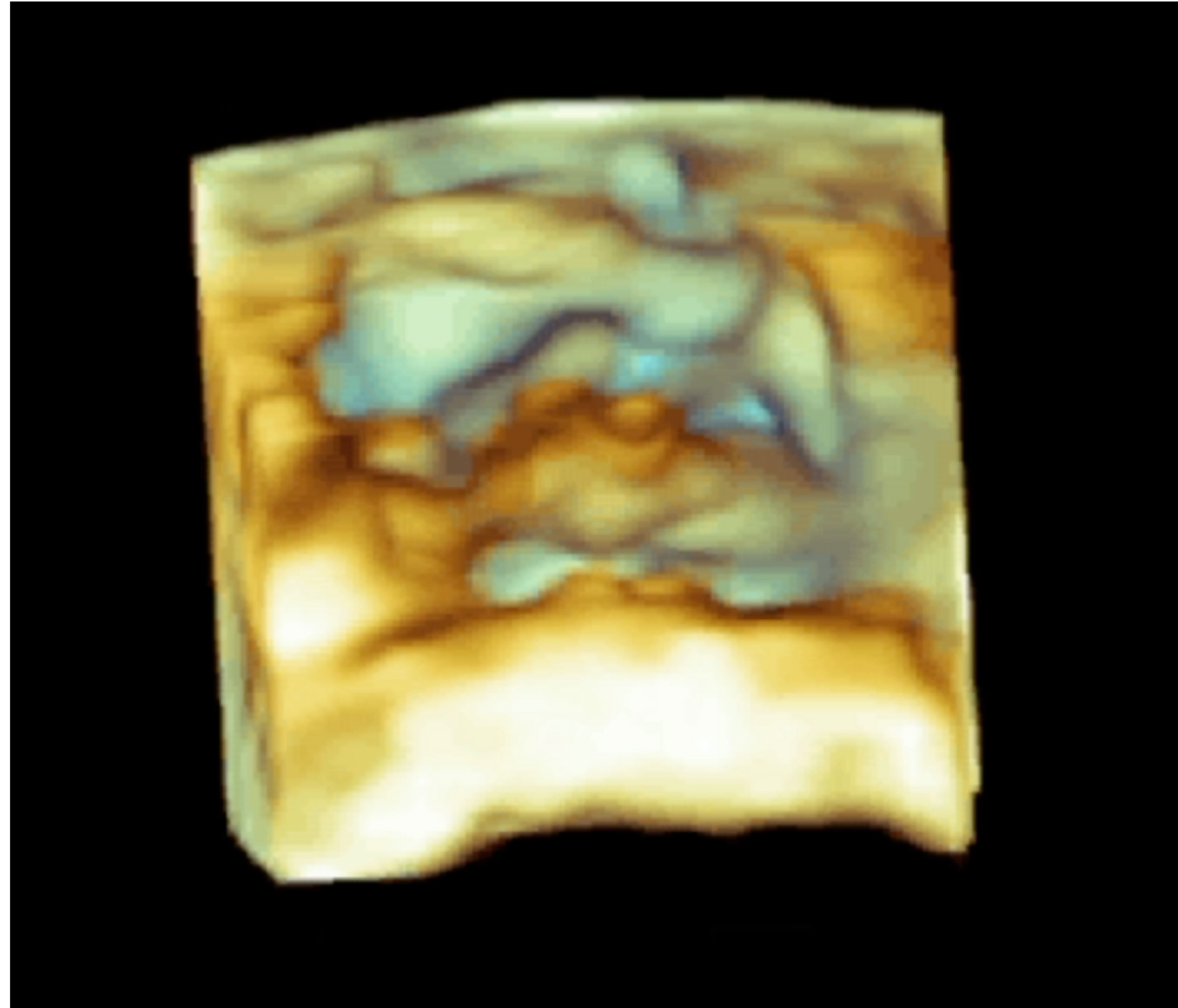
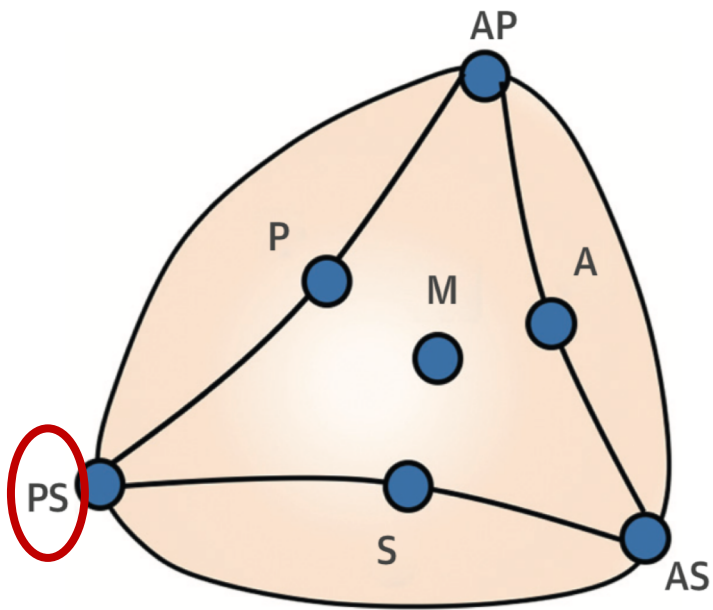
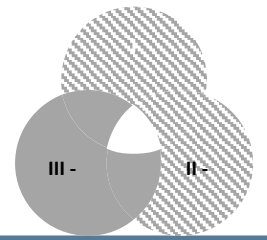


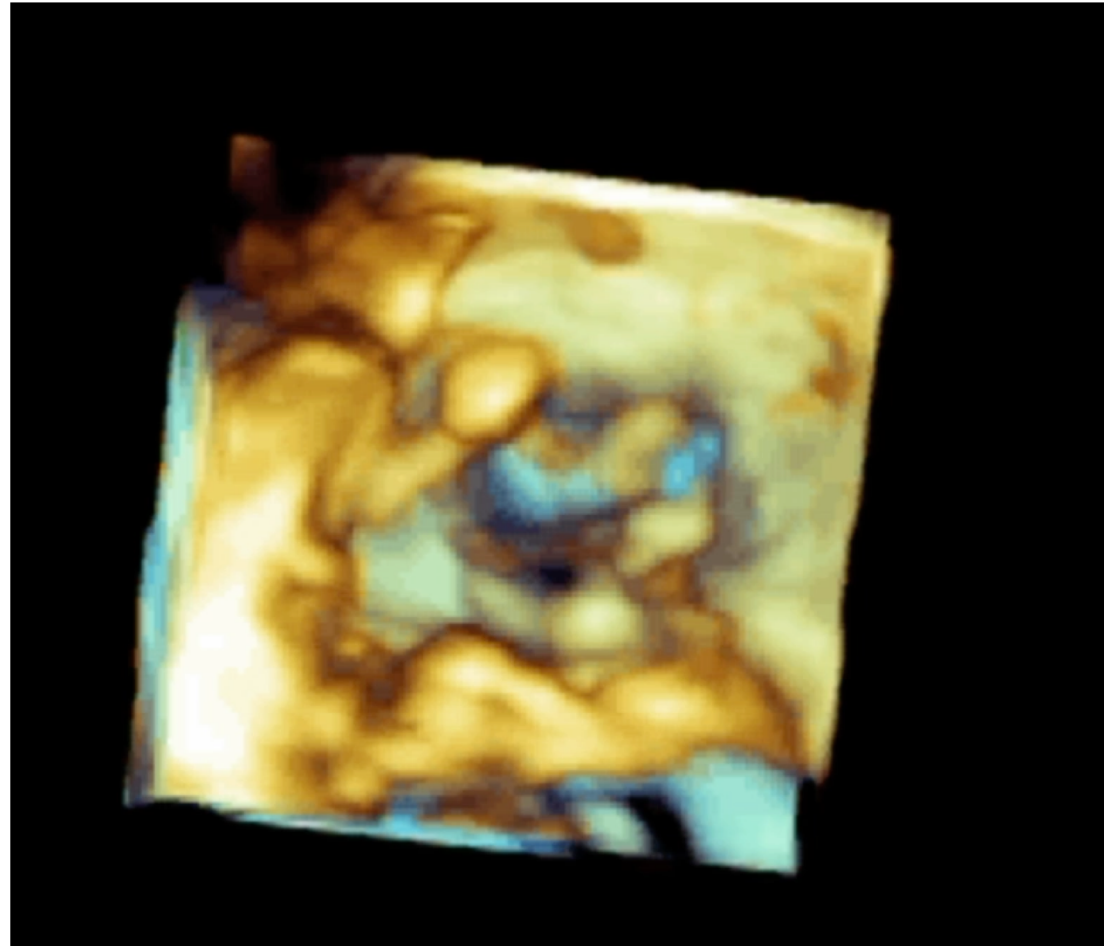
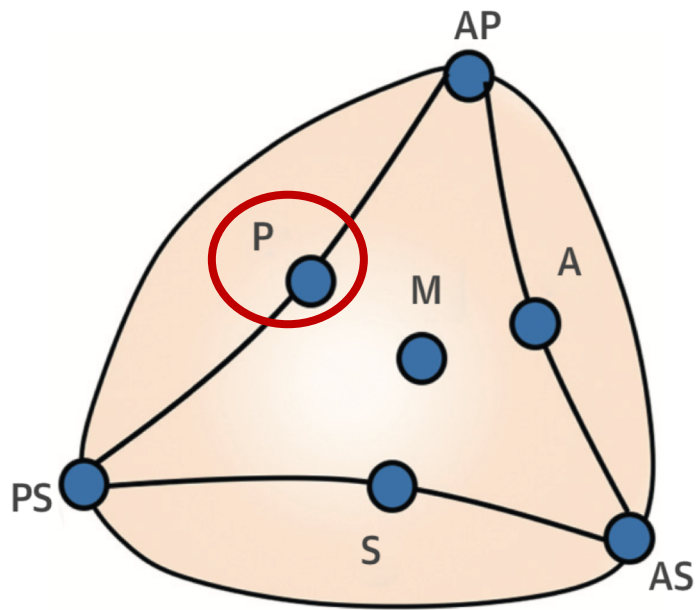
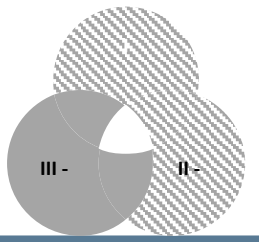
- Visualisation complète de la sonde
 - ETT : 15 %
 - ETO : 74 %
- Position
 - Centrale et commissurale = moins d'IT

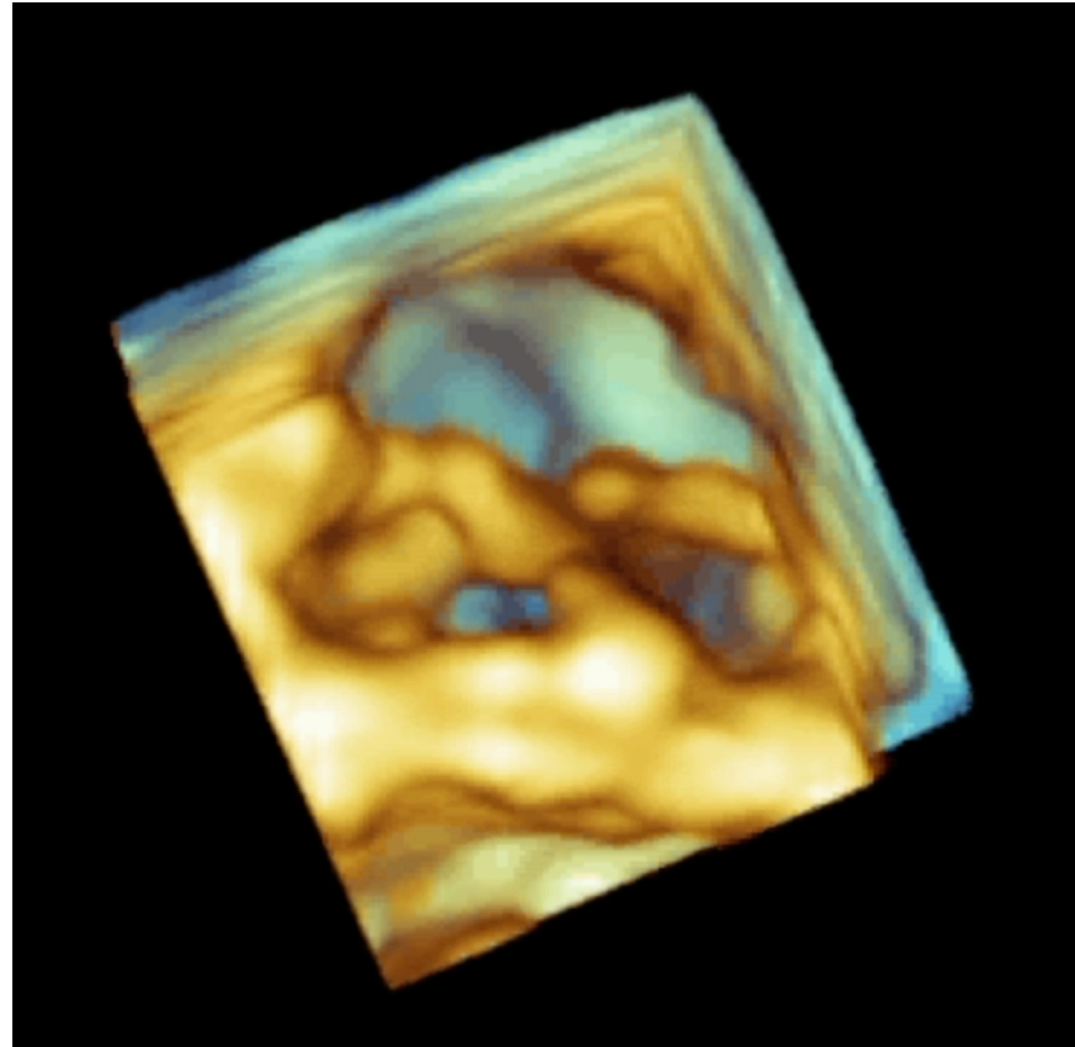
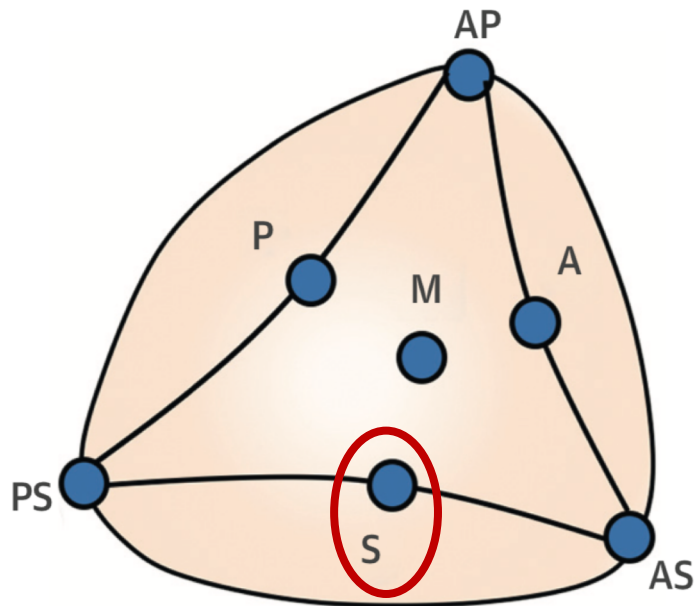
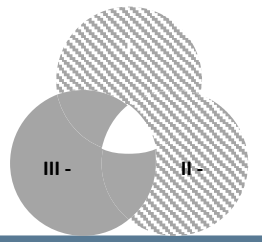


III - Position centrale





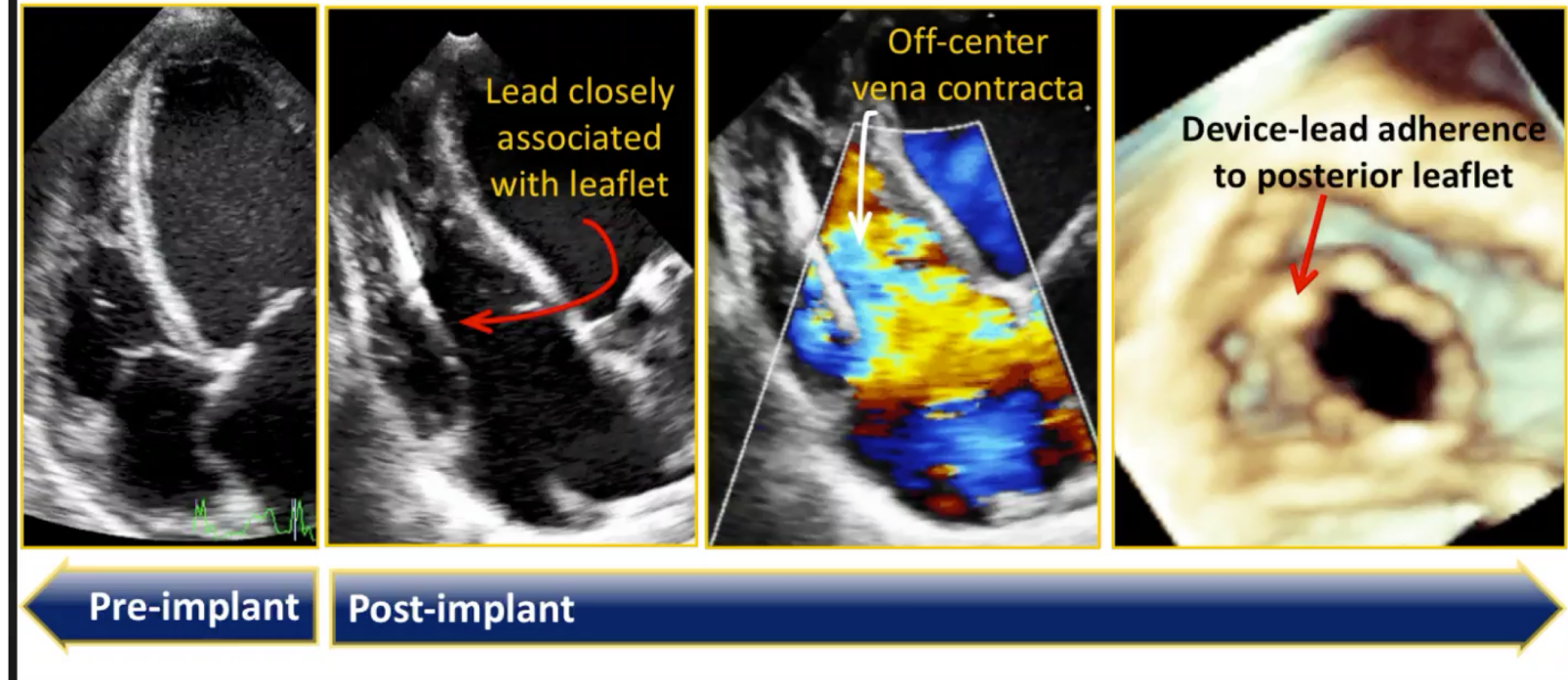






Prevalence and Mechanism of Tricuspid Regurgitation following Implantation of Endocardial Leads for Pacemaker or Cardioverter-Defibrillator – Journal of American Society of Echocardiography - 2012

- VC au-dessus du plan de l'anneau
- Flux de régurgitation le long de la sonde
- Défaut de coaptation
- Adhérence de la sonde (feuillet/ app ss-valvulaire)
- Perforation du feuillet



Objectifs de cette présentation

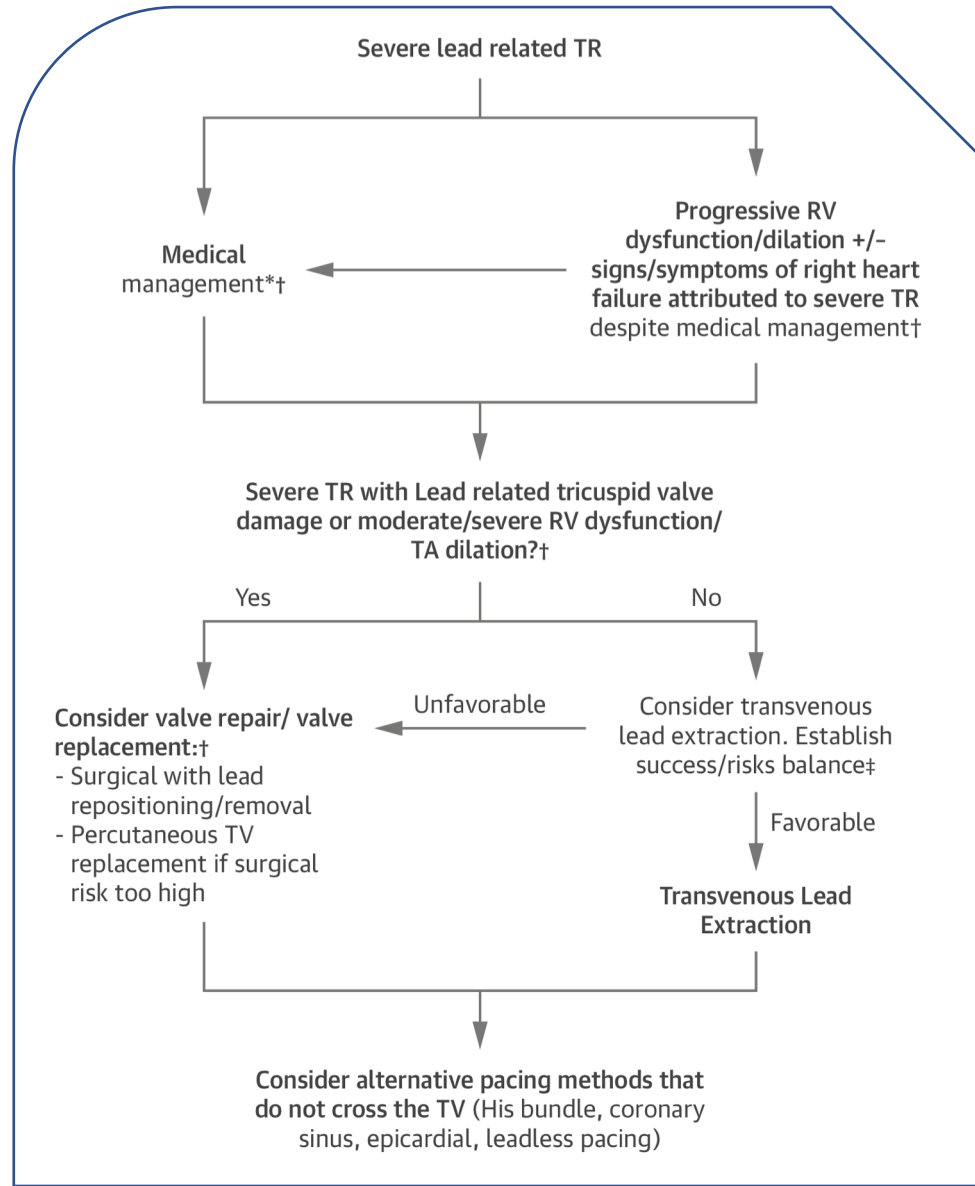
1

Quand suspecter une insuffisance tricuspide sur sonde

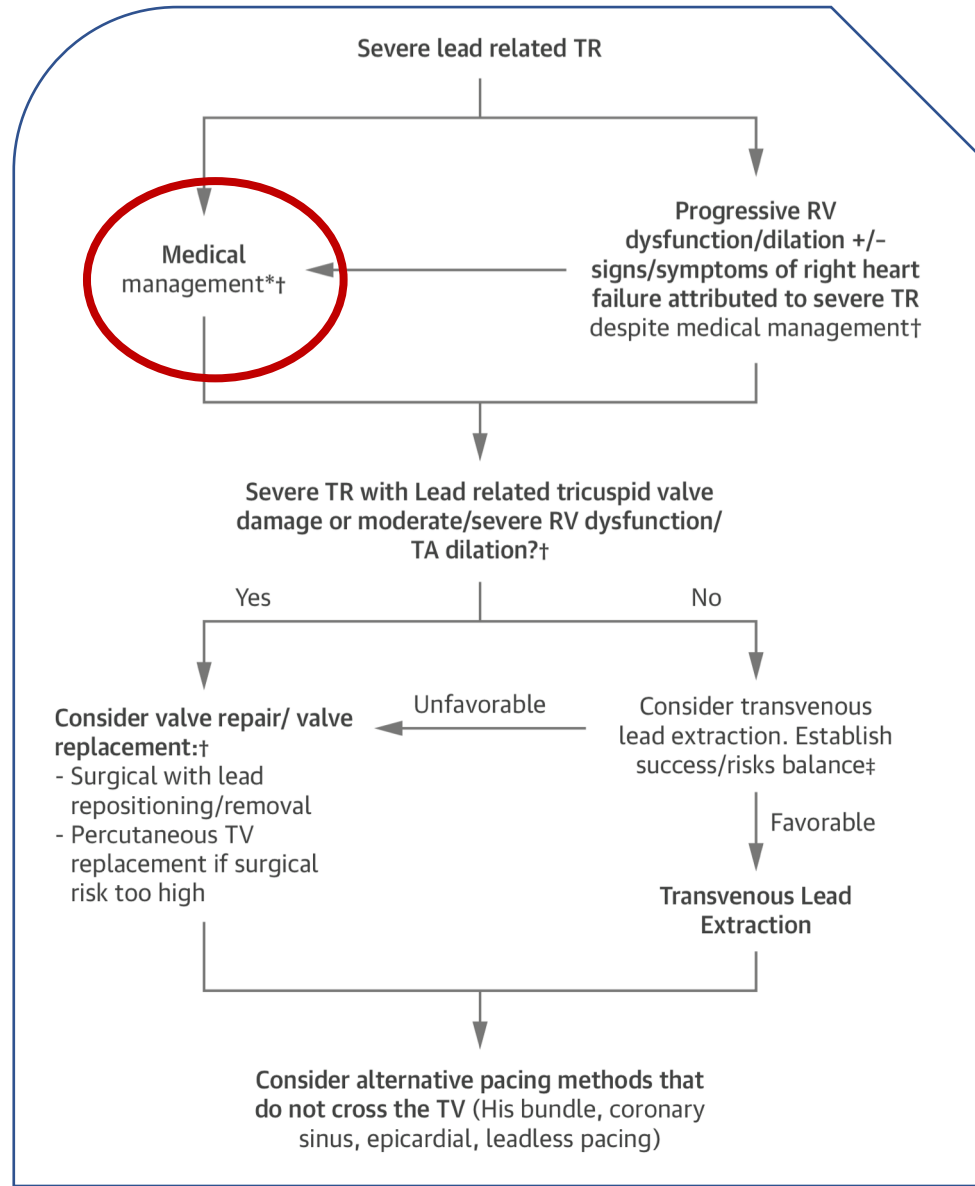
2

Comment prendre en charge cette valvulopathie

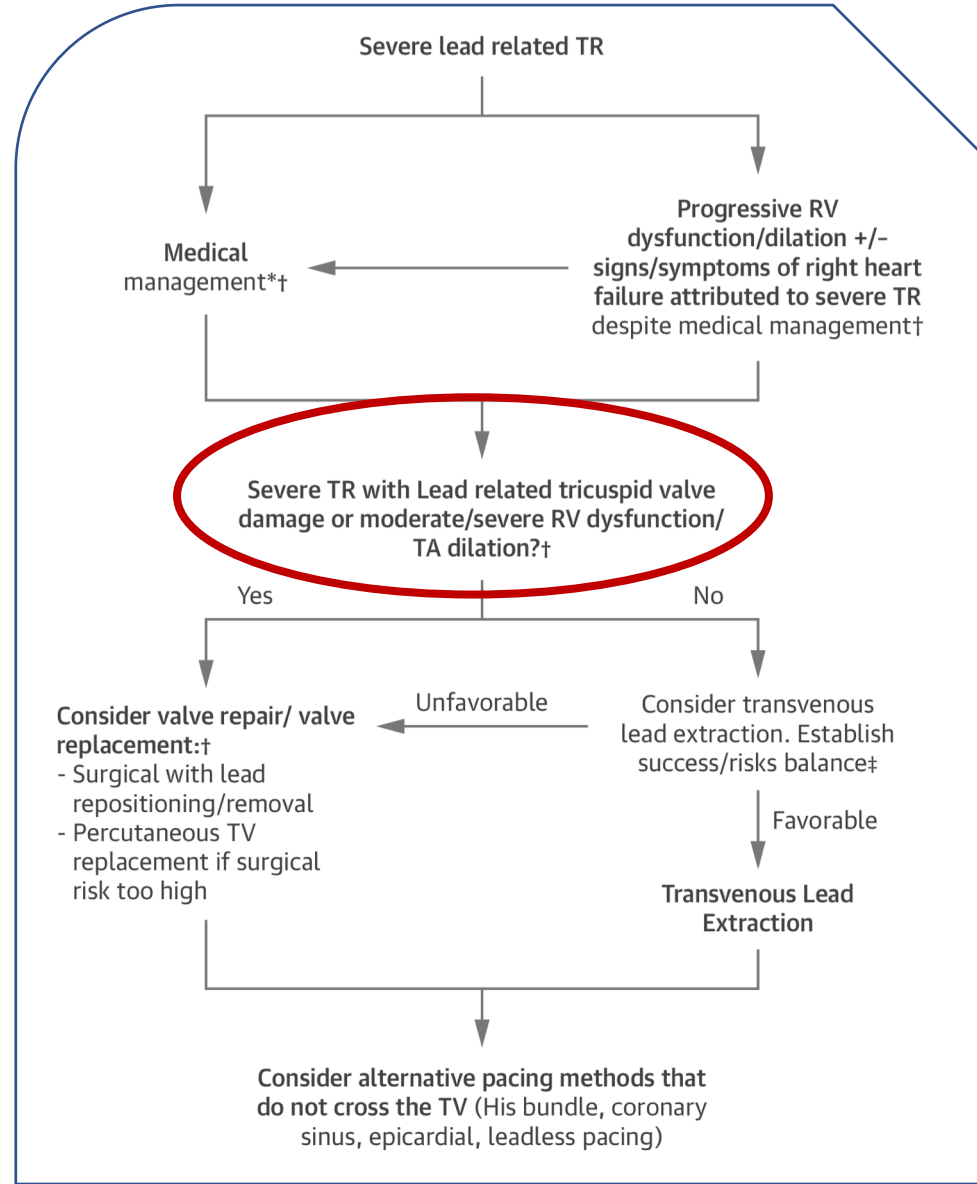
Prise en charge



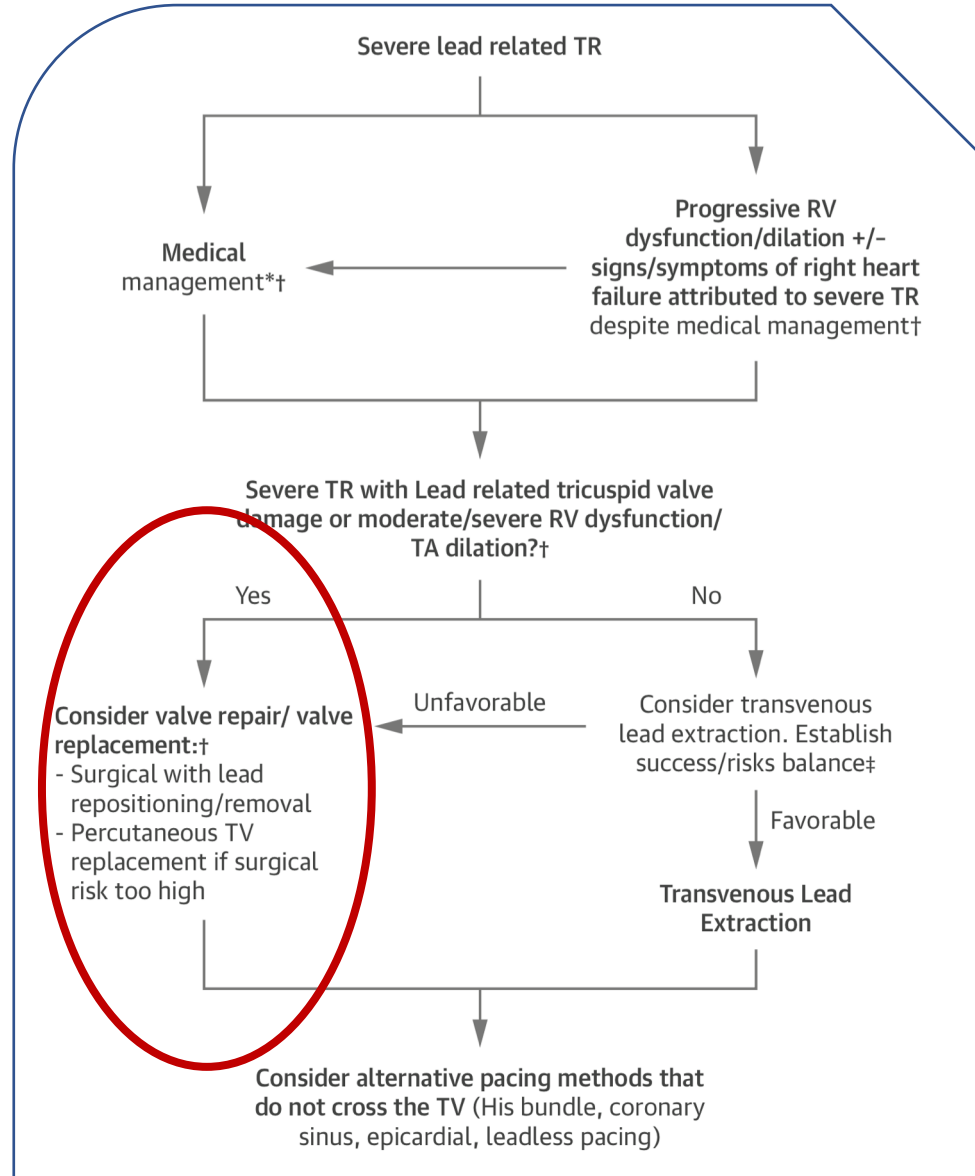
Prise en charge



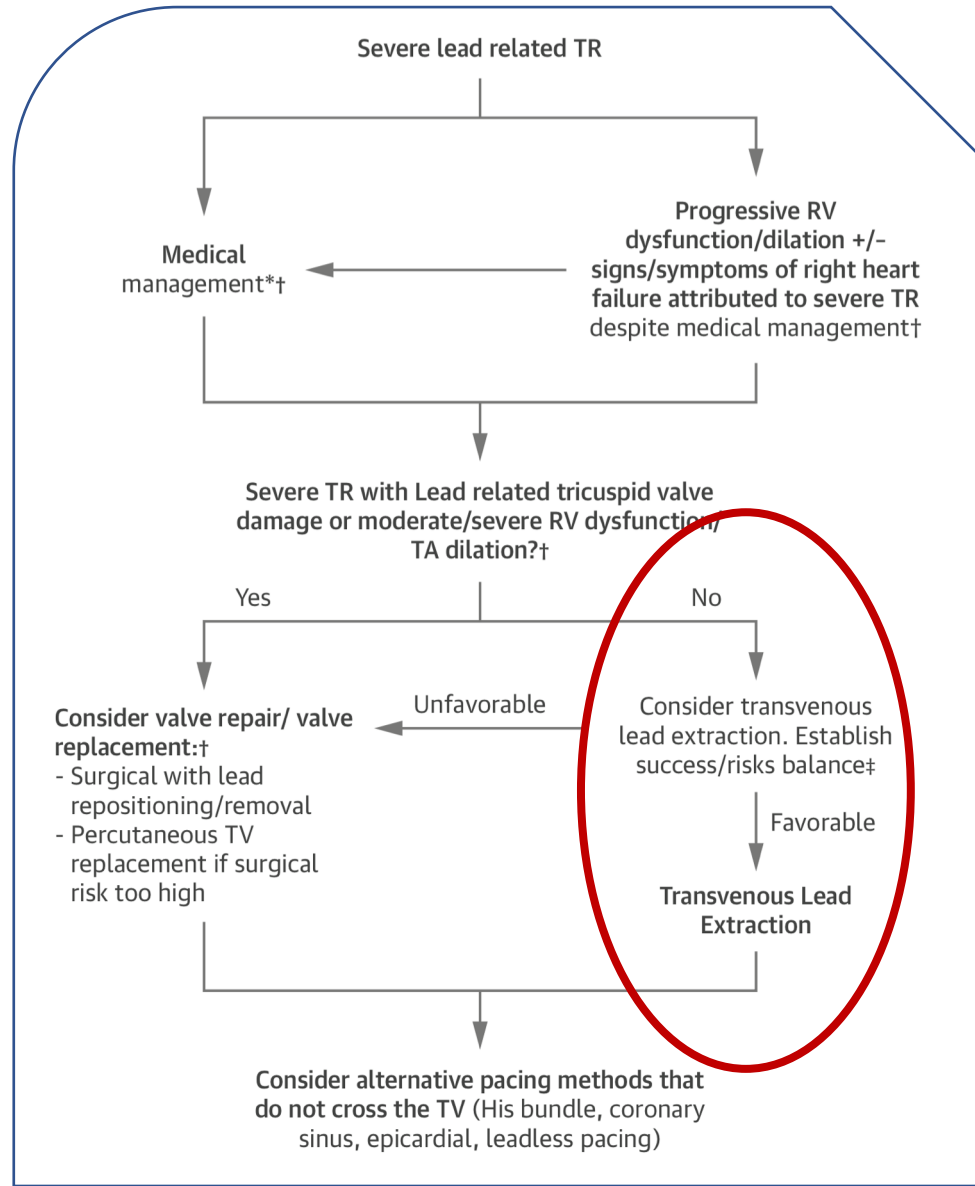
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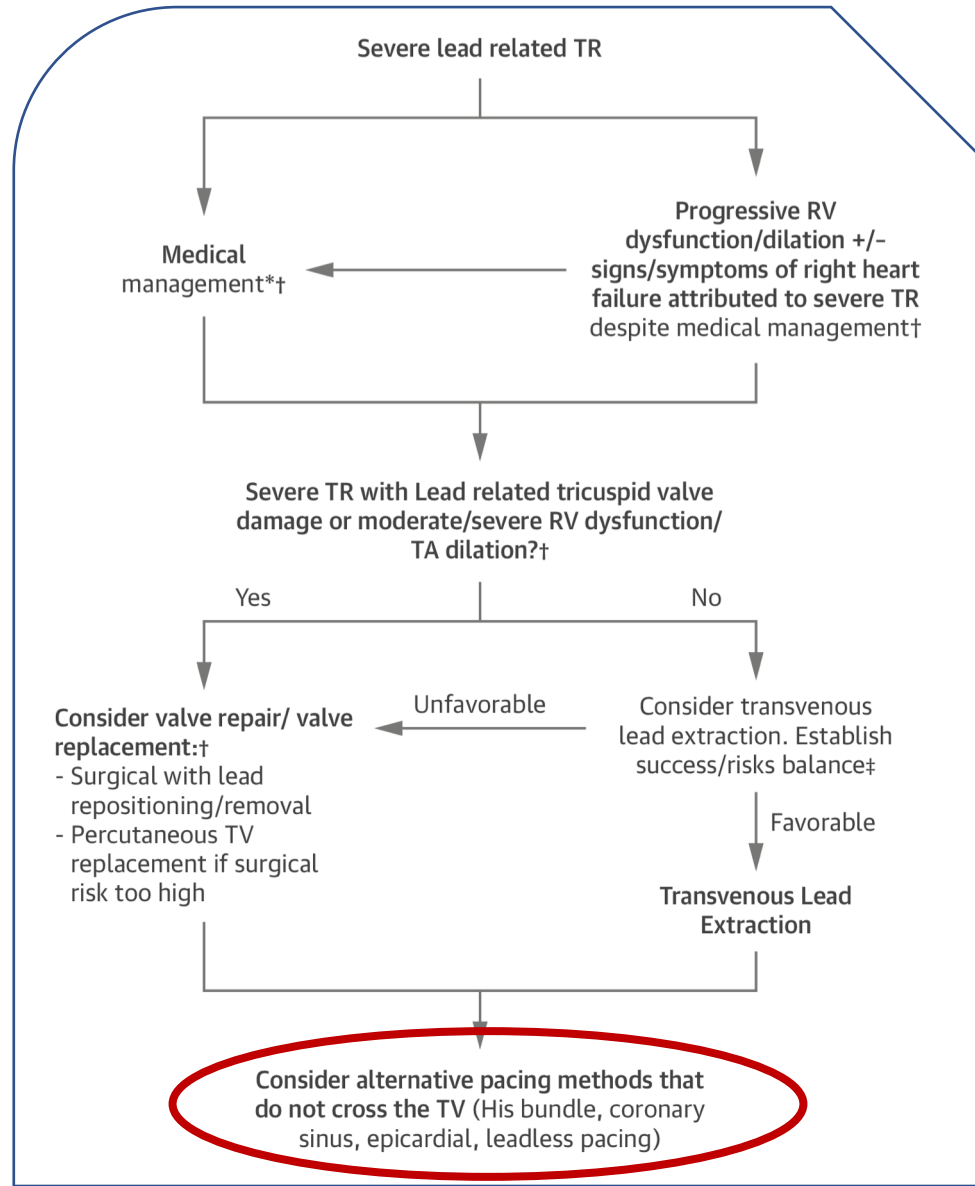
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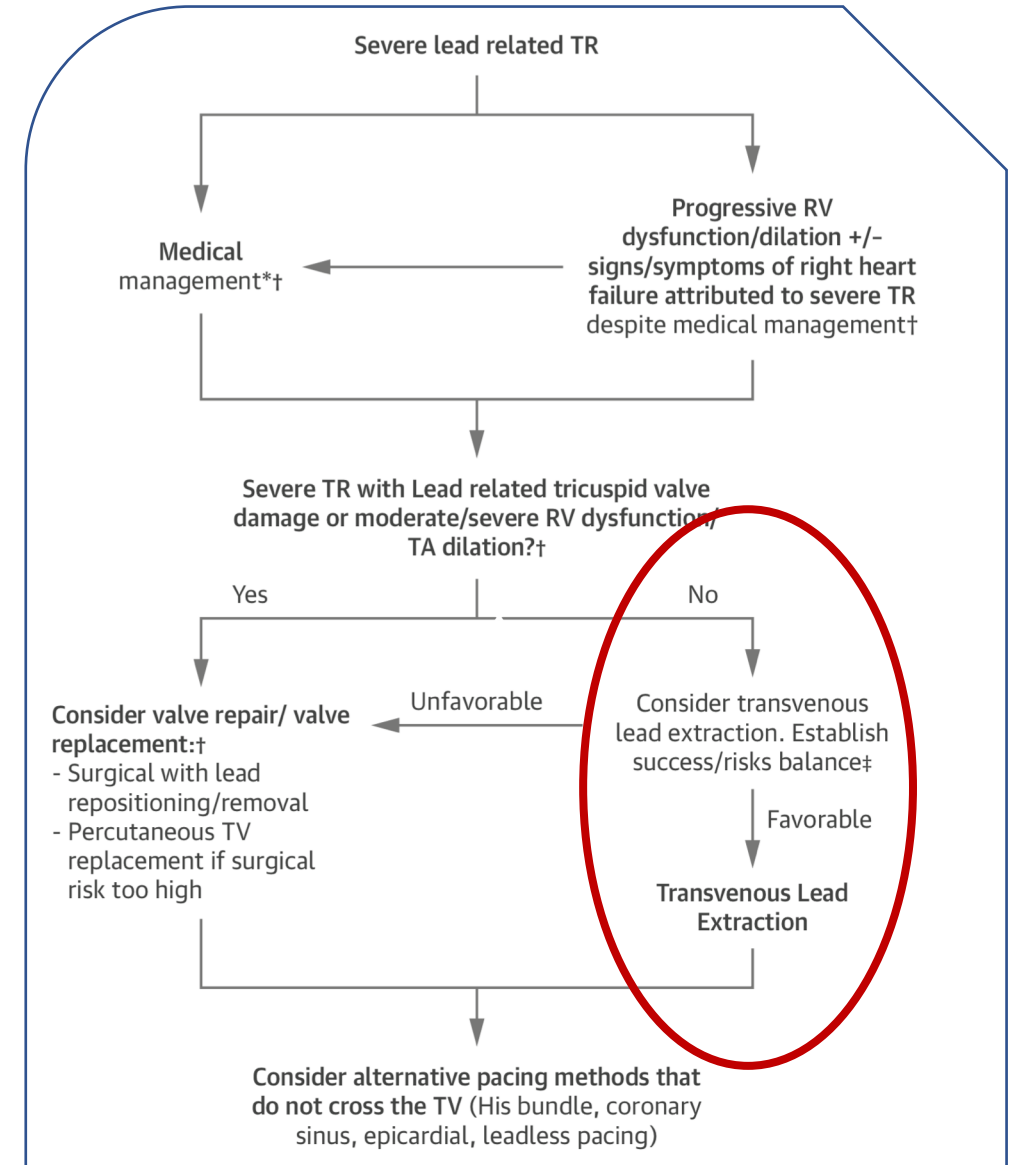
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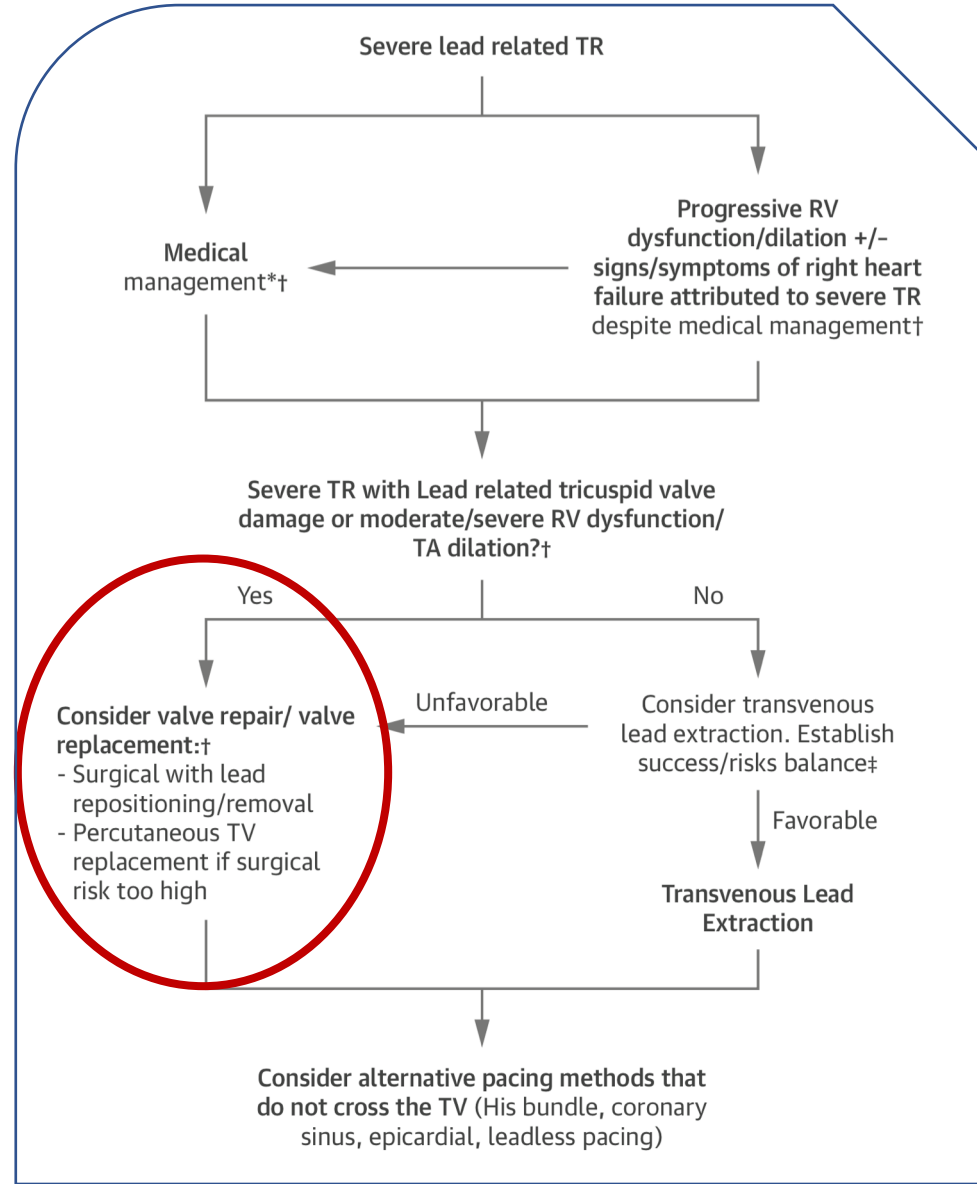
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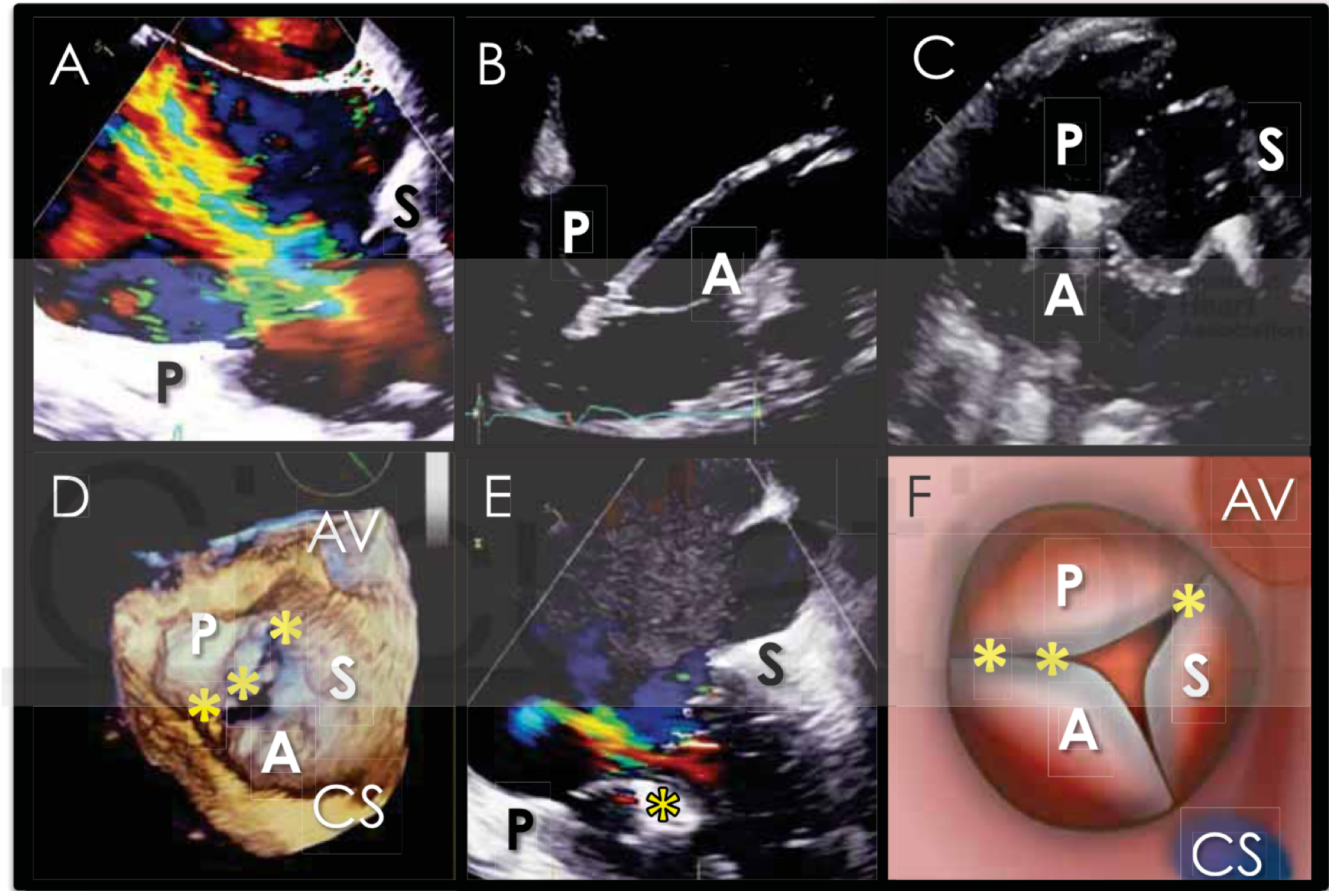
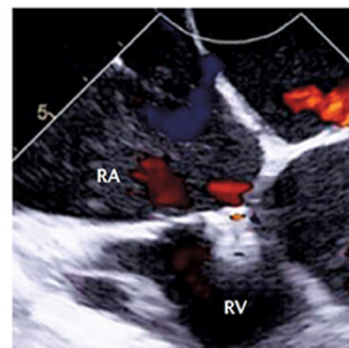
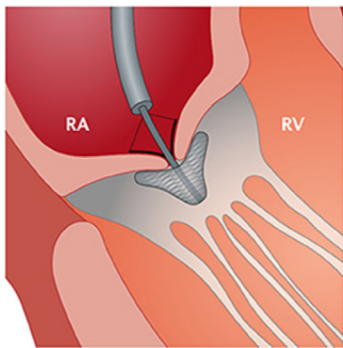
- Aucune donnée prospective sur l'extraction en dehors de l'infection de matériel
- Risque de lésion de la valve et de majoration de l'IT
- Extraction si :
 - Absence de dysfonction VD
 - Absence de dilatation de l'anneau
 - Absence de lésion de la valve
- Technique :
 - Traction si sonde < 1 an
 - Gaine (+/- active) si sonde > 1 an

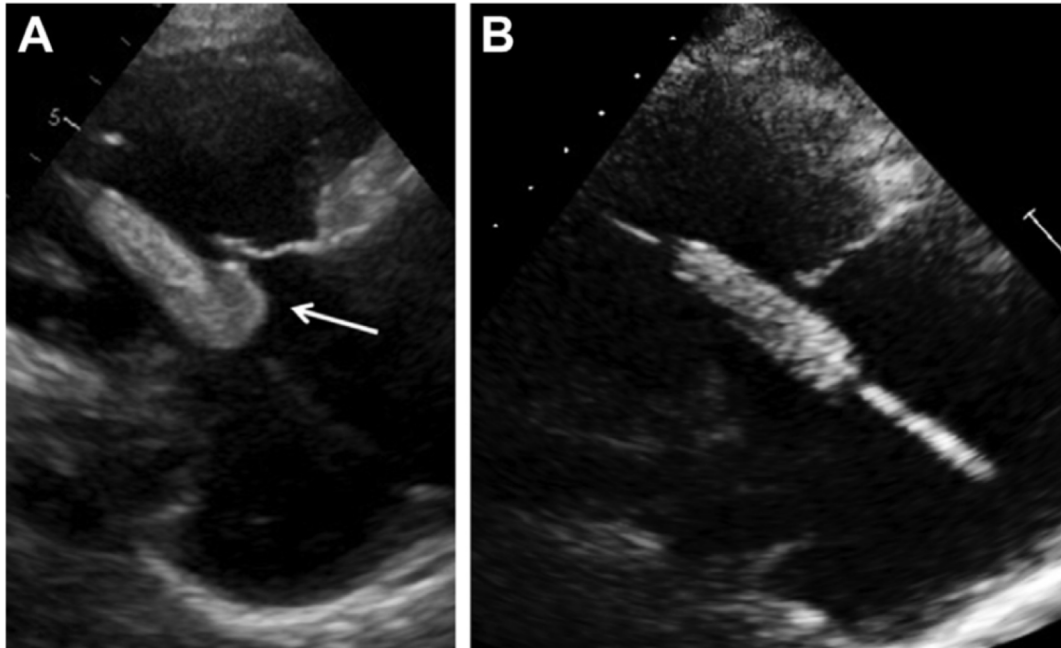


Prise en charge

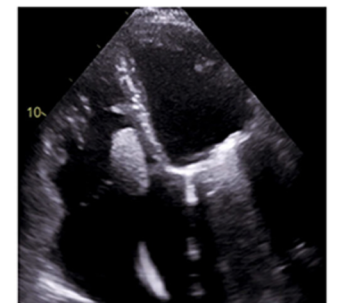
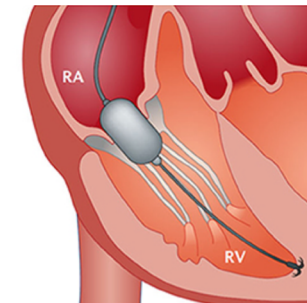
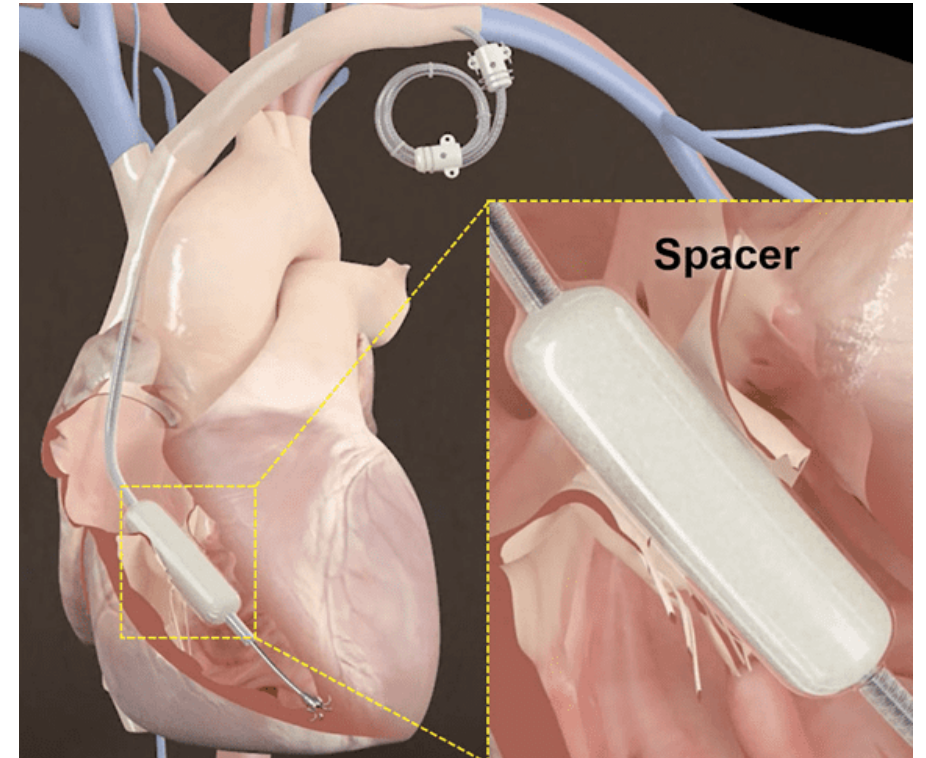


- Edge-to-edge repair using a MitraClip (Abbott) :
- 22/64 patients





- The investigational FORMA transcatheter tricuspid valve repair system (Edwards)
- 3/18 patients



Parce qu'ils ne sont jamais à court d'imagination...

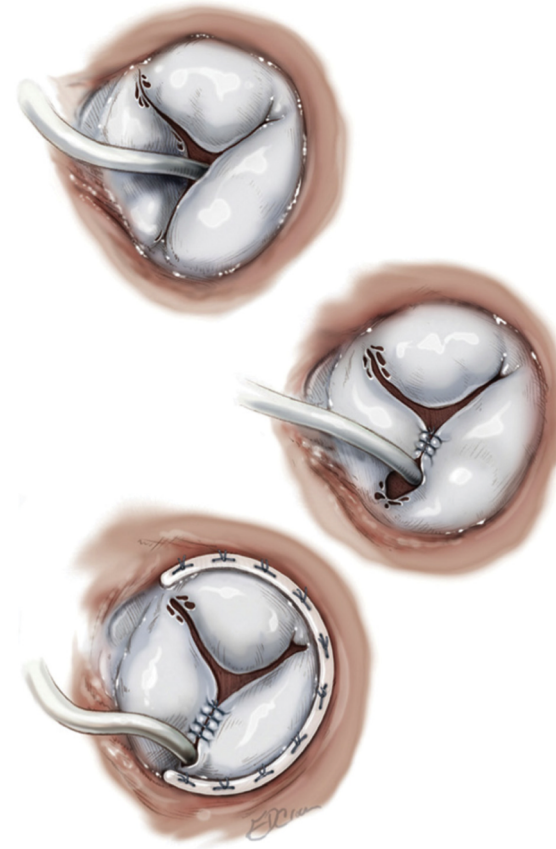


Fig 2. Steps of repair: (1) Mobilized defibrillator lead and leaflets of tricuspid valve, (2) lead repositioned in cleft between septal and inferior/posterior leaflets with suture approximation of leaflets above cleft, and (3) repositioned lead with cleft closure and tricuspid valve annuloplasty.

Stimulation après chirurgie de la valve tricuspide (ESC 2021)

**Sonde épiscopique per-
chirurgie (moins bonne
évolution)**

**Sonde endocardique
dans le sinus coronaire**

**Stimulation hissienne
(très prometteuse)**

**Pace maker sans
sonde (CI si valve
tricuspide mécanique)**

→ *Ne pas suturer la sonde entre l'anneau tricuspide et la prothèse (risque de rupture de sonde, si infection...)*

- IT iatrogène ou IT fonctionnelle secondaire ?
- Comparer les images échographiques avec une ETT antérieure à l'implantation
- Toujours faire une ETO (ETT : surestimation de l'IT, visualisation incomplète de la sonde)
- Signes échographiques :
 - Sonde adhérente à un feuillet et/ou à l'appareil sous valvulaire
 - Sonde en conflit avec un feuillet
 - Centre de la vena-contracta au-dessus du plan de l'anneau tricuspide
 - Flux de régurgitation le long de la sonde
 - Défaut de coaptation des feuillets

Prise en charge de l'IT sévère

