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5-6 DÉCEMBRE 2024

HOTEL VILLA MASSALIA,
MARSEILLE | FRANCE

18^{èmes} journées françaises
pratiques de rythmologie
& de stimulation cardiaque

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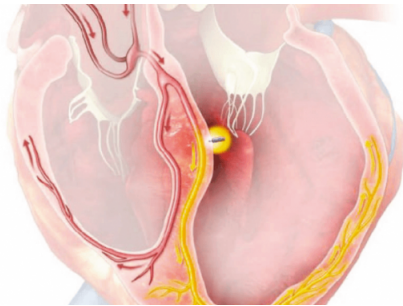
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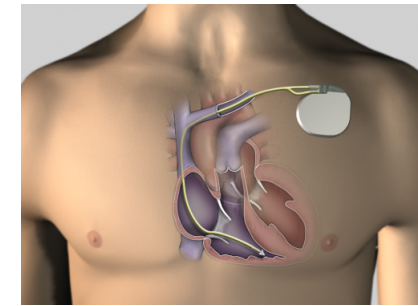
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Session anatomie cardiaque et Rythmologie Paramédicale

Focus sur anatomie cardiaque pour comprendre stimulation/défibrillation : atrial, VD, conduction



Claude Kouakam
Clinique de cardiologie
Institut Cœur Poumon
claude.kouakam@chru-lille.fr





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Liens d'intérêts

- Je déclare les liens d'intérêt potentiel suivants
:
- Consultant : Biotronik France, Medtronic France
- Honoraires : AstraZeneca, Pfizer

« Le contenu et/ou les opinions exprimées lors de cette présentation ont été réalisés en toute indépendance »



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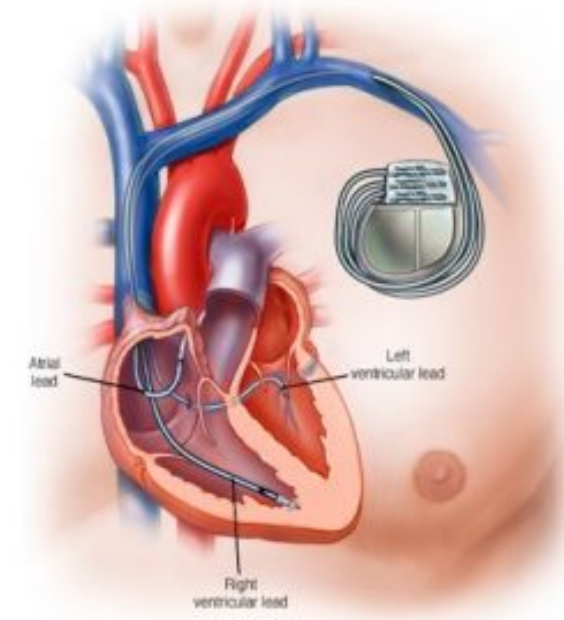
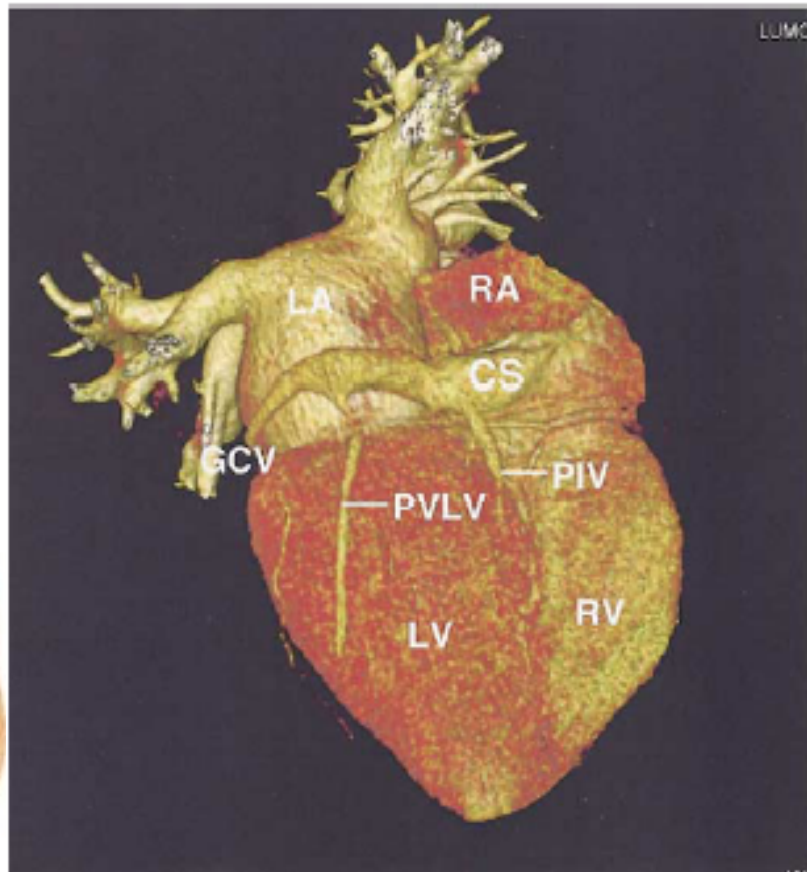
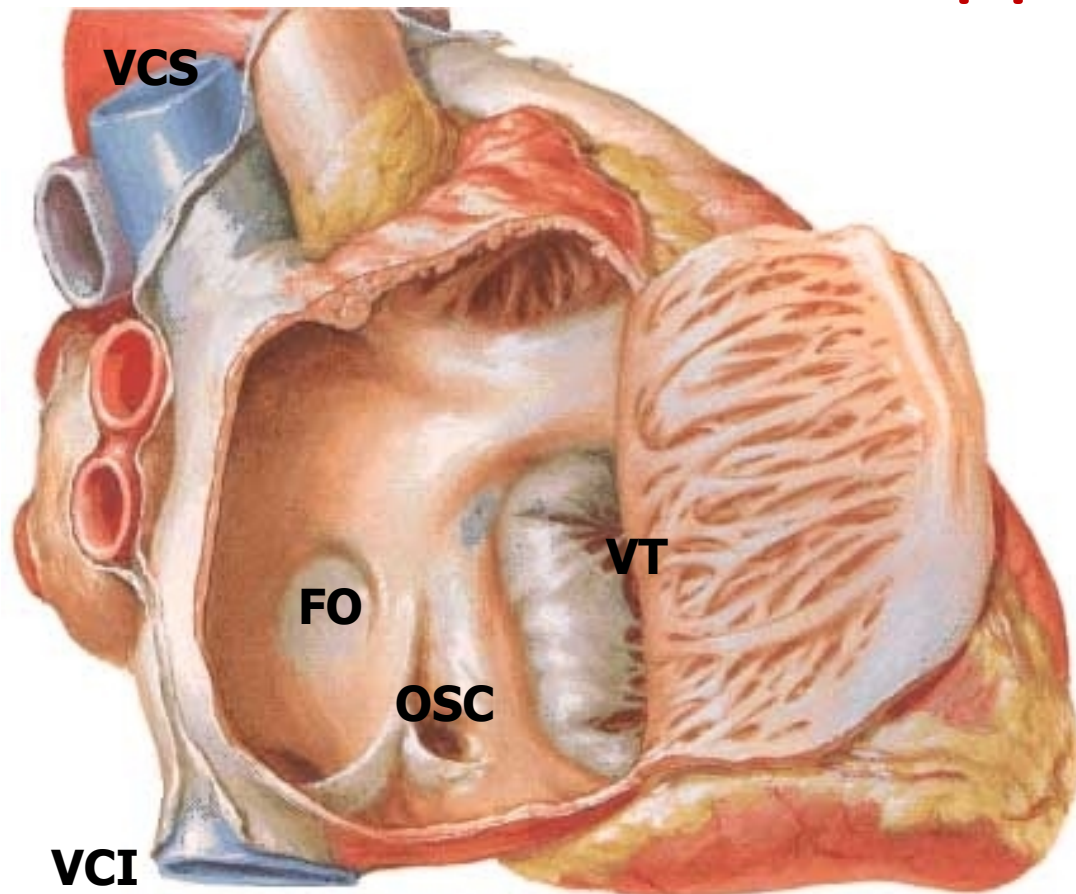
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Rappel anatomique





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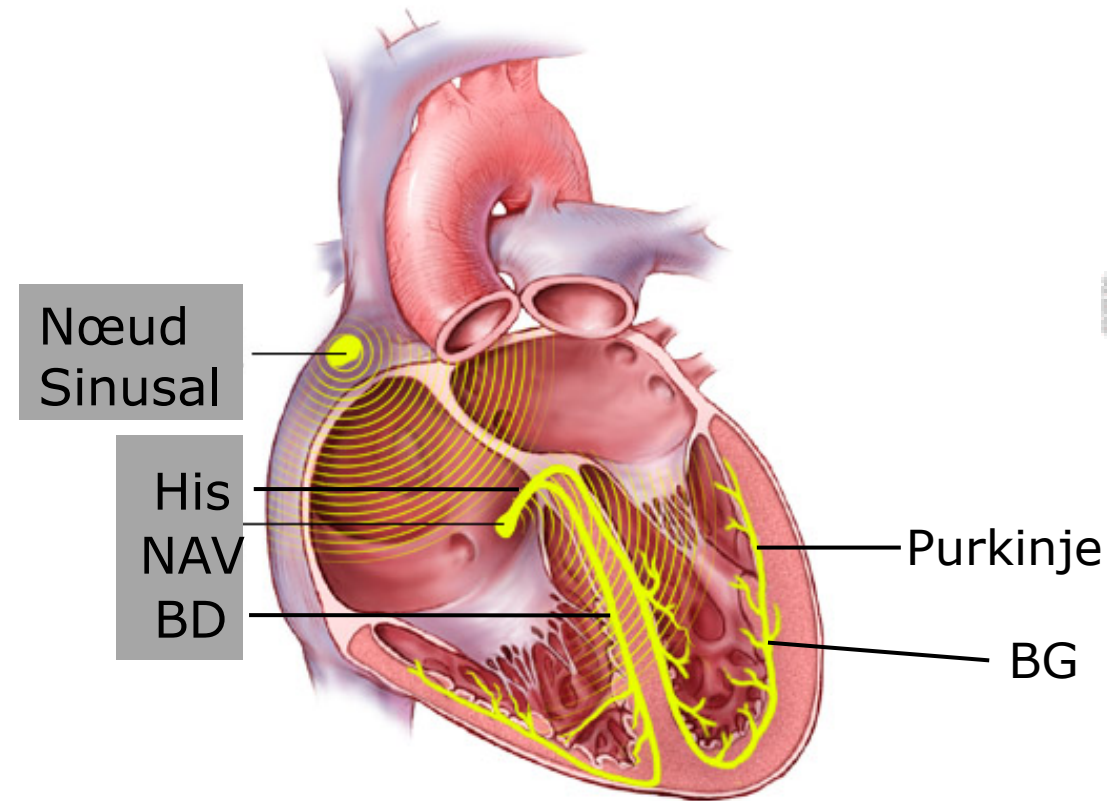
20 ans

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Physiologie du tissu nodal

Hiérarchie des # structures

- Centre de commande principal - NS
- Rôle freinateur du NAV
- Rôle conducteur du His et des branches
- Rôle de dispatching du Purkinje





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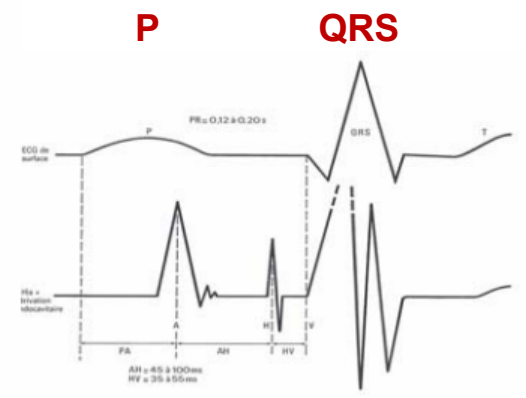
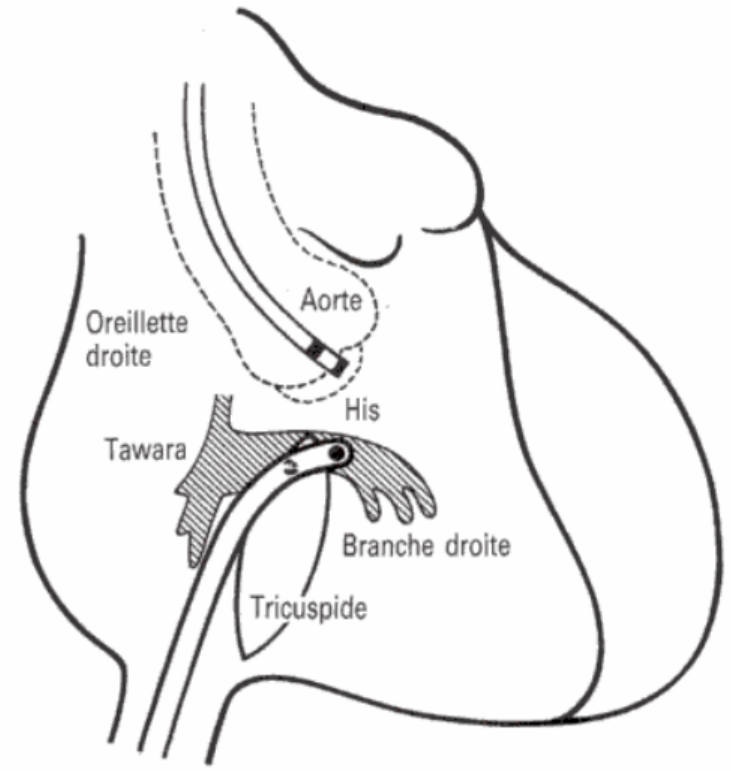
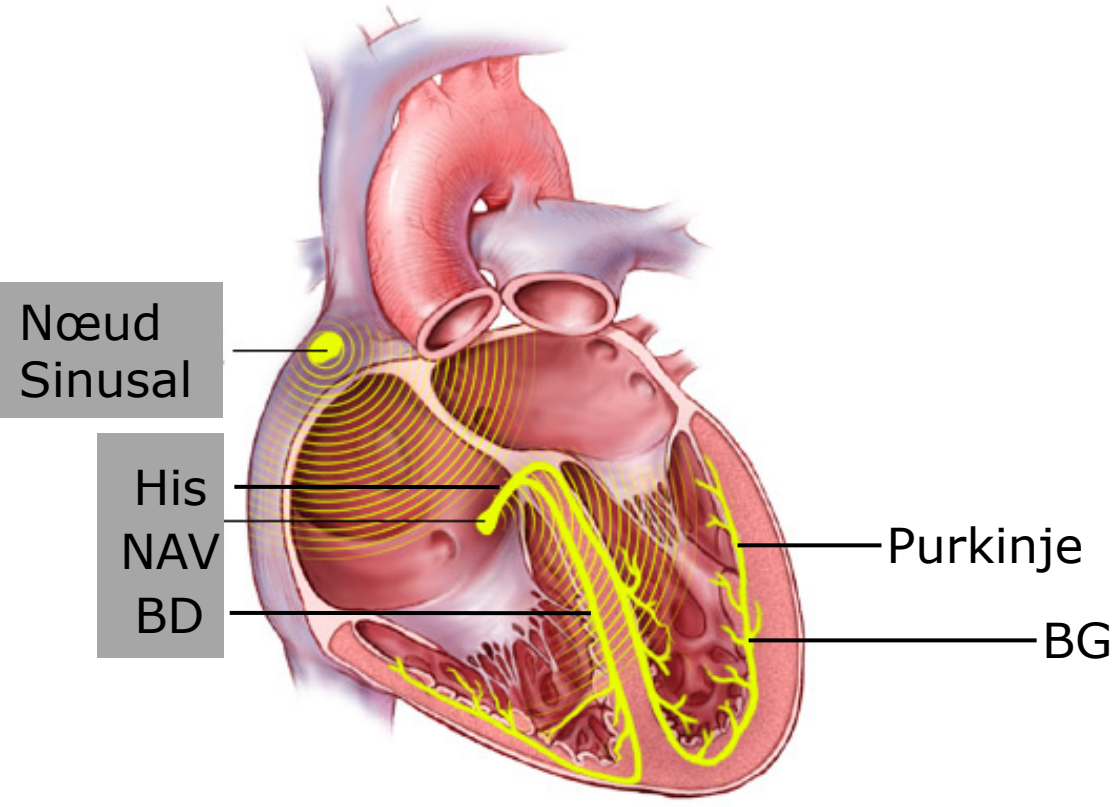
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Traduction ECG de la physiologie du tissu nodal





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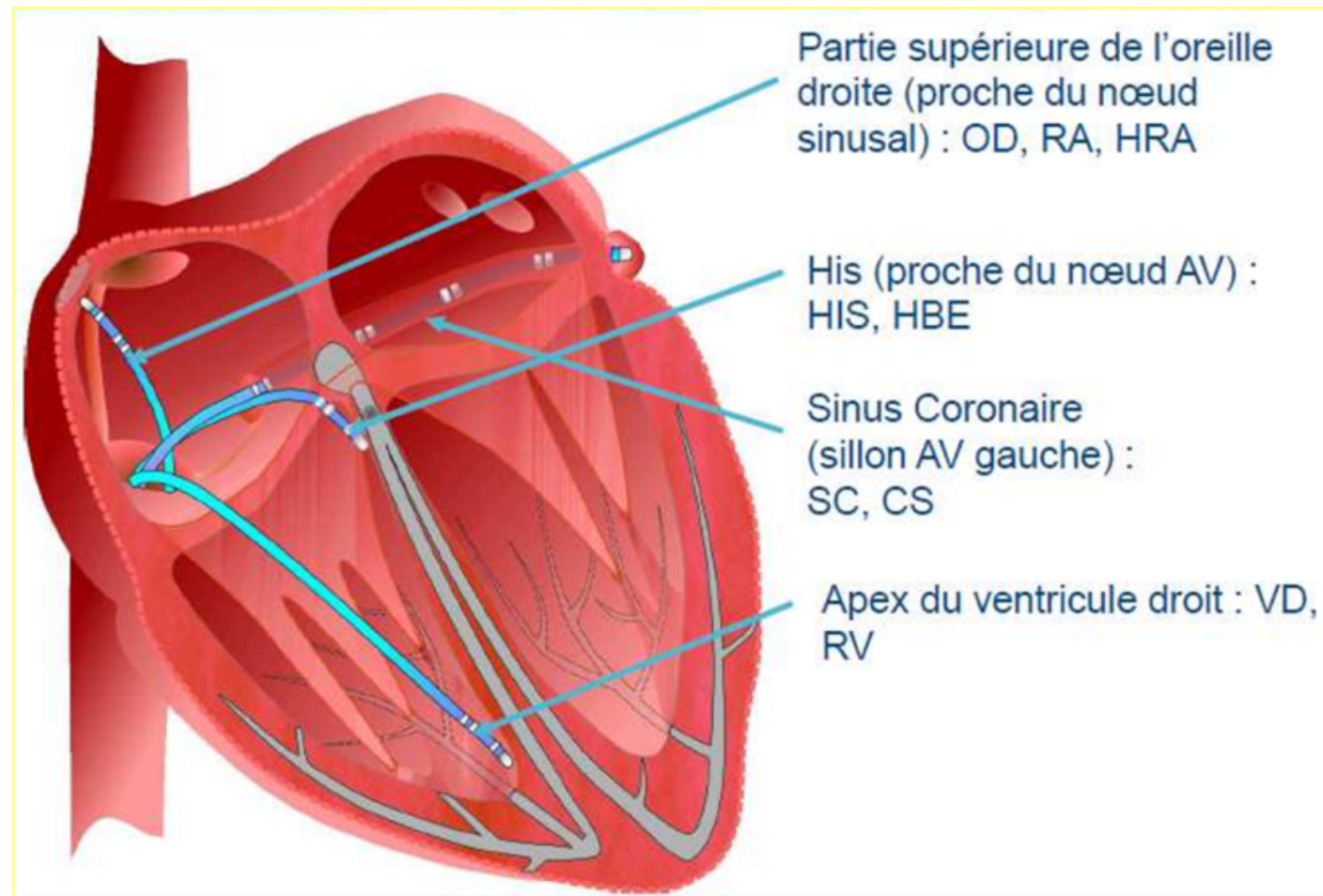
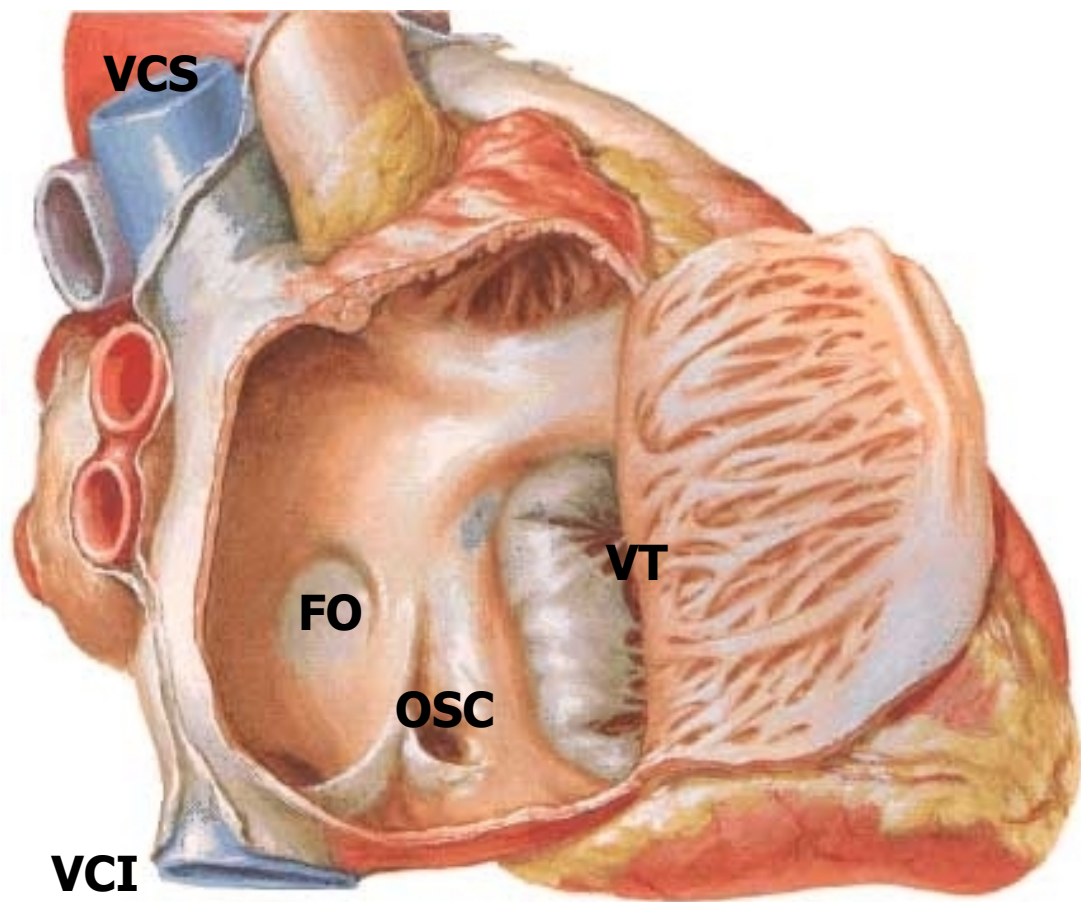
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Anatomie cardiaque &
Stimulation/défibrillation
conventionnelle



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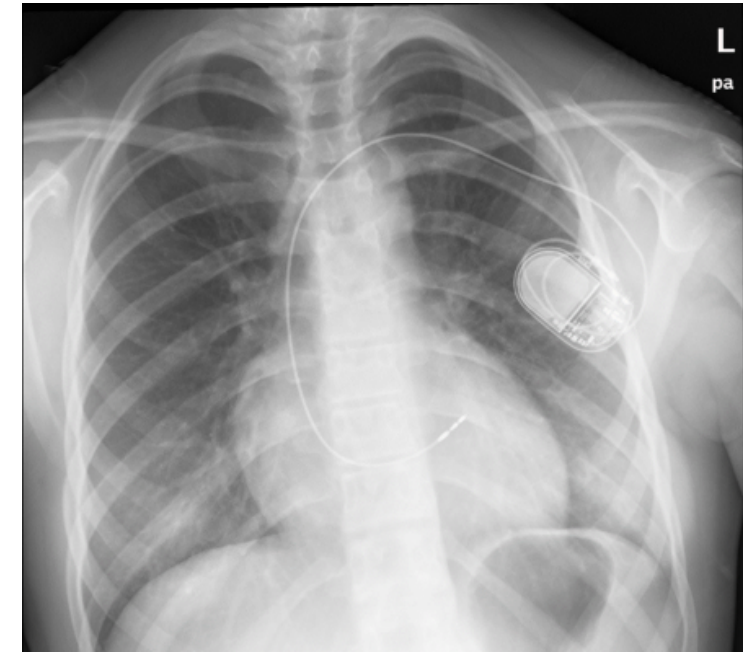
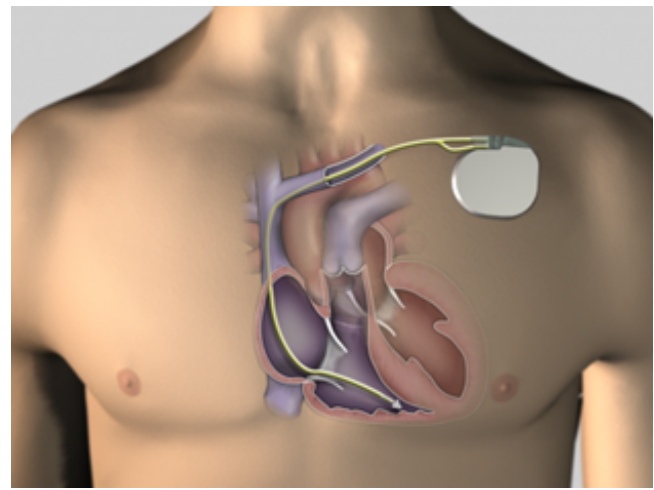
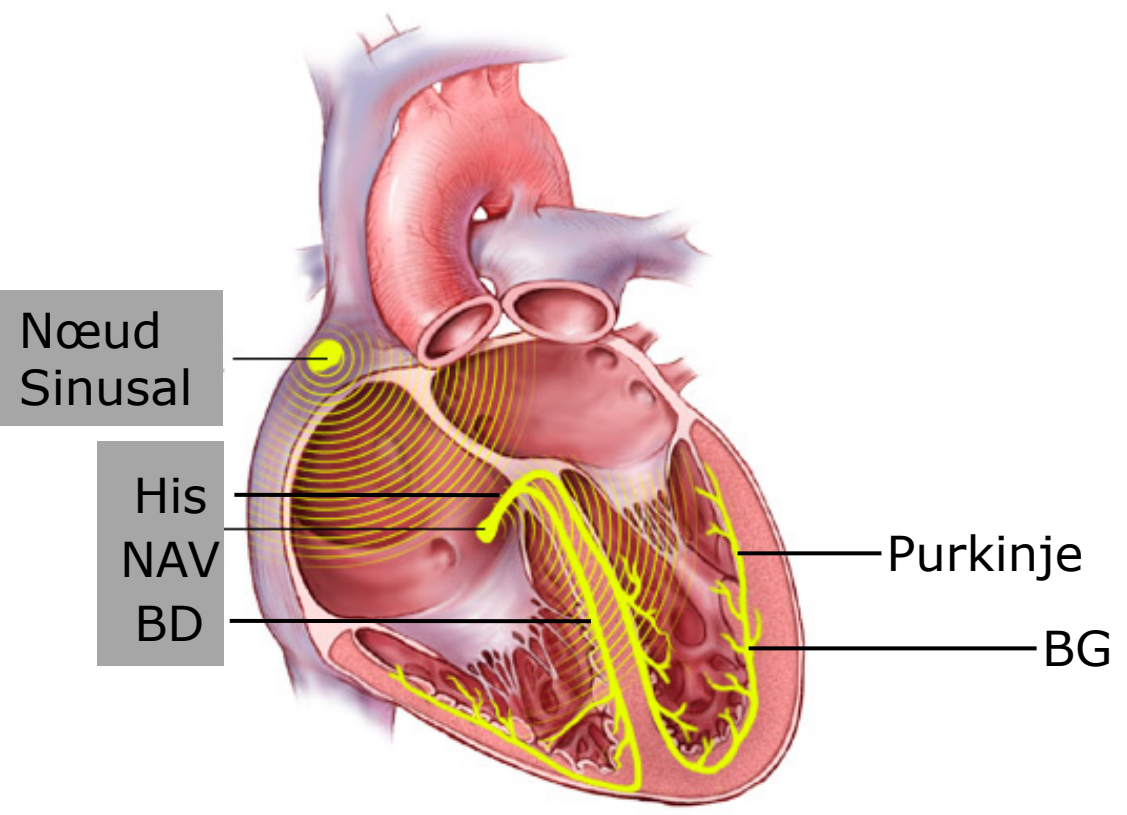
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Stimulation/défibrillation conventionnelle simple chambre





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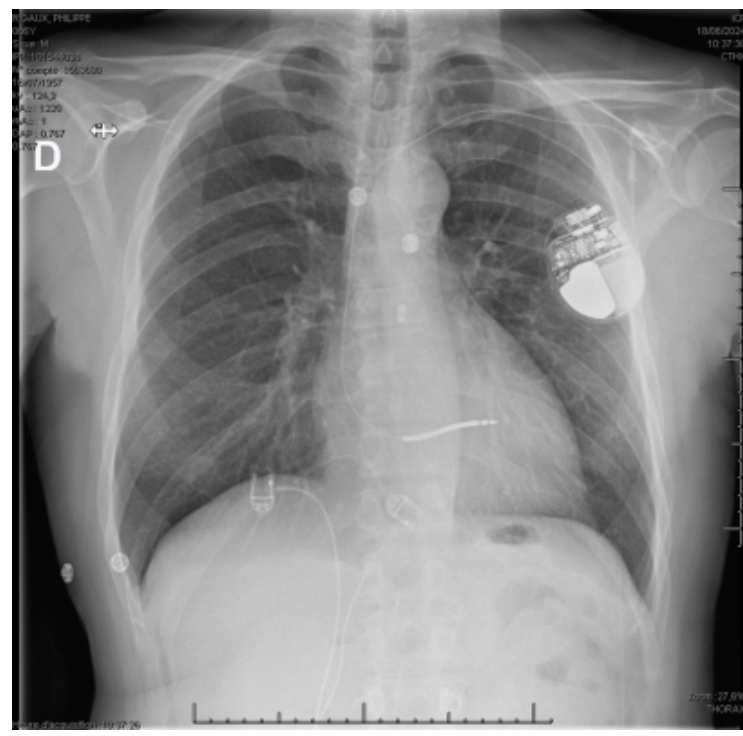
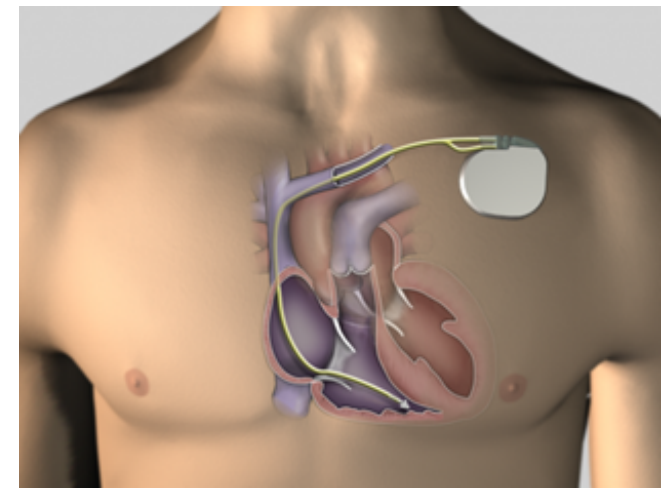
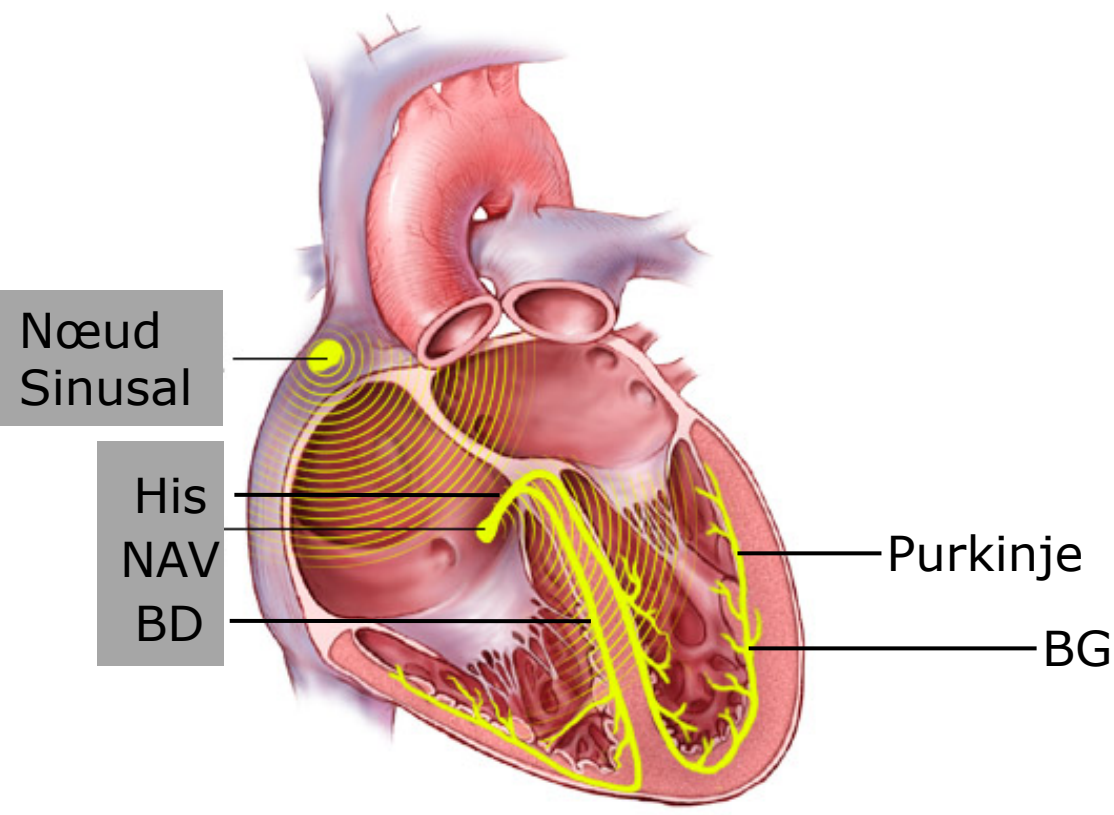
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Stimulation/défibrillation conventionnelle simple chambre





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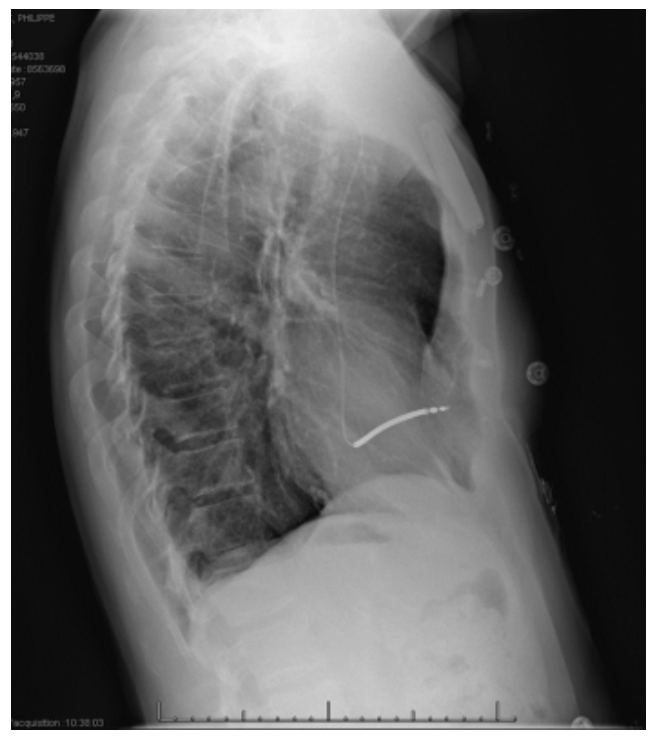
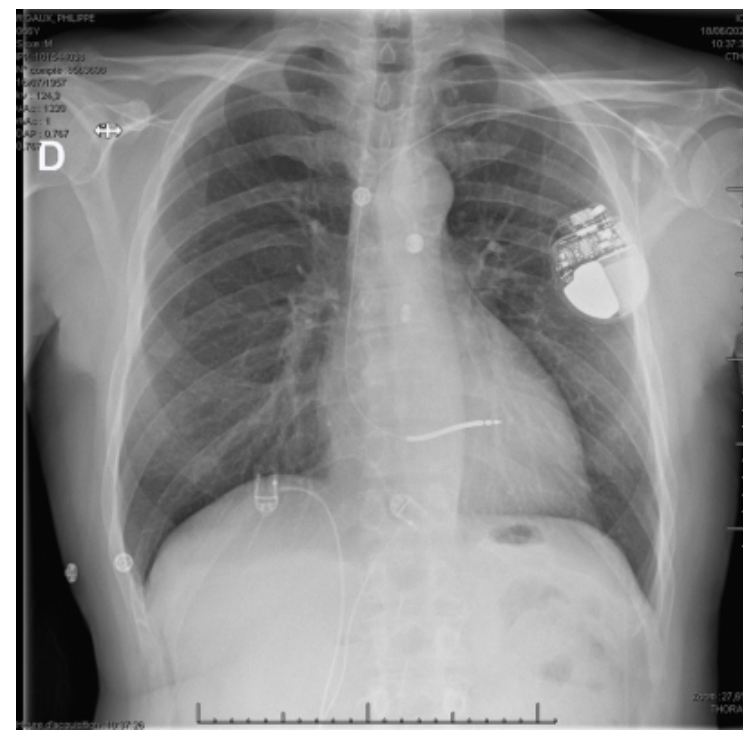
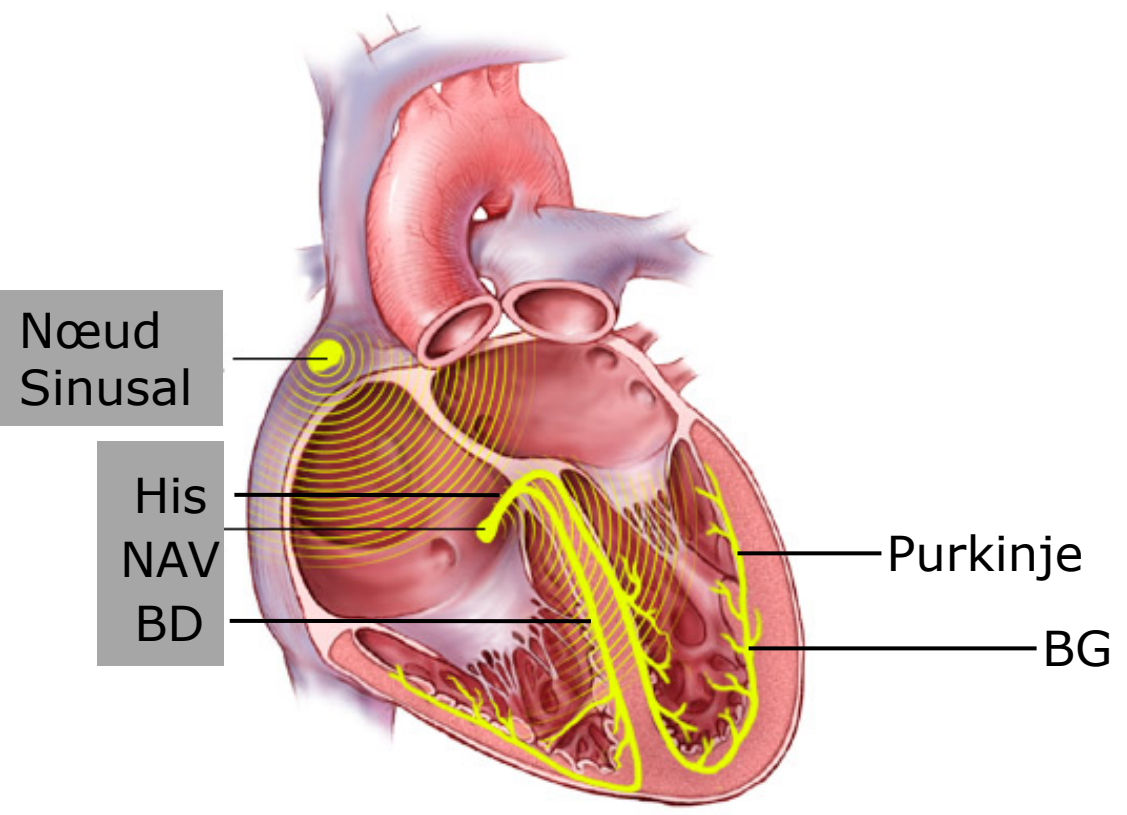
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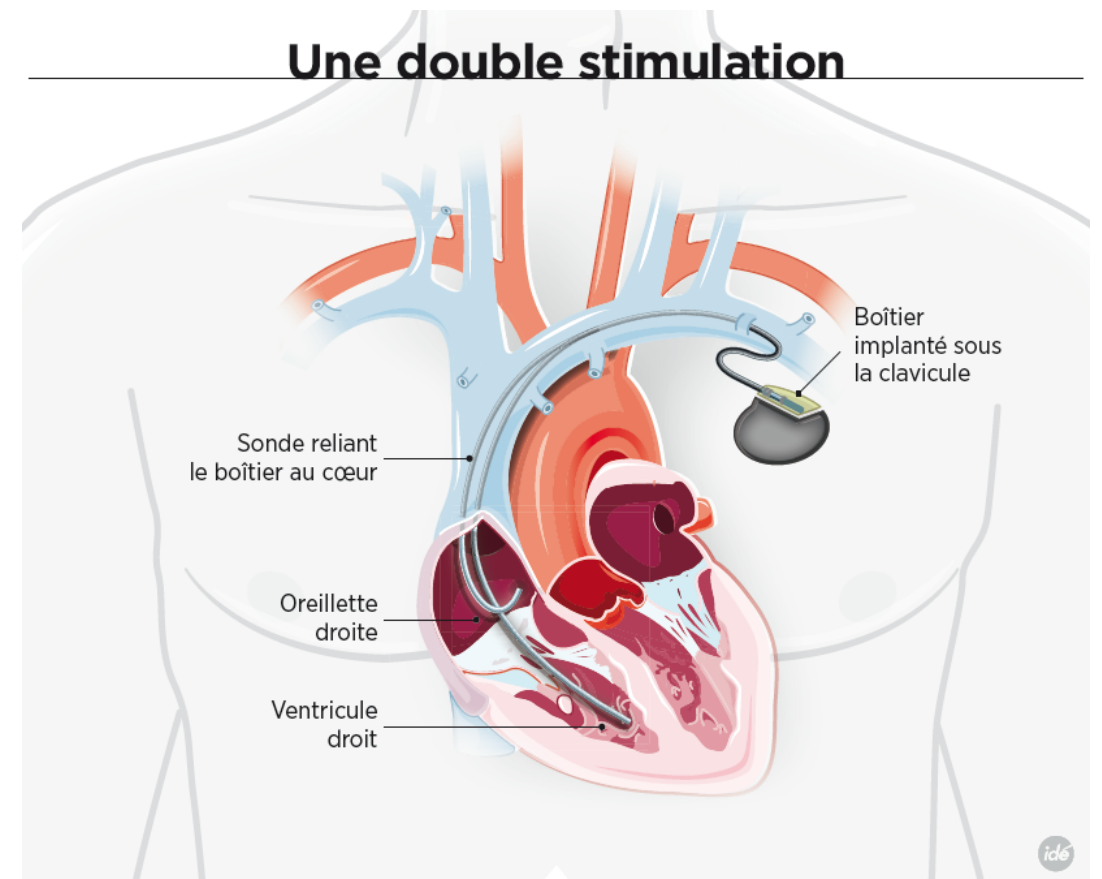
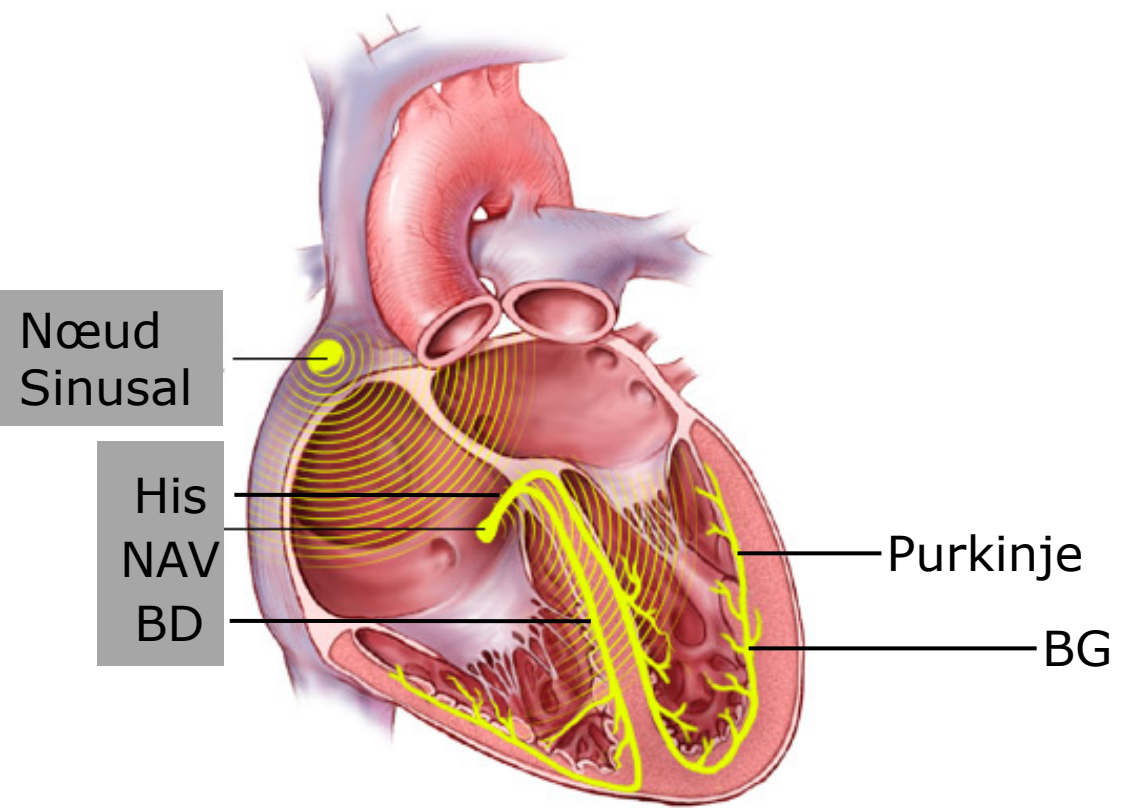
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Stimulation/défibrillation conventionnelle double chambre





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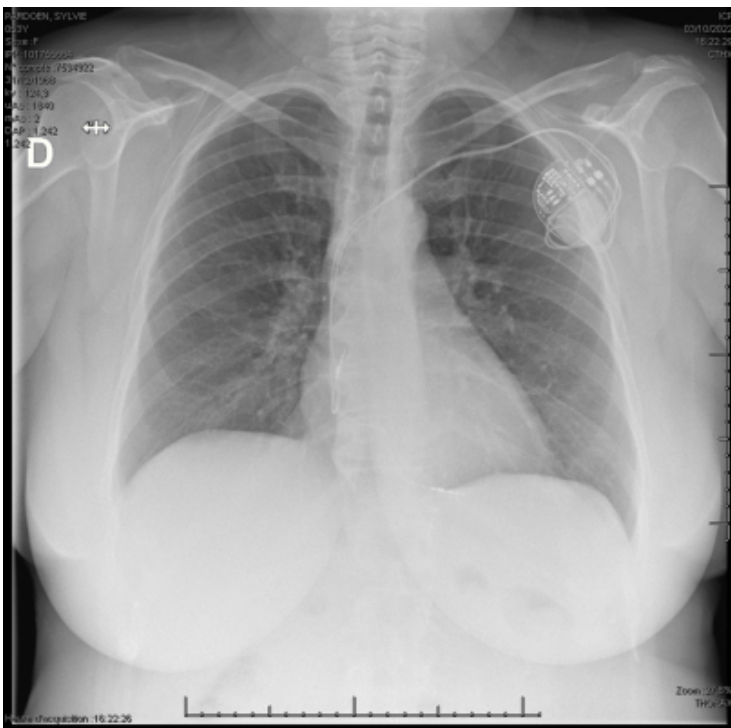
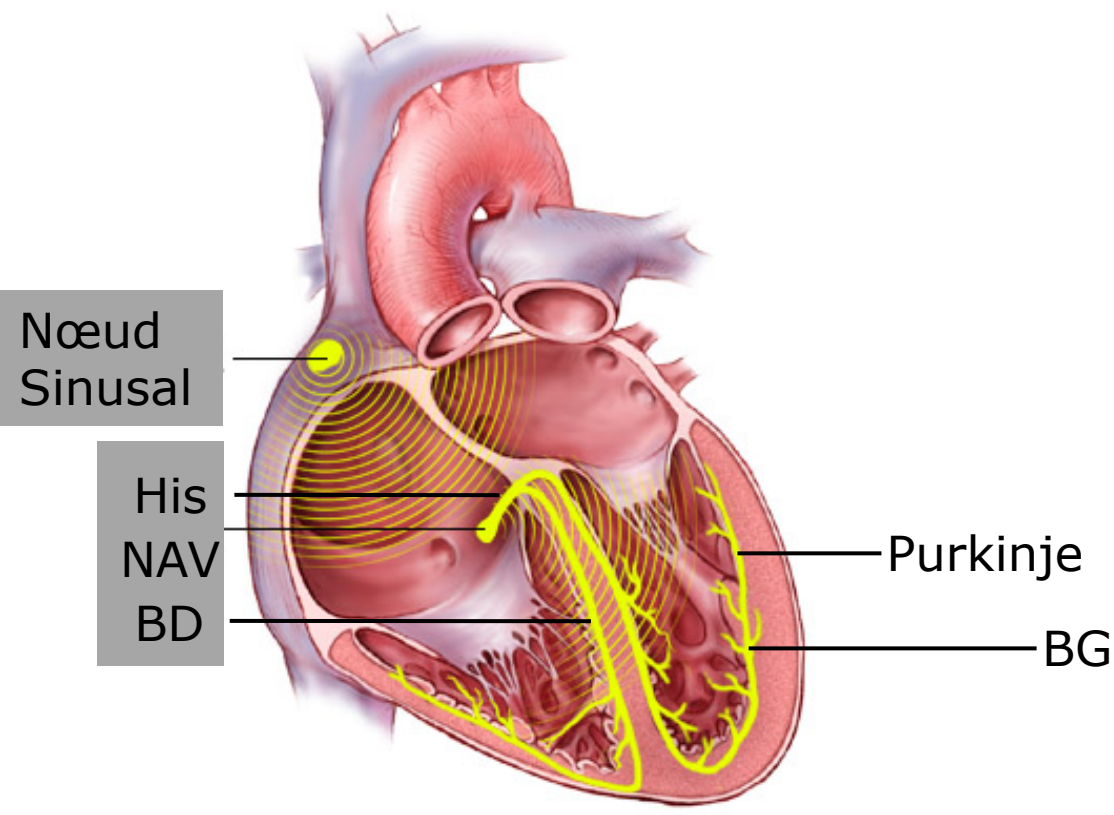
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Stimulation/défibrillation conventionnelle double chambre





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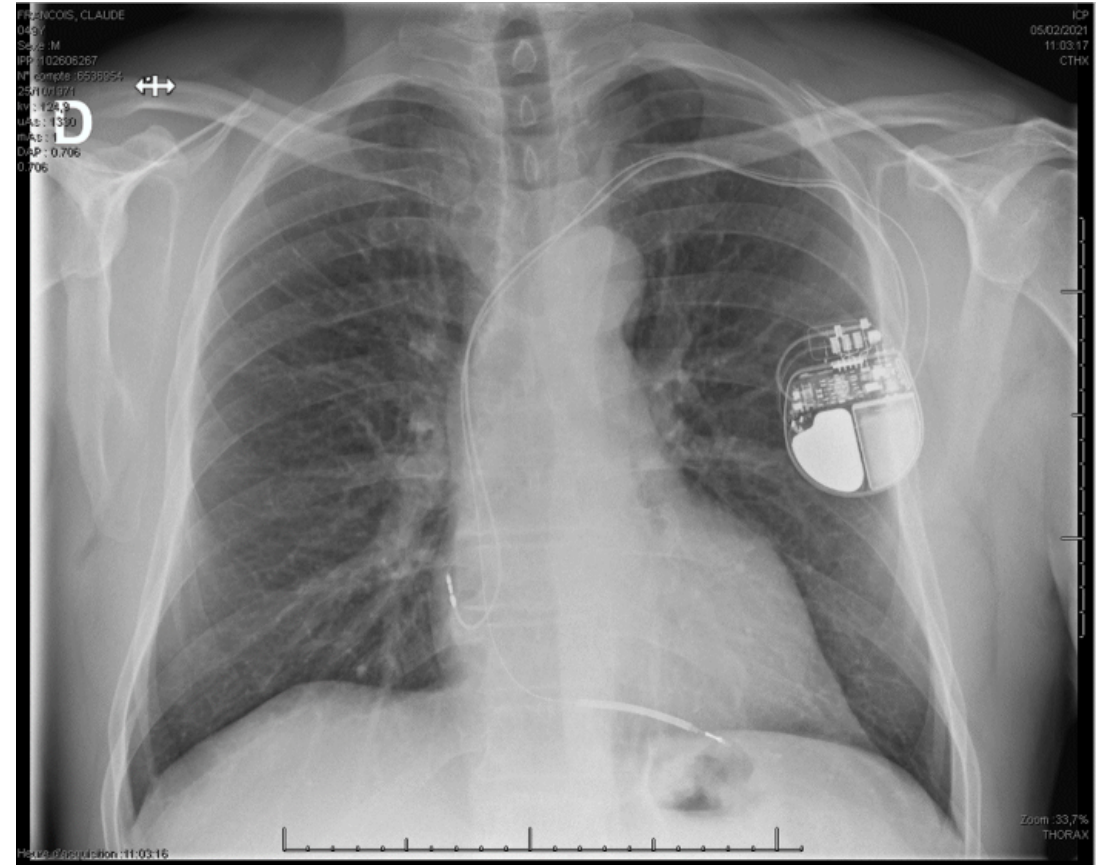
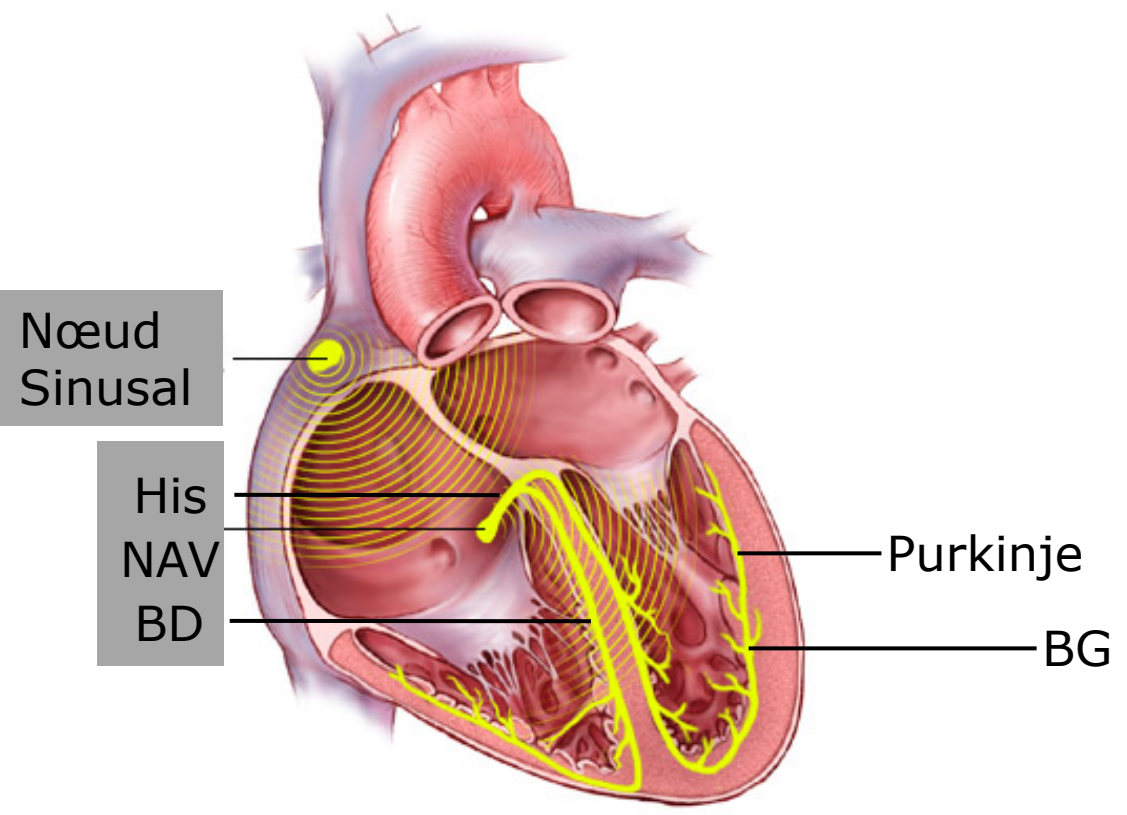
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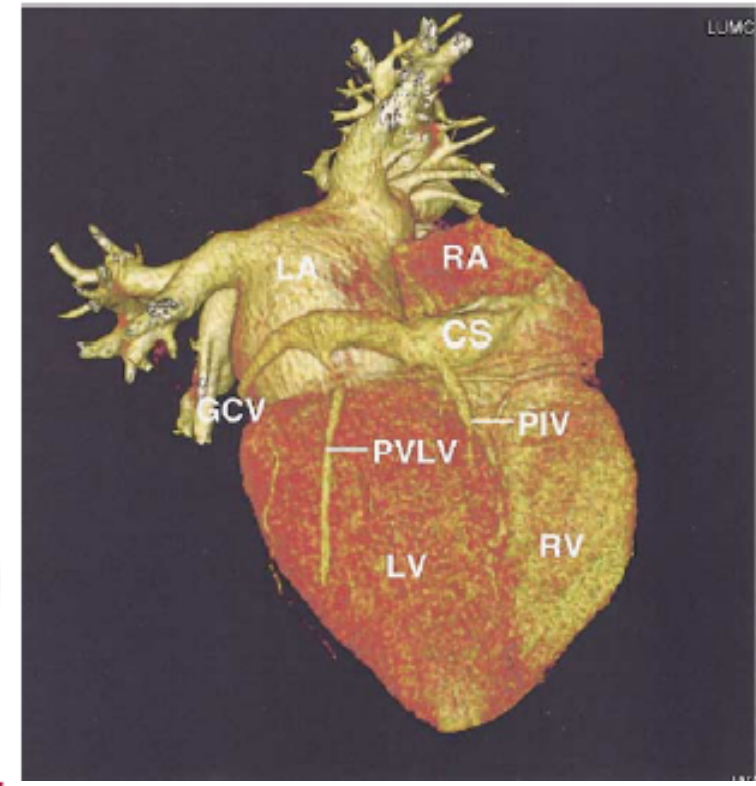
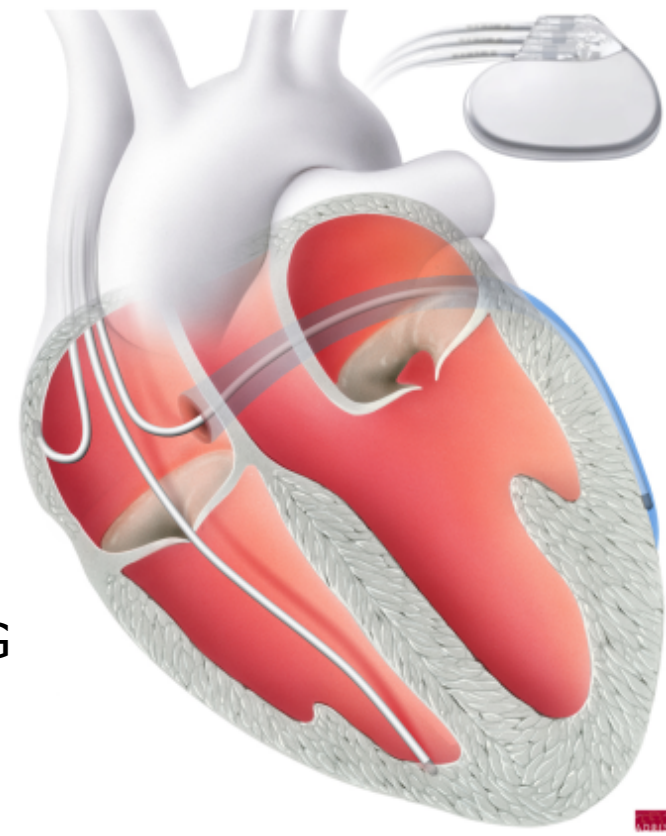
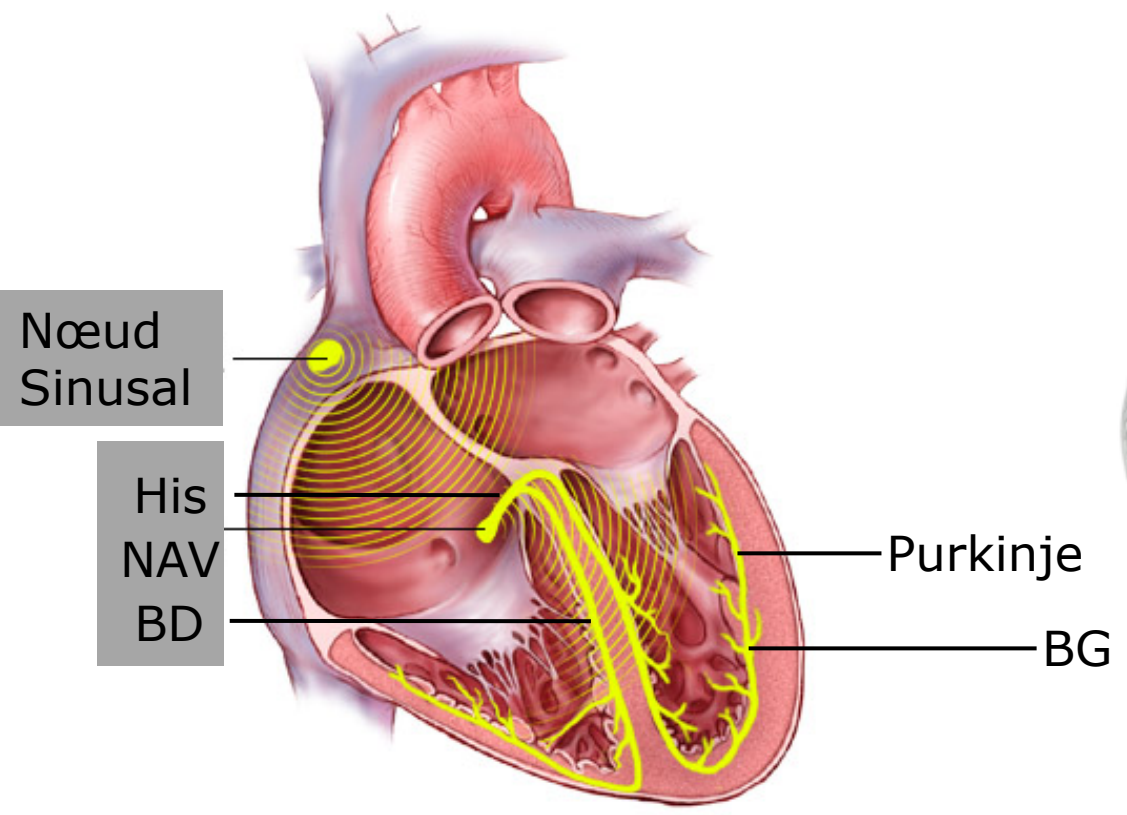
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Stimulation/défibrillation conventionnelle triple chambre





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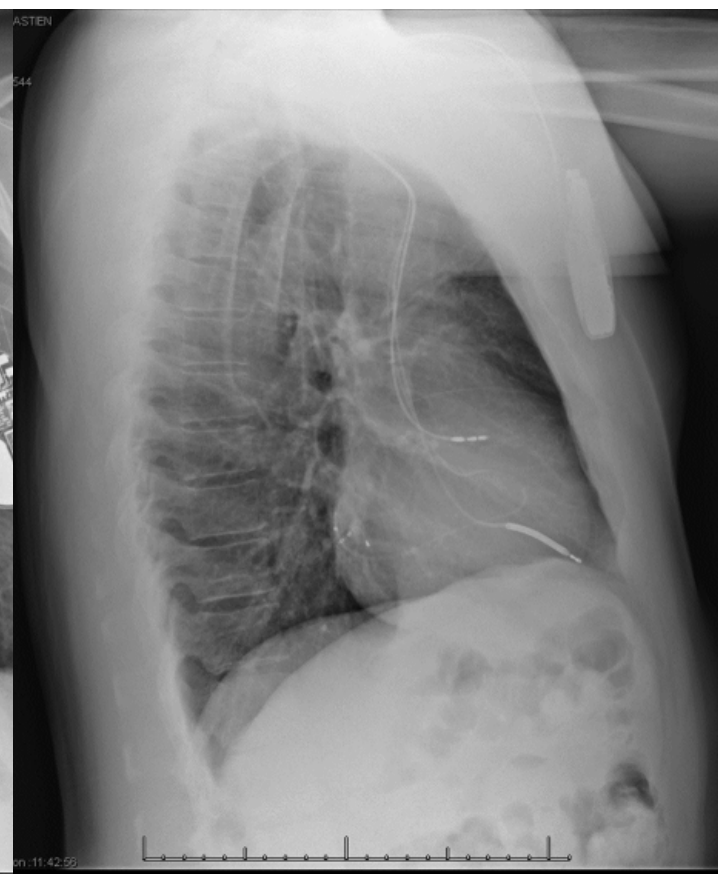
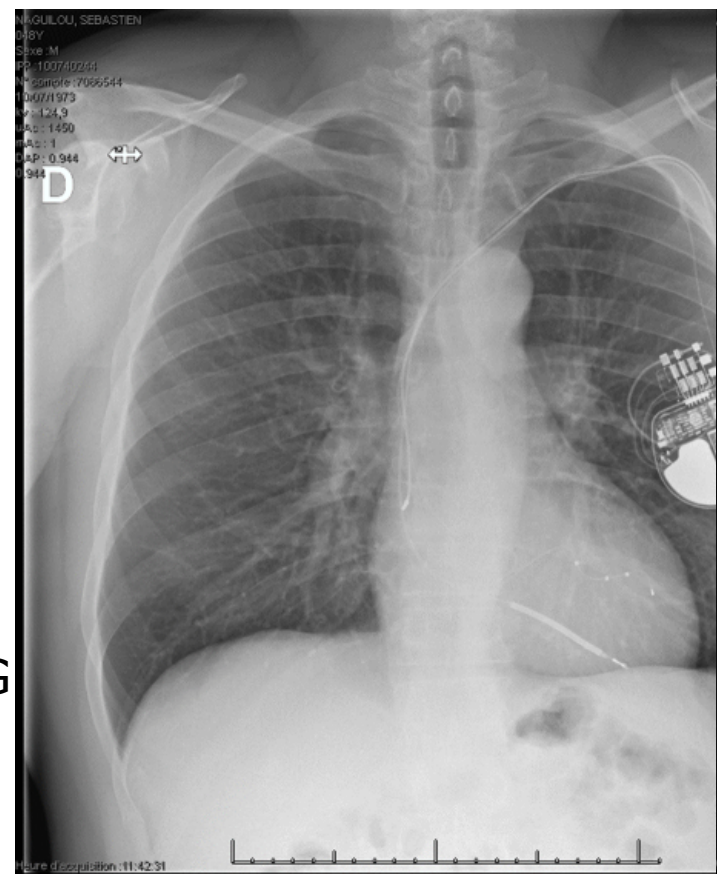
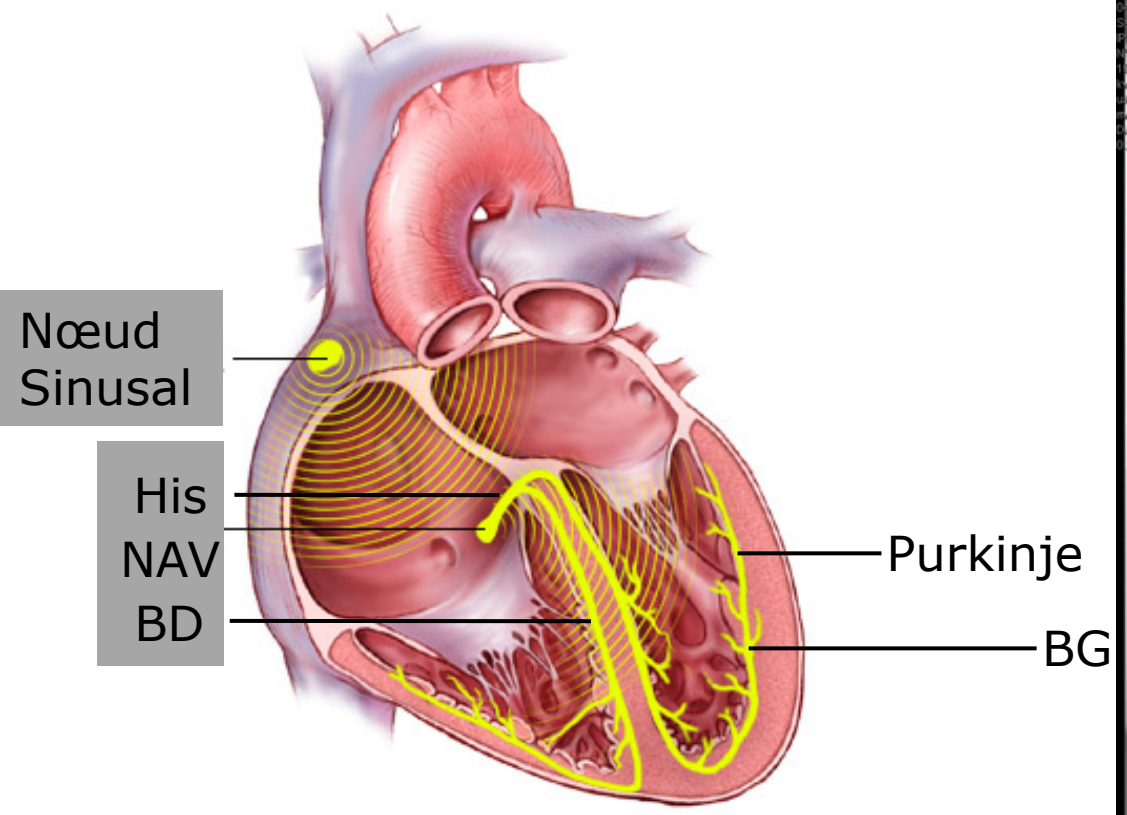
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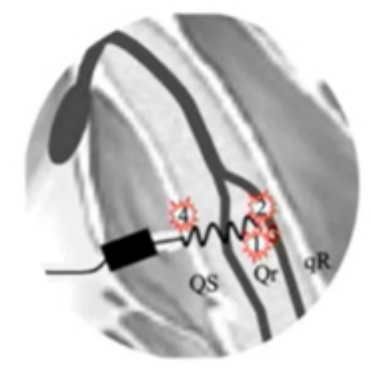
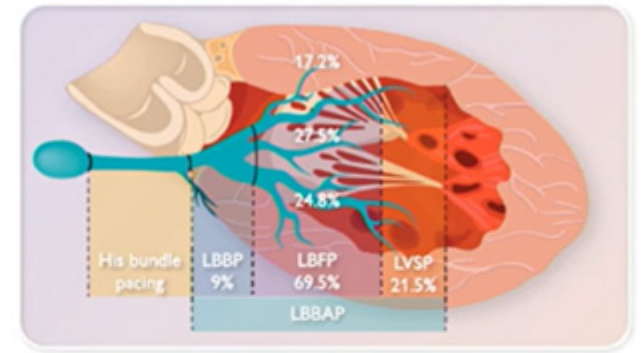
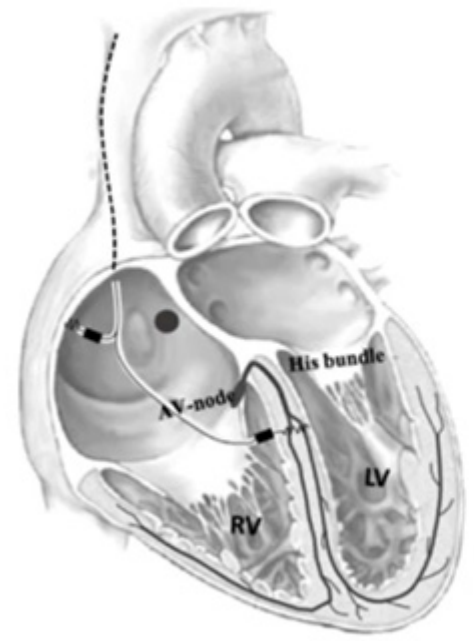
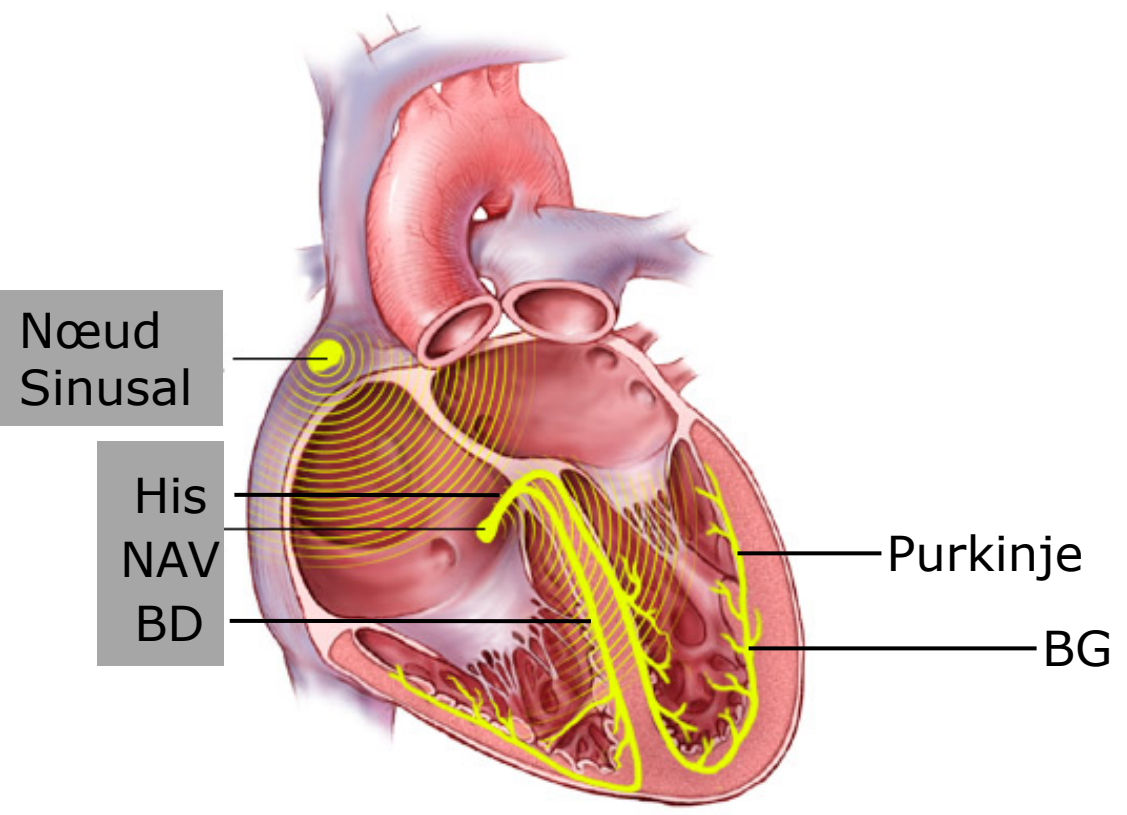
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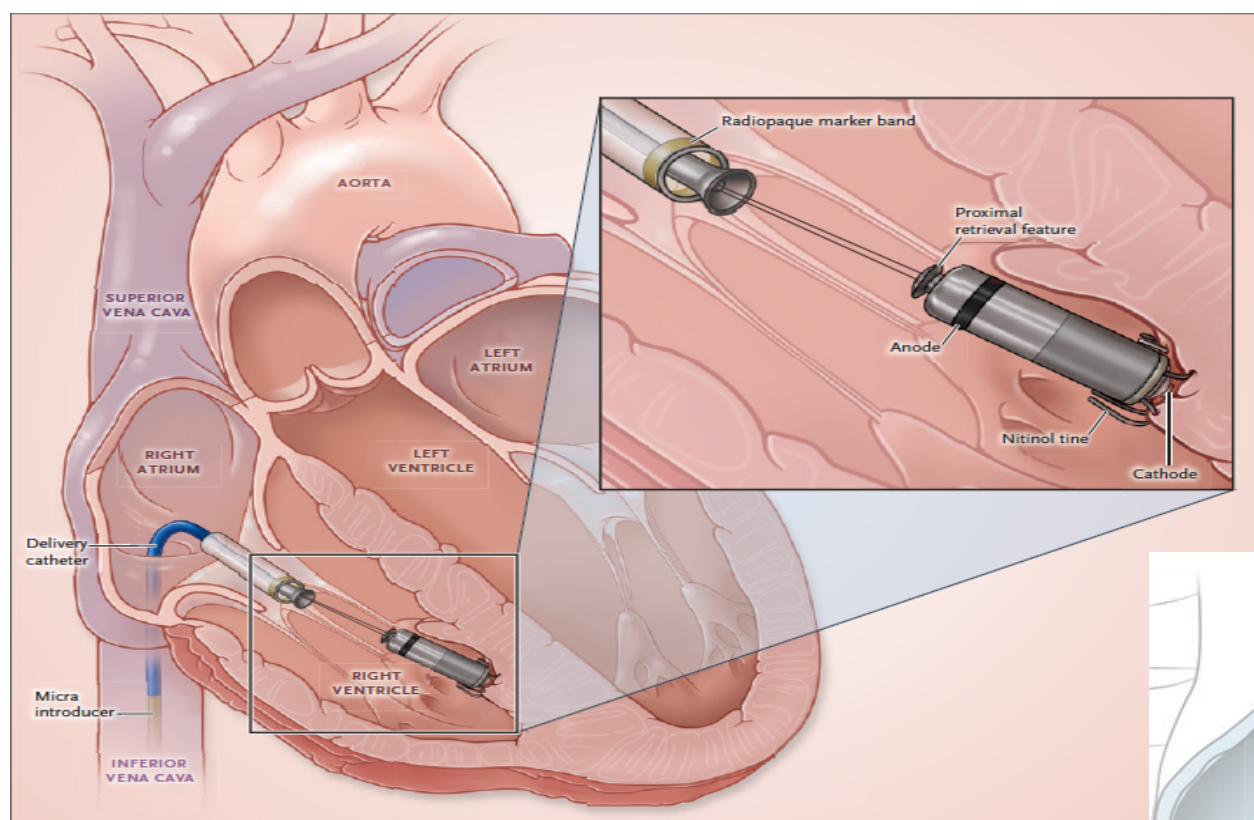
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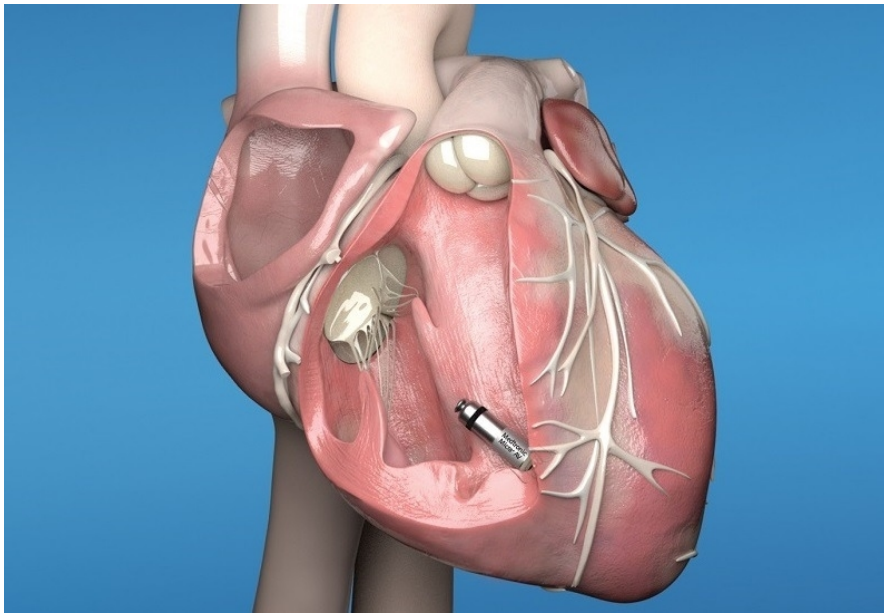
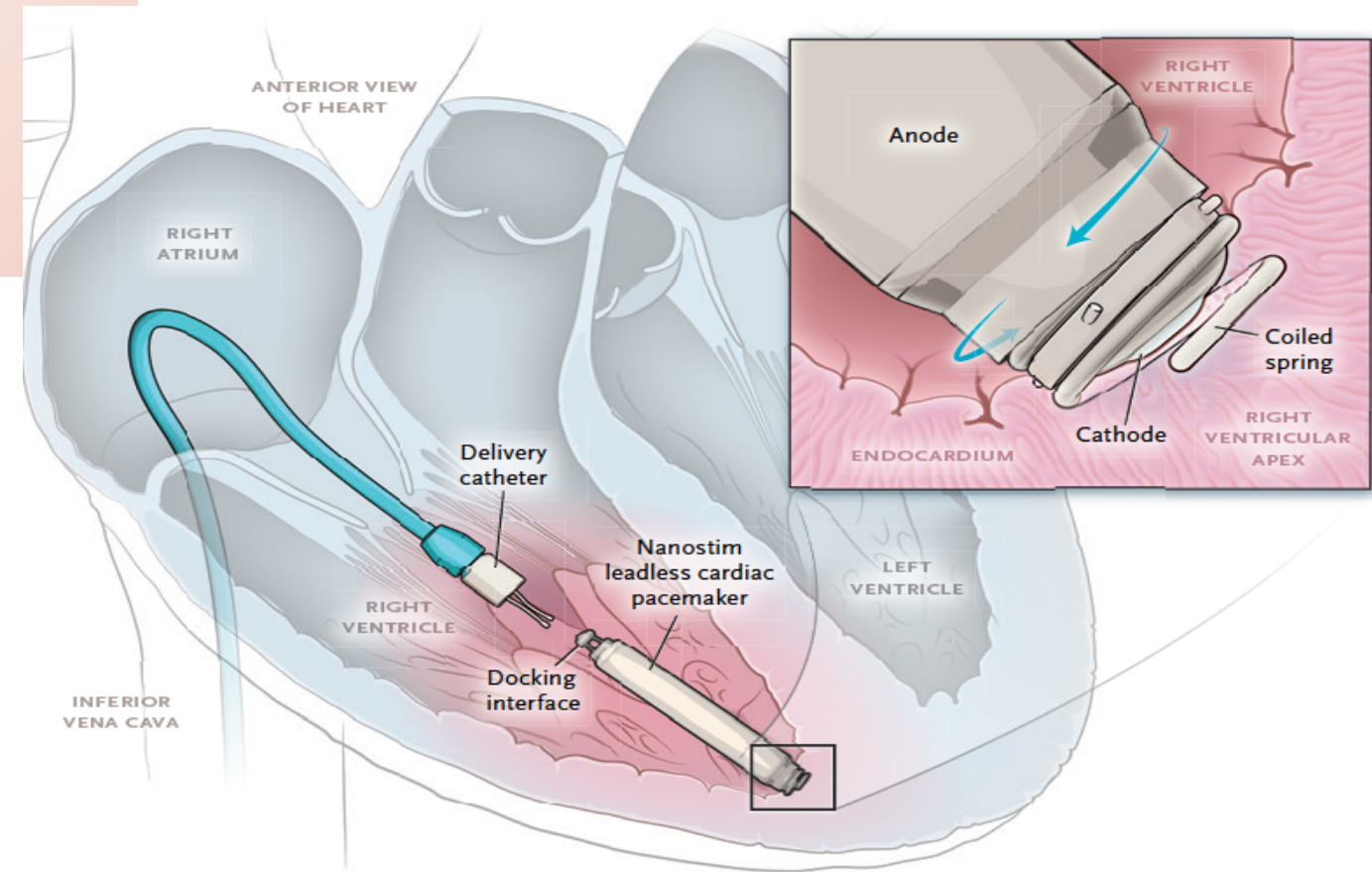
Stimulation/défibrillation de l'aire de la branche gauche



Anatomie cardiaque &
*Stimulation/défibrillation
transveineux ou avec sonde
extravasculaire*



2 fixations systems

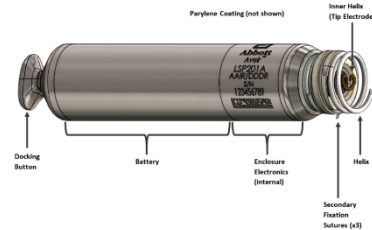


Leadless pacemakers

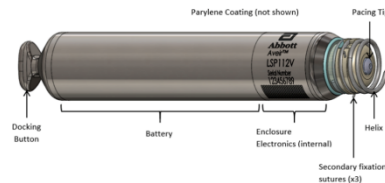
LCP™ Nanostim/Abbott



Aveir LP (Right Atrial)



Aveir LP (Right Ventricular)



41 mm
December 2012

January 2021
Aveir/38 mm

Micra™ Medtronic

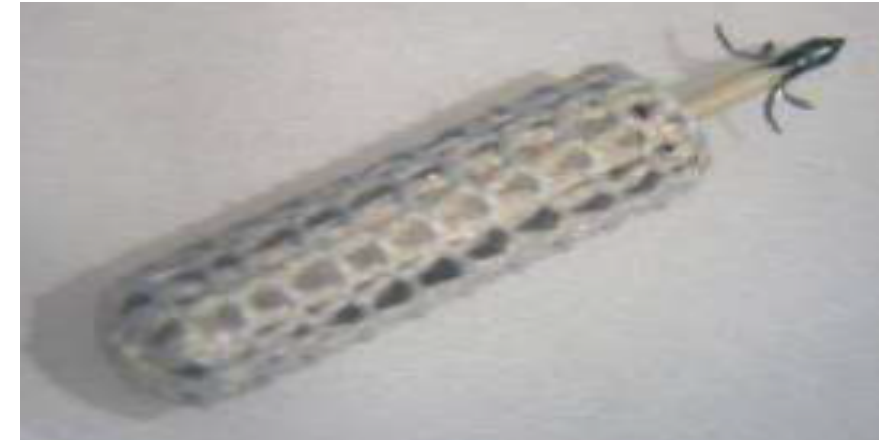


25 mm

December 2013

Micra AV™ 2020

WICS™ EBR



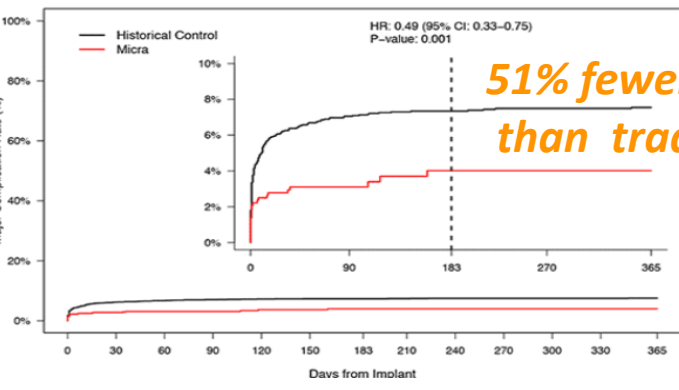
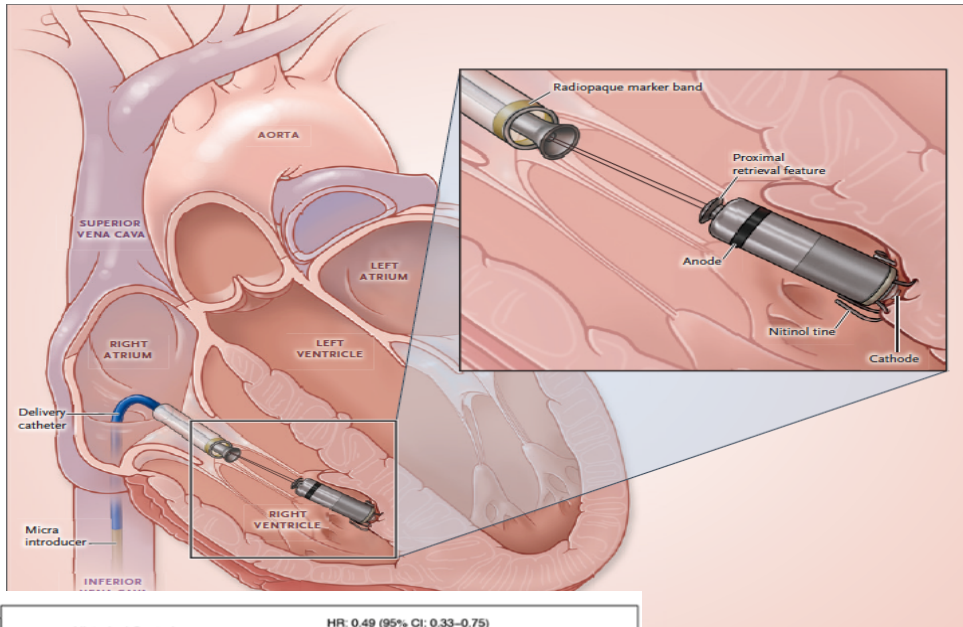
9 mm

May 2011

A Leadless Intracardiac Transcatheter Pacing System

Dwight Reynolds, M.D., Gabor Z. Duray, M.D., Ph.D., Razali Omar, M.D., Kyoko Soejima, M.D., Petr Neuzil, M.D., Shu Zhang, M.D., Calambur Narasimhan, M.D., Clemens Steinwender, M.D., Josep Brugada, M.D., Ph.D., Michael Lloyd, M.D., Paul R. Roberts, M.D., Venkata Sagi, M.D., John Hummel, M.D., Maria Grazia Bongiorno, M.D., Reinoud E. Knops, M.D., Christopher R. Ellis, M.D., Charles C. Gornick, M.D., Matthew A. Bernabei, M.D., Verla Laager, M.A., Kurt Stromberg, M.S., Eric R. Williams, B.S., J. Harrison Hudnall, B.S., and Philippe Ritter, M.D., for the Micra Transcatheter Pacing Study Group*

725 patients **Micra TPS study**



51% fewer major complications than traditional pacemakers

N Engl J Med 2016

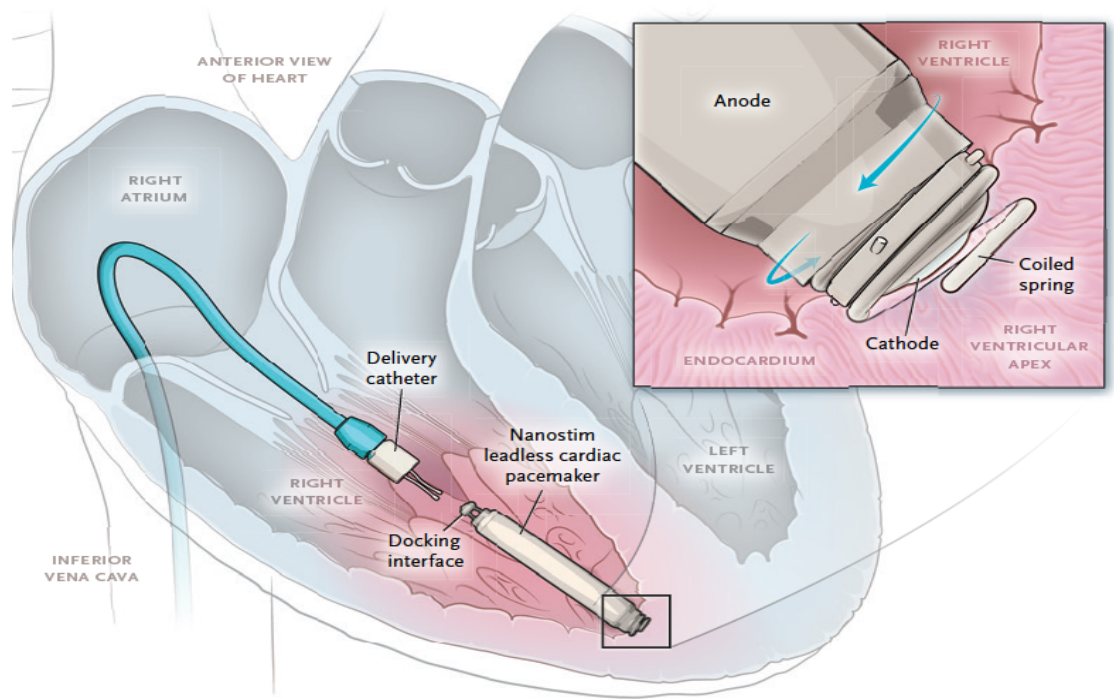
ORIGINAL ARTICLE

Percutaneous Implantation of an Entirely Intracardiac Leadless Pacemaker

Vivek Y. Reddy, M.D., Derek V. Exner, M.D., M.P.H., Daniel J. Cantillon, M.D., Rahul Doshi, M.D., T. Jared Bunch, M.D., Gery F. Tomassoni, M.D., Paul A. Friedman, M.D., N.A. Mark Estes III, M.D., John Ip, M.D., Imran Niazi, M.D., Kenneth Plunkitt, M.D., Rajesh Banker, M.D., James Porterfield, M.D., James E. Ip, M.D., and Srinivas R. Dukkupati, M.D., for the LEADLESS II Study Investigators*

526 patients

Leadless II

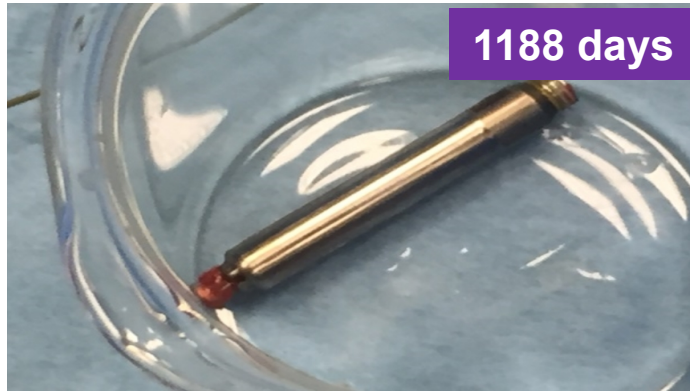


N Engl J Med 2015

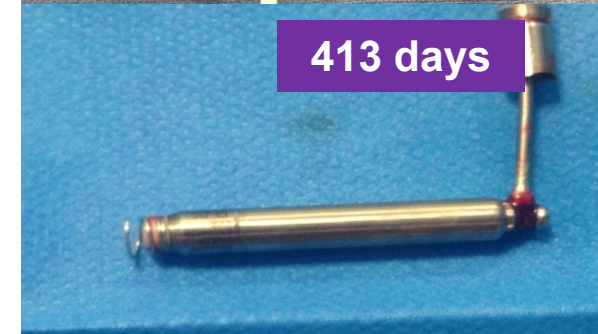
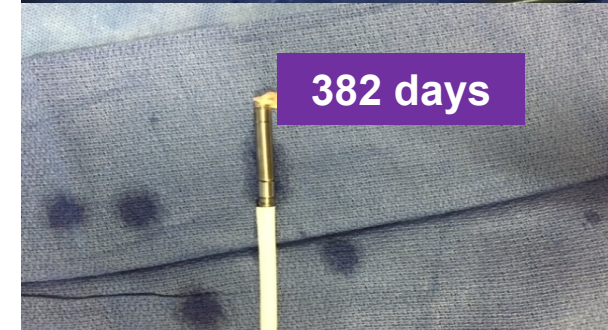
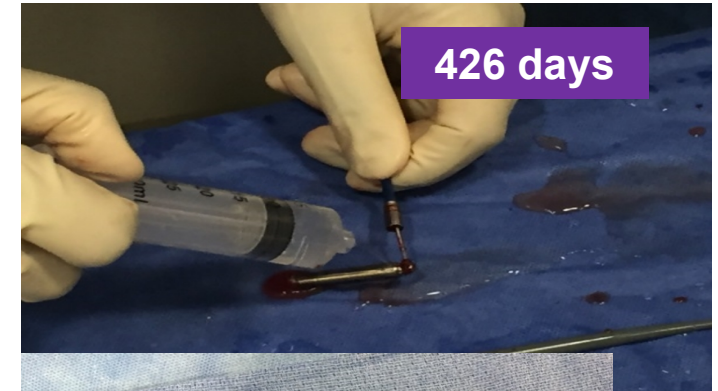
A worldwide experience of the management of battery failures and chronic device retrieval of the Nanostim leadless pacemaker

Dhanunjaya Lakkireddy, MD, FACC, FHRS,* Reinoud Knops, MD,[†] Brett Atwater, MD,[‡] Petr Neuzil, MD,[§] John Ip, MD,^{||} Elkin Gonzalez, MD,[¶] Paul Friedman, MD, FHRS,** Pascal Defaye, MD,^{††} Derek Exner, MD,^{‡‡} Kazutaka Aonuma, MD,^{§§} Rahul Doshi, MD, FHRS,^{|||} Johannes Sperzel, MD,^{¶¶} Vivek Reddy, MD^{***}

Possibility of leadless retrieval (Nanostim™/Aveir™)



Nanostim Retrieval Gross Pathology



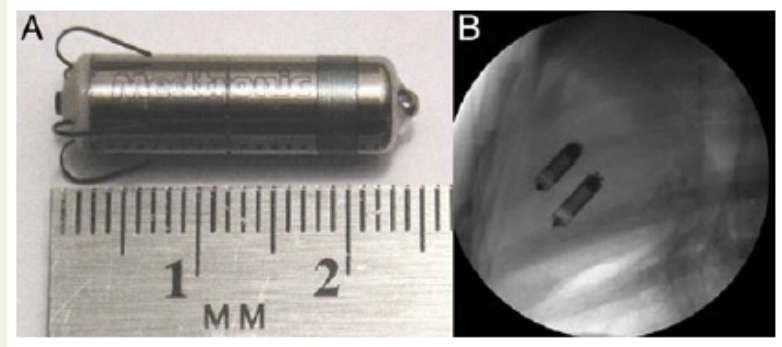
90.4% success retrieval/implant duration range: 0.2–4.0 years

Multiple leadless pacemakers implanted in the right ventricle of swine

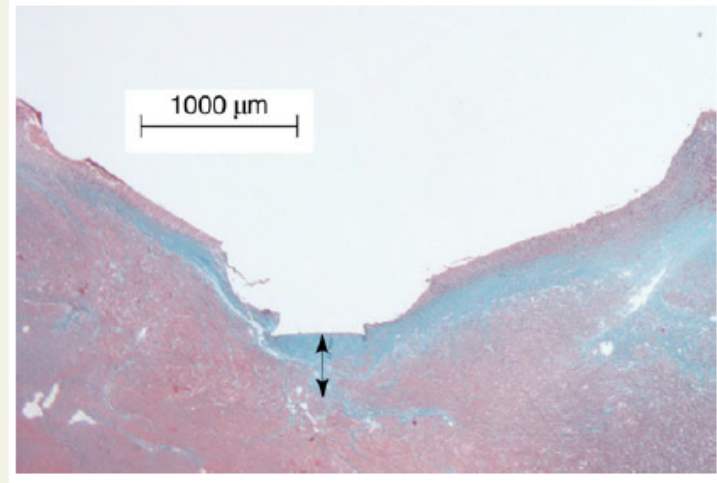
Keping Chen^{1†}, Xiaolin Zheng^{1†}, Yan Dai¹, Hao Wang², Yue Tang³, Tingyu Lan², Jinping Zhang², Yi Tian³, Baojie Zhang³, Xiaohong Zhou⁴, Matthew Bonner⁴, and Shu Zhang^{1*}

Multiple implantations possible

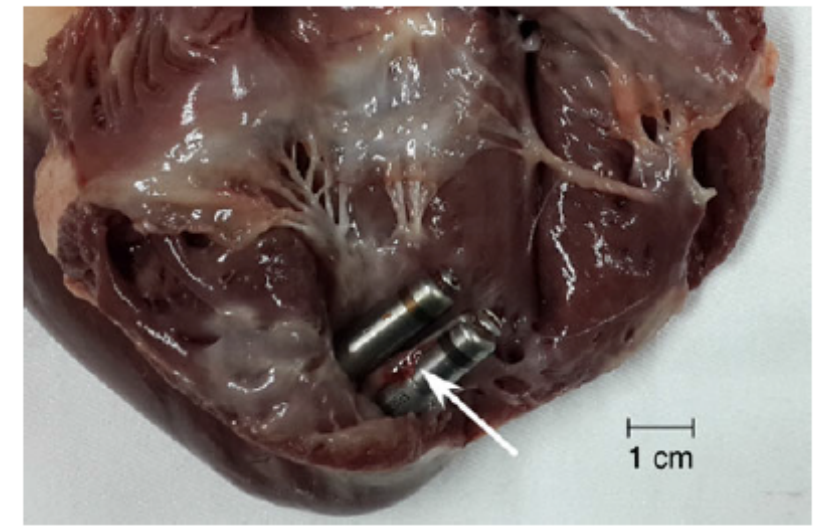
14 mini pigs received 2 leadless
1month interval between



Micra device and fluoroscopic imaging with Micra devices: (A) an example of the Micra device and (B) fluoroscopic imaging of two Micra devices implanted in the RV.

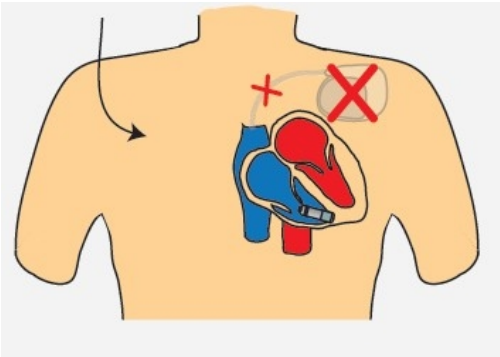


Tissue fibrosis beneath the Micra pacing electrode. Arrow indicates the thickness of the fibrosis measured from the endocardium where the device was placed.

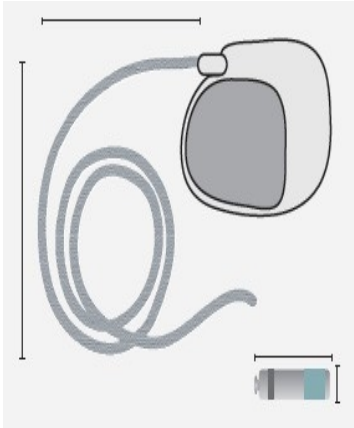


Fibrous tissue attaching around Micra devices observed at necropsy. Arrow indicates the fibrous tissue attachment.

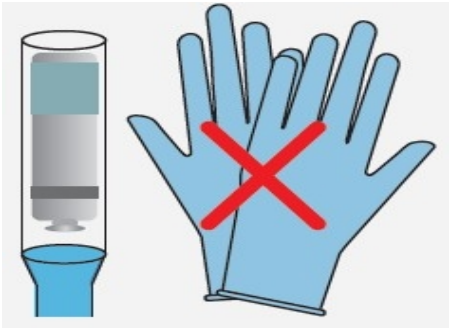
Low infection rate with leadless PM



No lead, no pocket



Small size



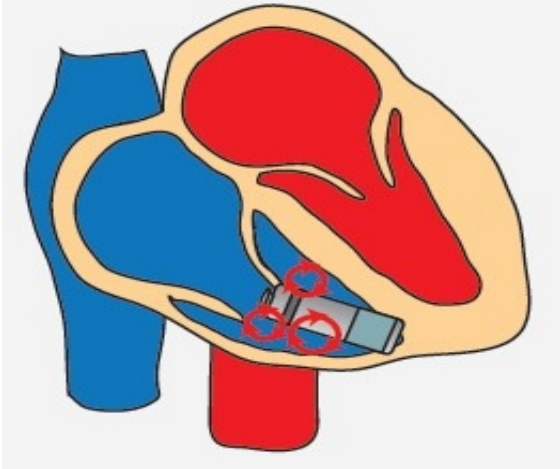
Reduced handling



Encapsulation

Strongest Protection	
Parylene Coated	X
Strong Protection	
Polyurethane Coated	X
Less Protection	
Bare Titanium	X

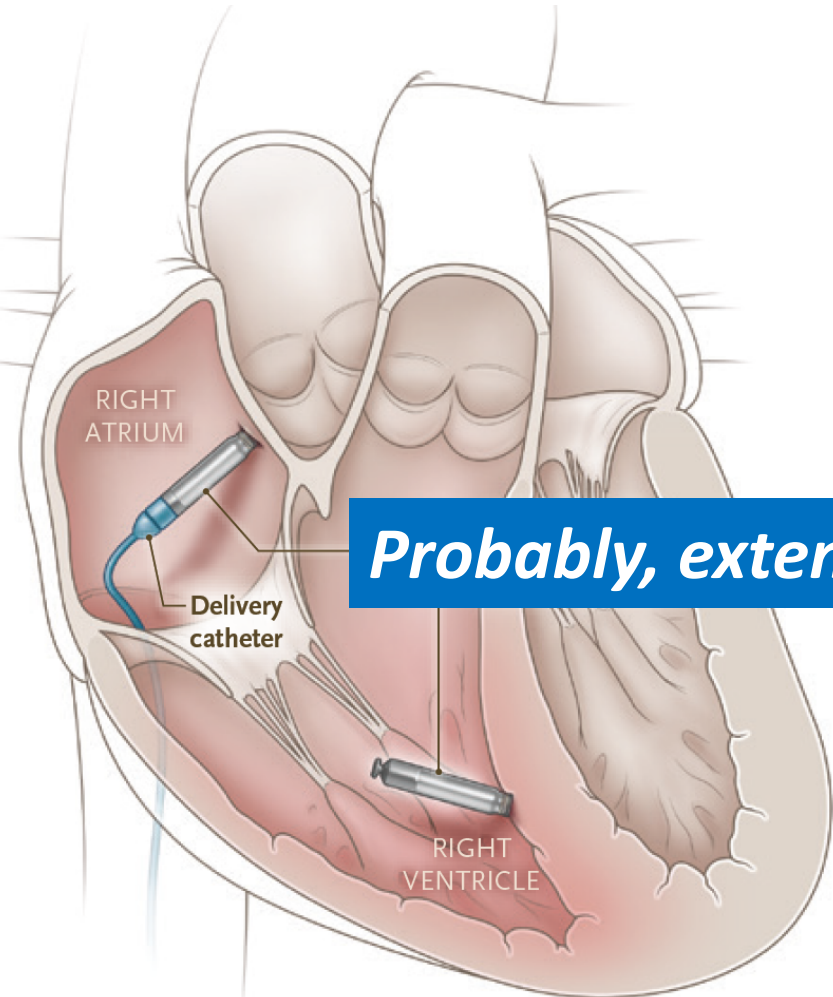
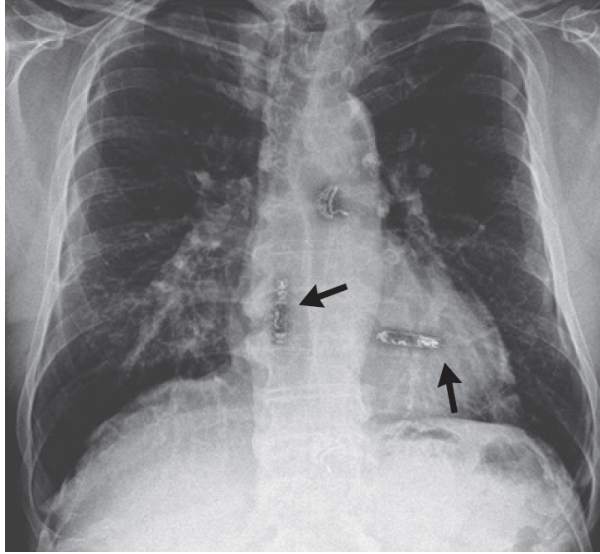
Protective covering



Turbulent flow

A Dual-Chamber Leadless Pacemaker

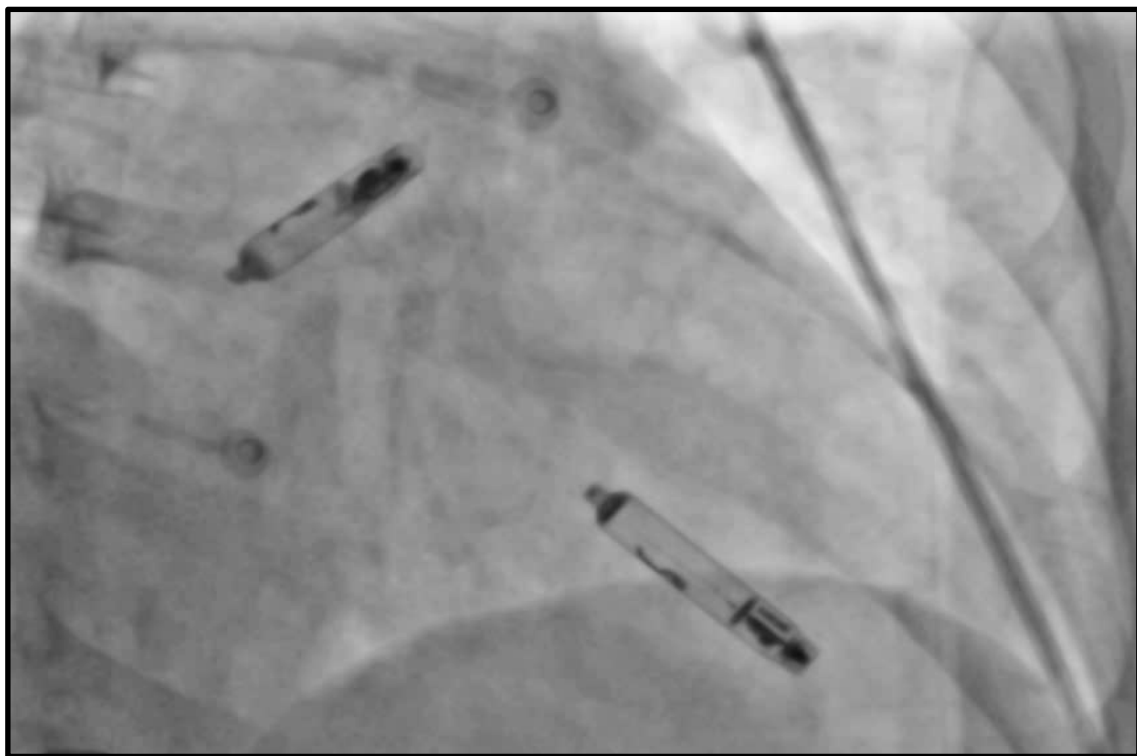
Reinoud E. Knops, M.D., Ph.D., Vivek Y. Reddy, M.D., James E. Ip, M.D., Rahul Doshi, M.D., Derek V. Exner, M.D., M.P.H., Pascal Defaye, M.D., Robert Canby, M.D., Maria Grazia Bongiorno, M.D., Morio Shoda, M.D., Gerhard Hindricks, M.D., Petr Neuzil, M.D., Mayer Rashtian, M.D., Karel T.N. Breeman, M.D., Jordan R. Nevo, M.S., Leonard Ganz, M.D., Chris Hubbard, M.B.A., and Daniel J. Cantillon, M.D., for the Aveir DR i2i Study Investigators*



Probably, extended indications of leadless pacing in the future

Complications within 90 Days.*		
Event†	Population with Attempted Implantation (N = 300)‡	
	No. of Events	No. of Patients with an Event (%)
Cardiac arrhythmia	10	10 (3.3)
communication		
Intraprocedural dislodgement	6	5 (1.7)
Due to inadequate fixation	5	4 (1.3)
Due to mechanical dislodgement‡	1	1 (0.3)
Postprocedural dislodgement¶	5	5 (1.7)
Urinary retention	3	3 (1.0)
Pericardial effusion	2	2 (0.7)
Treated with percutaneous pericardiocentesis	1	1 (0.3)
Managed conservatively	1	1 (0.3)
Capture threshold issues	2	2 (0.7)
Threshold elevation in the atrial leadless pacemaker	1	1 (0.3)
Intermittent capture in the ventricular leadless pacemaker	1	1 (0.3)
Access site bleeding	1	1 (0.3)
Retroperitoneal hematoma	1	1 (0.3)

***1st Implantation Aveir DDD in France
March 2022
CHU Grenoble Alpes***

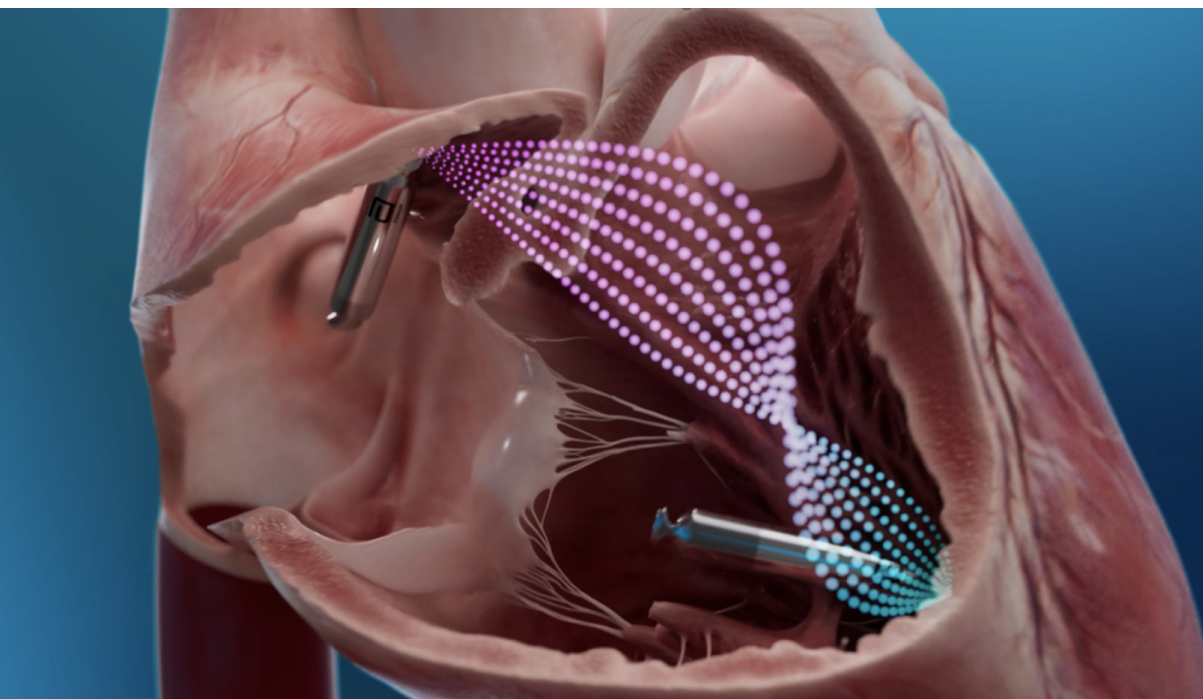


DDD leadless pacemaker

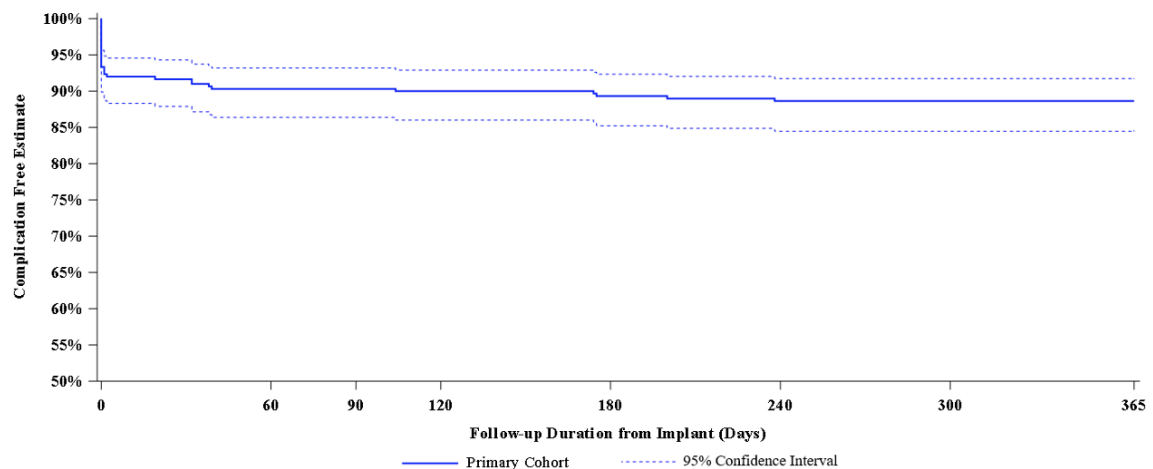
One-year safety and performance of a dual-chamber leadless pacemaker: a single-cohort

clinical study

¹Reinoud E. Knops, M.D., Ph.D, ²James E. Ip, M.D., ³Rahul Doshi, M.D., ⁴Derek V. Exner, M.D., M.P.H., ⁵Pascal Defaye, M.D., ⁶Robert Canby, M.D., ⁷Maria Grazia Bongiorni, M.D., ⁸Morio Shoda, M.D., ⁹Gerhard Hindricks, M.D., ¹⁰Petr Neuzil, M.D., ¹¹Mayer Rashtian, M.D., ¹Karel T.N. Breeman M.D., ¹²Jordan R. Nevo, M.S., ¹²Leonard Ganz, M.D., ¹²Chris Hubbard, M.B.A., and ^{10,13}Vivek Y. Reddy, M.D.,



421 Figure 3 Kaplan Meier: Primary Safety Endpoint



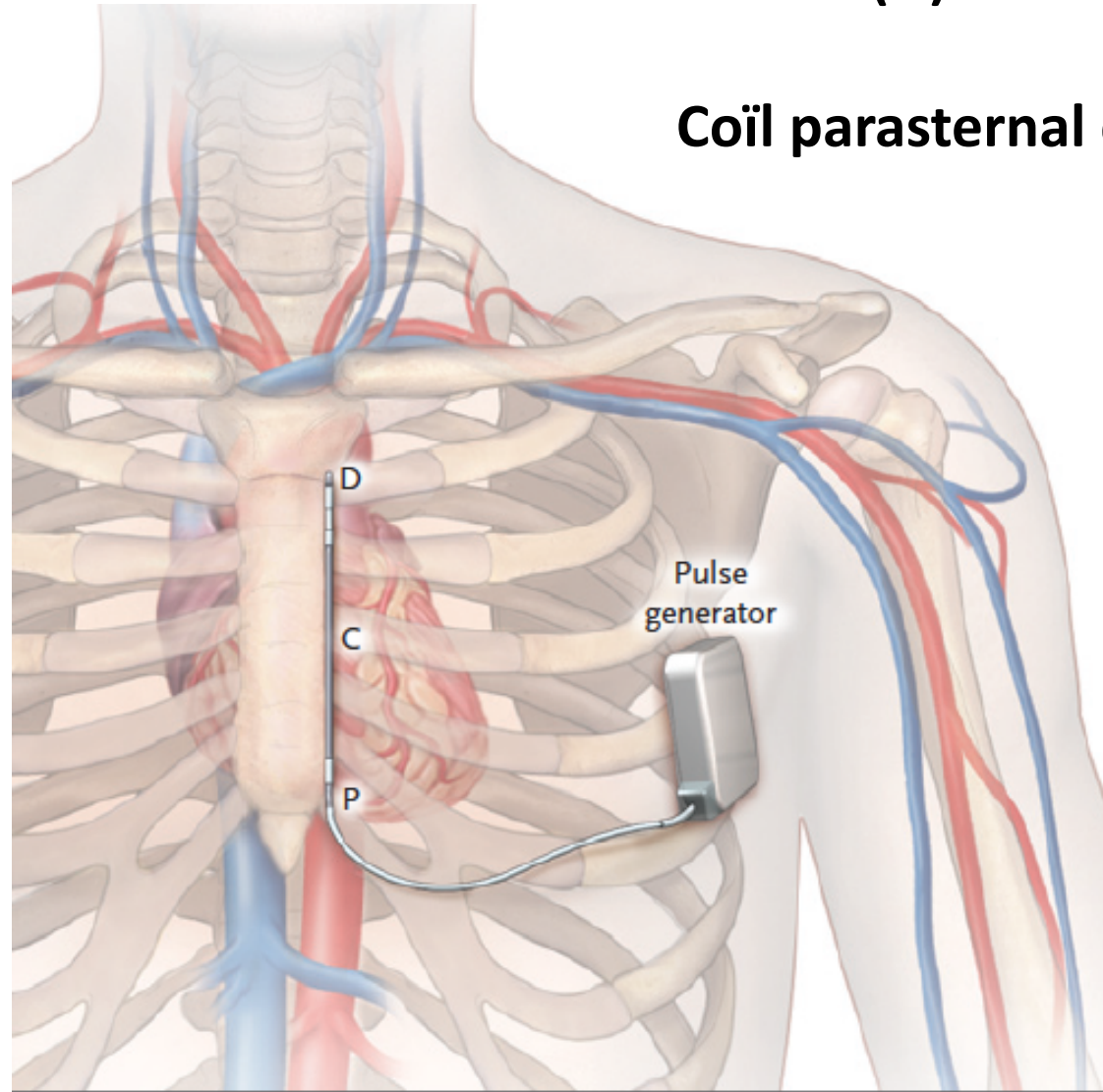
422

# Patients At Risk	300	271	268	267	265	263	260	251
# Patients with Complication	20	29	29	30	32	34	34	34
Complication Rate (%)	6.7%	9.7%	9.7%	10.0%	10.7%	11.4%	11.4%	11.4%
Complication Free Rate (%)	93.3%	90.3%	90.3%	90.0%	89.3%	88.6%	88.6%	88.6%
Standard Error (%)	1.4%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%
95% Confidence Interval	(89.9%, 95.6%)	(86.4%, 93.2%)	(86.4%, 93.2%)	(86.0%, 92.9%)	(85.2%, 92.3%)	(84.5%, 91.8%)	(84.5%, 91.8%)	(84.5%, 91.8%)

DAI sous cutané



- **Totalement sous cutané :**
- **Ne nécessite aucune électrode « dans ou sur » le cœur**
- **Pas besoin de fluoroscopie**



**Electrodes de détection
Distale (D) et Proximale (P)**

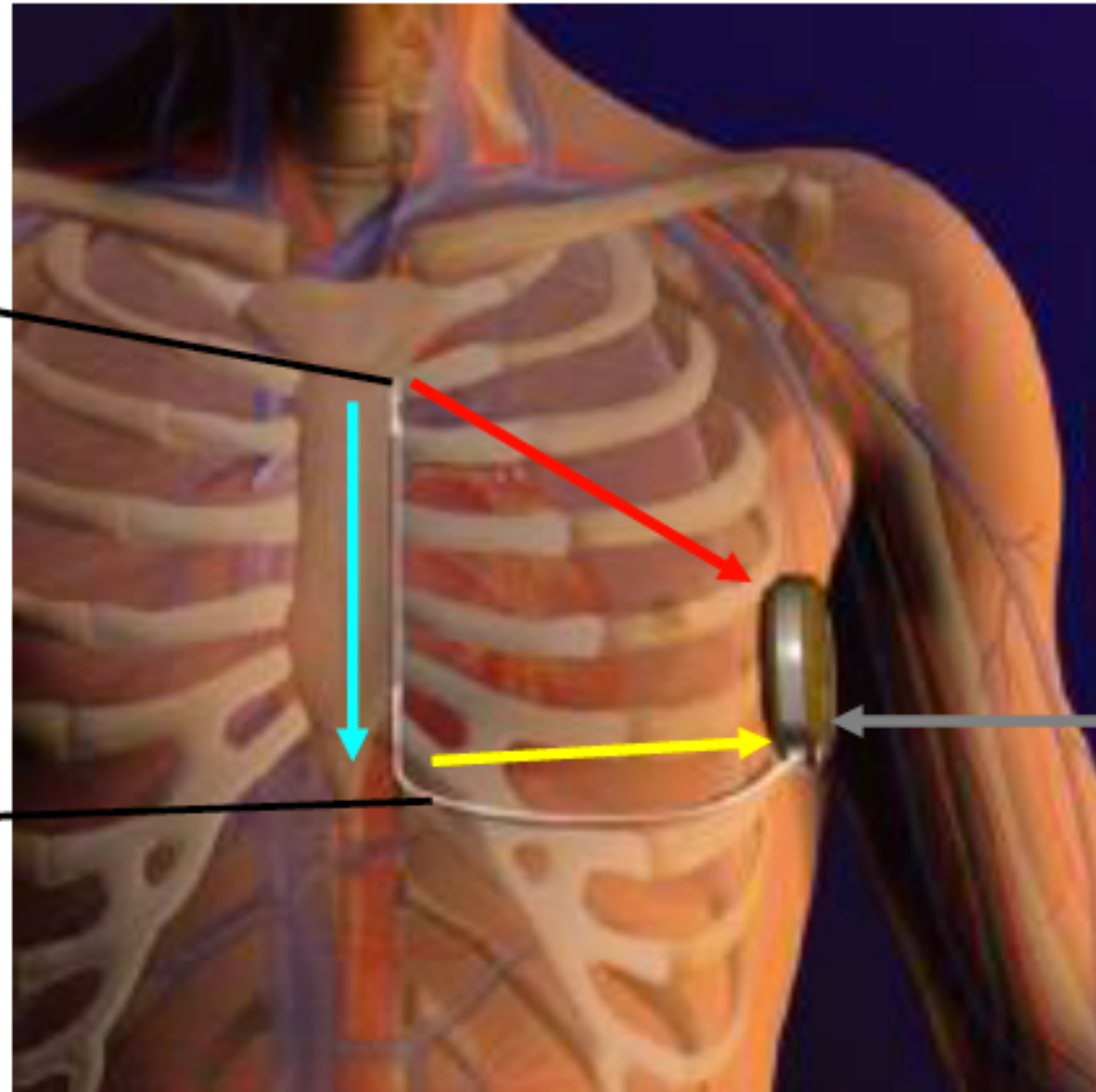
Coil parasternal de 8 cm (C)

3 different vectors for sensing : primary (yellow), secondary (red) and alternative vector (blue)

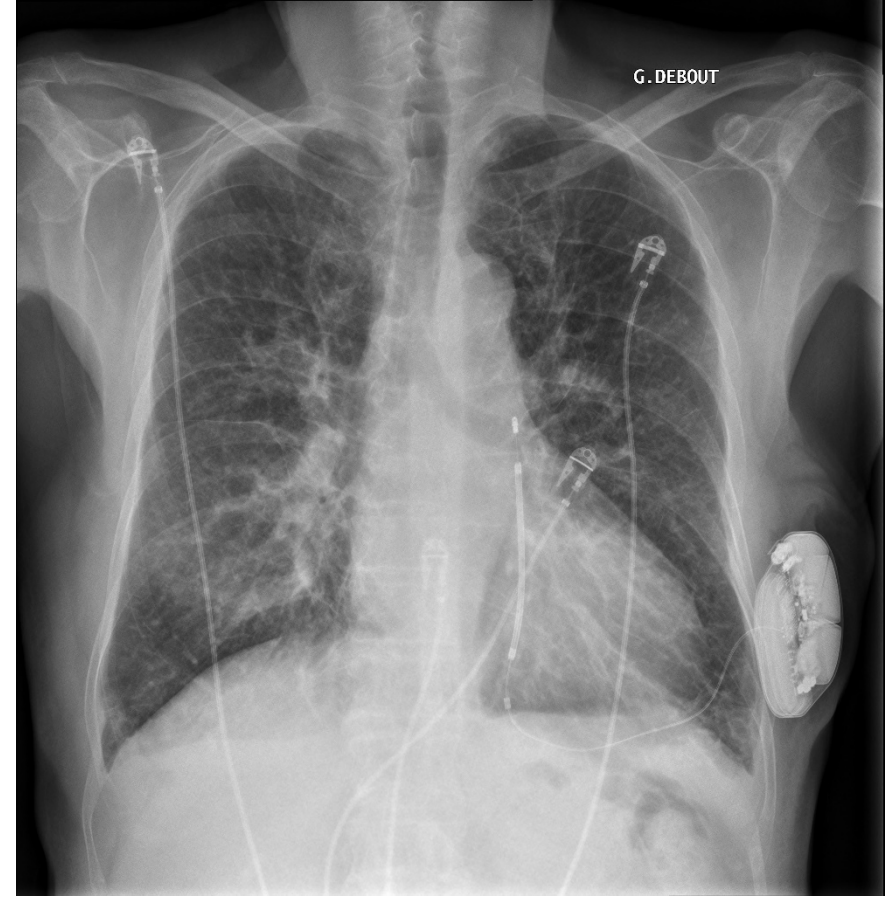
**25% des DAI
implantés en France
1792/7558 en 2023**

Distal tip
for detection

Proximal ring
for detection



Device



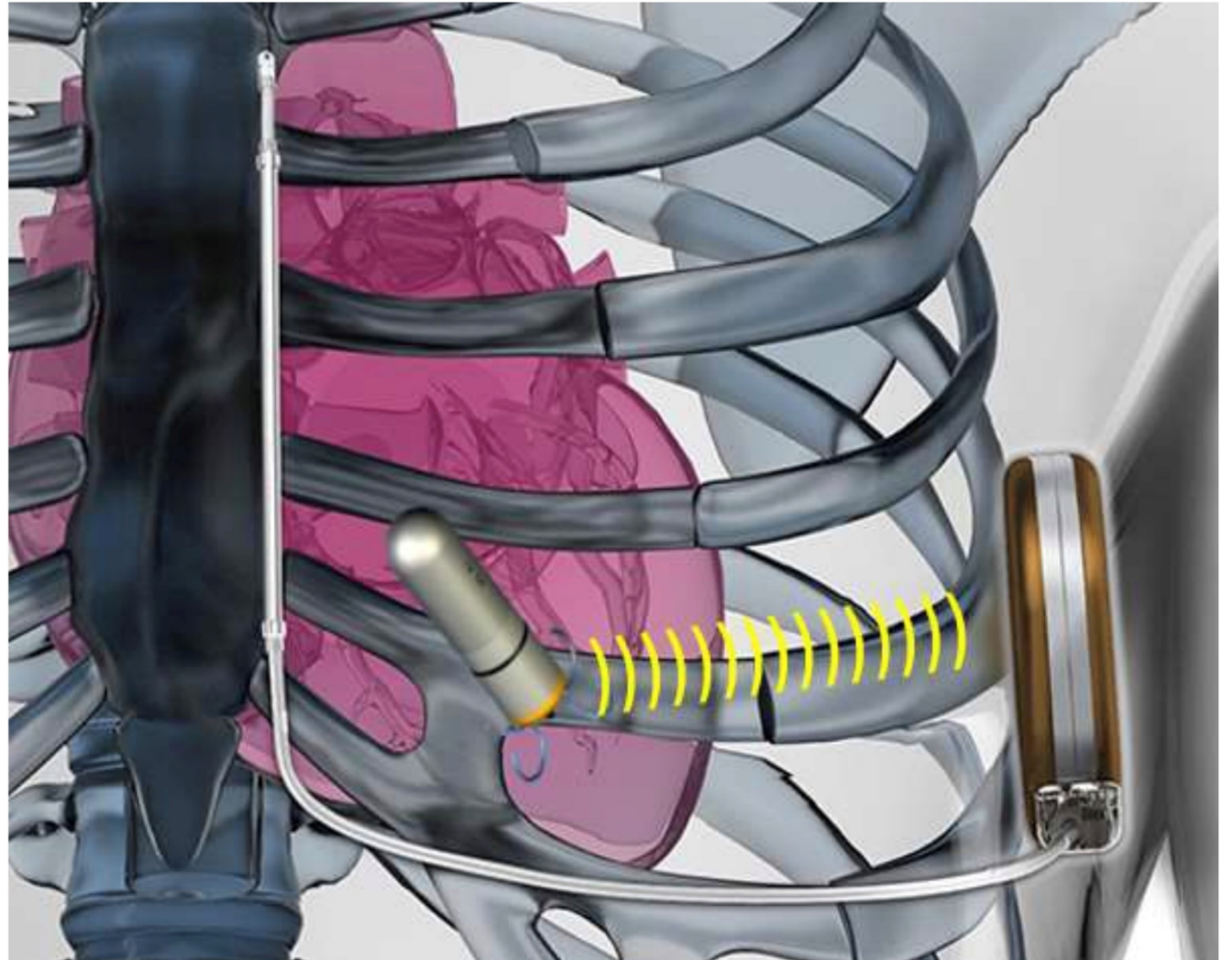
Technique : 2 incisions

Future Directions: S-ICD coupled with leadless PM?

Limitations of the S-ICD:

S-ICD patients may develop a need for:

- ✓ **Pacing support** (0.06% - 2.4%/year)
- ✓ **ATP** for recurrent monomorphic VT (0.4% - 1.8% /year)



Burke MC *J Am Coll Cardiol* 2015; 65(16): 1605–1615

Poole JE *Circ Arrhythm Electrophysiol* 2013; 6: 1236–1245

A Modular Communicative Leadless Pacing–Defibrillator System

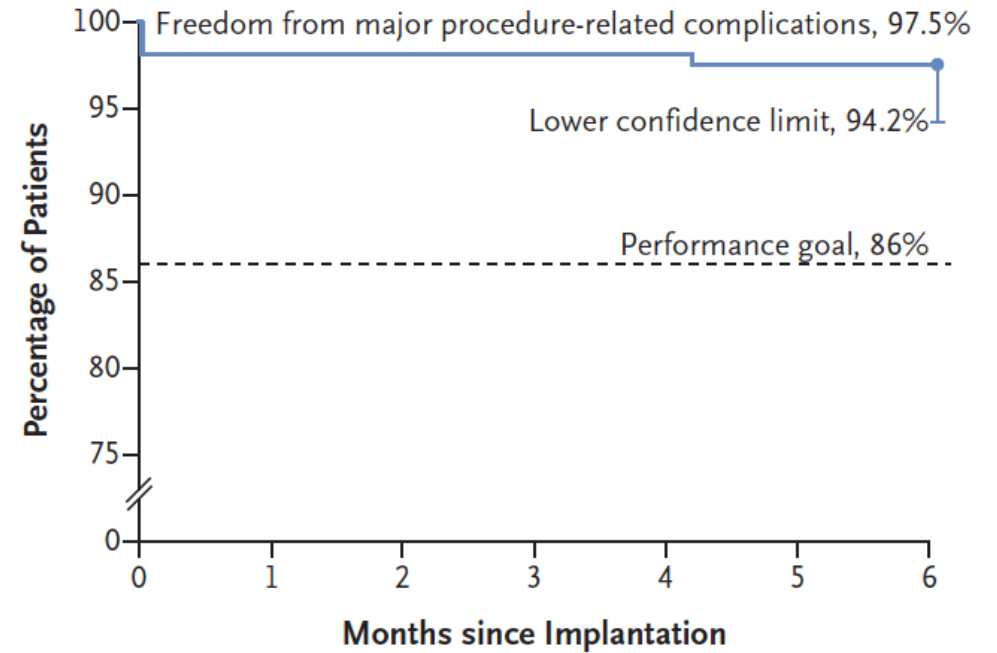
R.E. Knops, M.S. Lloyd, P.R. Roberts, D.J. Wright, L.V.A. Boersma, R. Doshi, P.A. Friedman, P. Neuzil, C. Blomström-Lundqvist, M.G. Bongiorno, M.C. Burke, D. Gras, S.P. Kutalek, A.K. Amin, E.Y. Fu, L.M. Epstein, J.M. Tolosana, T.D. Callahan, J.D. Aasbo, R. Augostini, H. Manyam, D.G. Nair, B. Mondésert, W.W. Su, C. Pepper, M.A. Miller, J. Grammes, K. Saleh, C. Marquie, F.M. Merchant, Y.-M. Cha, C. Cunnington, D.S. Frankel, J. West, E. Matznick, B. Swackhamer, A.J. Brisben, J. Weinstock, K.M. Stein, V.Y. Reddy, and L. Mont, for the MODULAR ATP Investigators*

Table 2. Complications Related to the Pacing–Defibrillator System or Implantation Procedure.*

Complication	Events	Patients (N=162)
	no.	no. (%)
Any complication	18	16 (9.9)
Related to leadless pacemaker or procedure, during procedure	6	5 (3.1)
Myocardial perforation with tamponade†	2	2 (1.2)
Leadless pacemaker inadvertently implanted in left ventricle†	1	1 (0.4)
Adverse reaction, respiratory	1	1 (0.6)
Venous access site bleeding	1	1 (0.6)
Atrial fibrillation	1	1 (0.6)
Related to S-ICD system or procedure, during procedure	3	3 (1.9)
Adverse reaction, vasovagal syncope‡	1	1 (0.6)
Adverse reaction, respiratory	1	1 (0.6)
Hypotension attributed to IV antibiotic	1	1 (0.6)
Hematoma, S-ICD pocket at ≤30 days after implantation	1	1 (0.6)
Related to S-ICD programmable generator	2	2 (1.2)
Premature cell-battery depletion	1	1 (0.6)
S-ICD migration or revision	1	1 (0.6)
Related to S-ICD electrode	2	2 (1.2)
Invasive intervention to address inappropriate tachycardia therapy, noise (noncardiac), electrode	1	1 (0.6)
Electrode migration or revision	1	1 (0.6)
Related to S-ICD system, therapy: invasive intervention to address ventricular tachycardia below rate cutoff with oversensing	1	1 (0.6)
Related to S-ICD system, diagnosis: random component failure, memory corruption	1	1 (0.6)
Related to S-ICD system, patient related: incisional or superficial infection >30 days after implantation, without explantation	1	1 (0.6)
Cardiovascular	0	0
Noncardiovascular	2	2 (1.2)
Unclassified	0	0

N Engl J Med 2024

162 patients

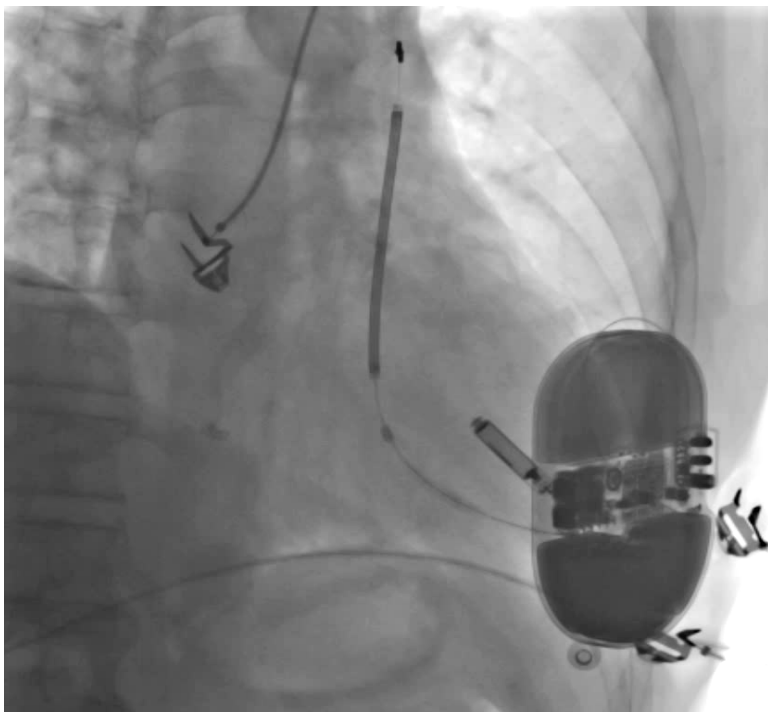
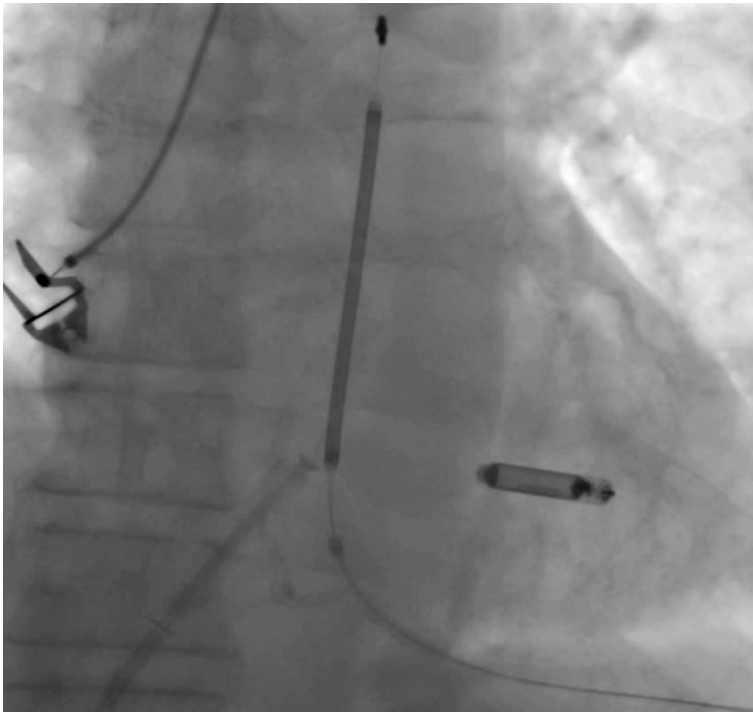
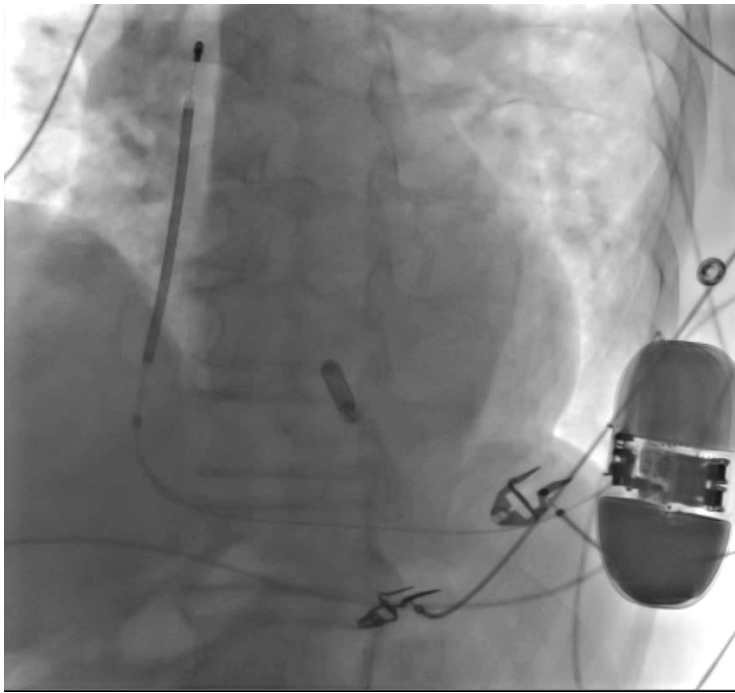
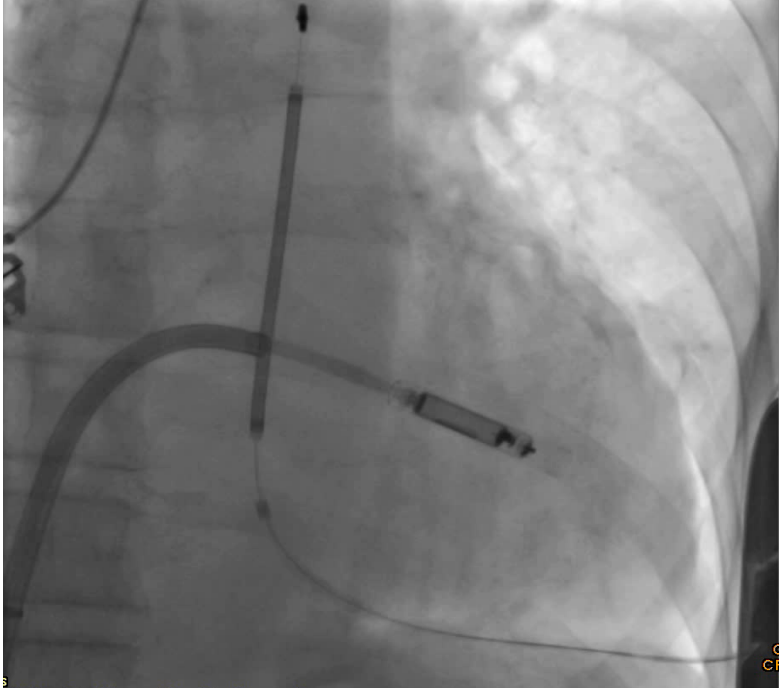


Major Complications	0	3	3	3	3	4	4
No. at Risk	162	159	158	157	157	155	155

Figure 2. Freedom from Major Complications Related to the Leadless Pacemaker or Implantation Procedure.

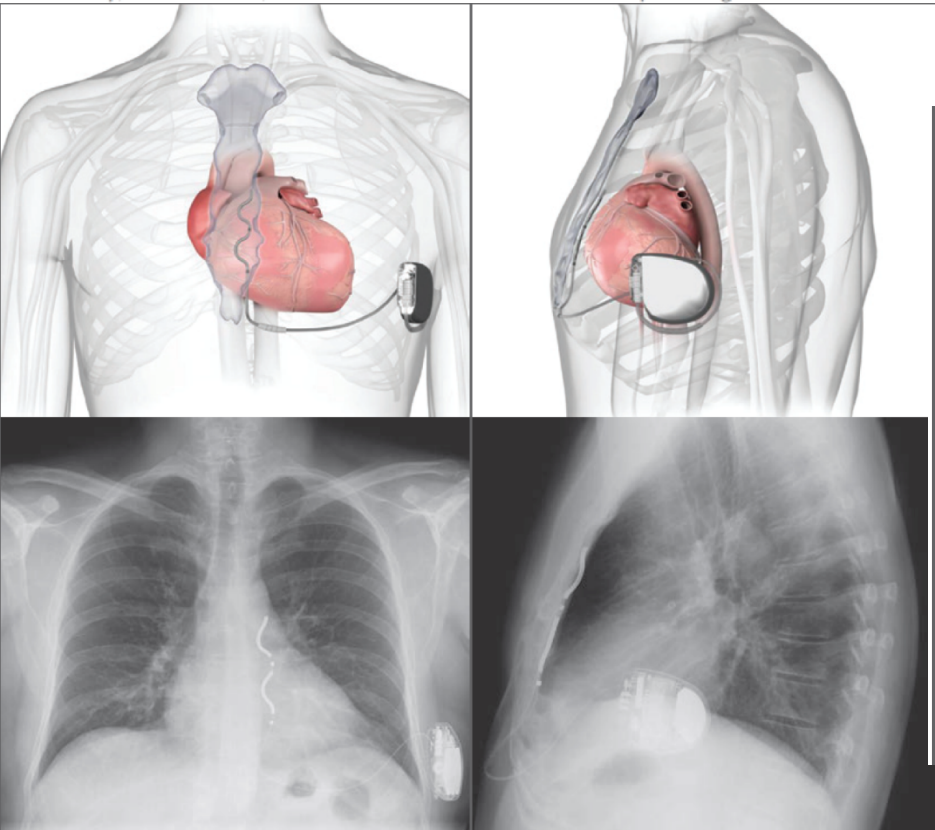
Shown is the percentage of patients free from pacemaker- or procedure-related complications at 6 months, along with the lower boundary of the one-sided 98.8% confidence interval and the prespecified performance goal of 86%.

20/07/2023
CHU Grenoble Alpes

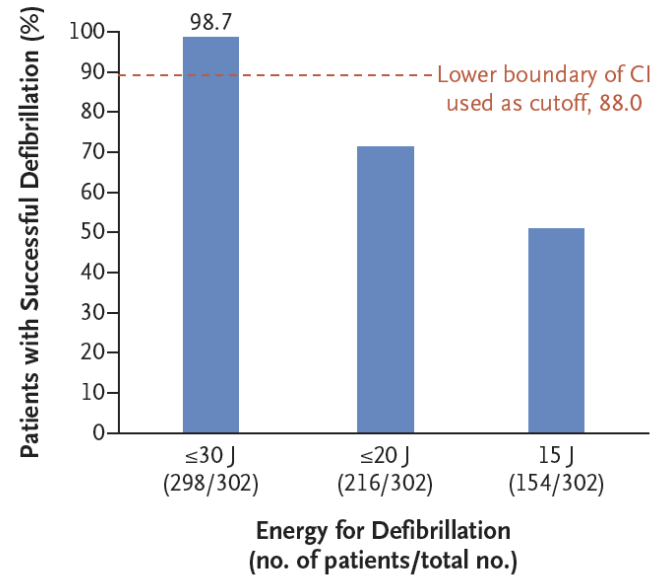


Efficacy and Safety of an Extravascular Implantable Cardioverter–Defibrillator

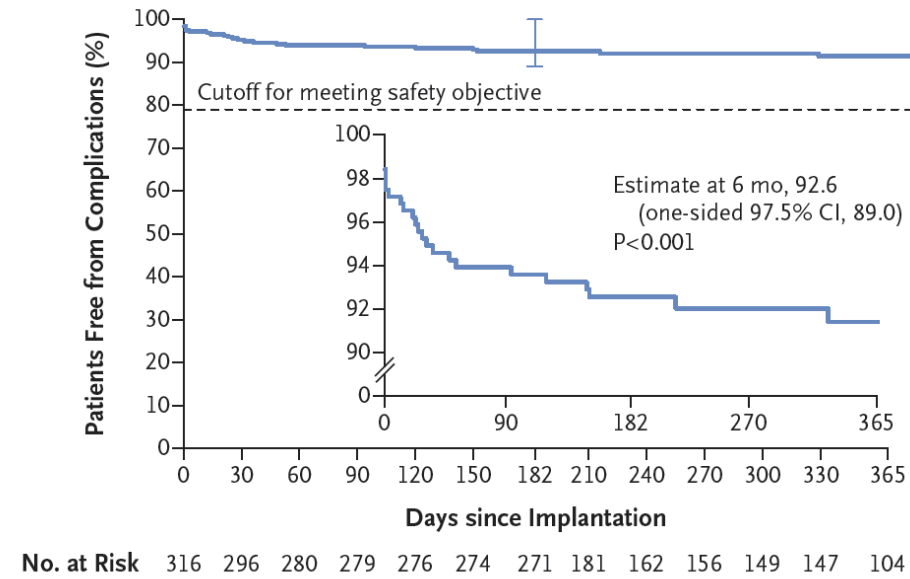
P. Friedman, F. Murgatroyd, L.V.A. Boersma, J. Manlucu, D. O'Donnell, B.P. Knight, N. Clémenty, C. Leclercq, A. Amin, B.P. Merkely, U.M. Birgersdotter-Green, J.Y.S. Chan, M. Biffi, R.E. Knops, G. Engel, I. Muñoz Carvajal, L.M. Epstein, V. Sagi, J.B. Johansen, M. Sterliński, C. Steinwender, T. Hounshell, R. Abben, A.E. Thompson, C. Wiggenhorn, S. Willey, and I. Crozier, for the Extravascular ICD Pivotal Study Investigators*



A Defibrillation Efficacy at Implantation

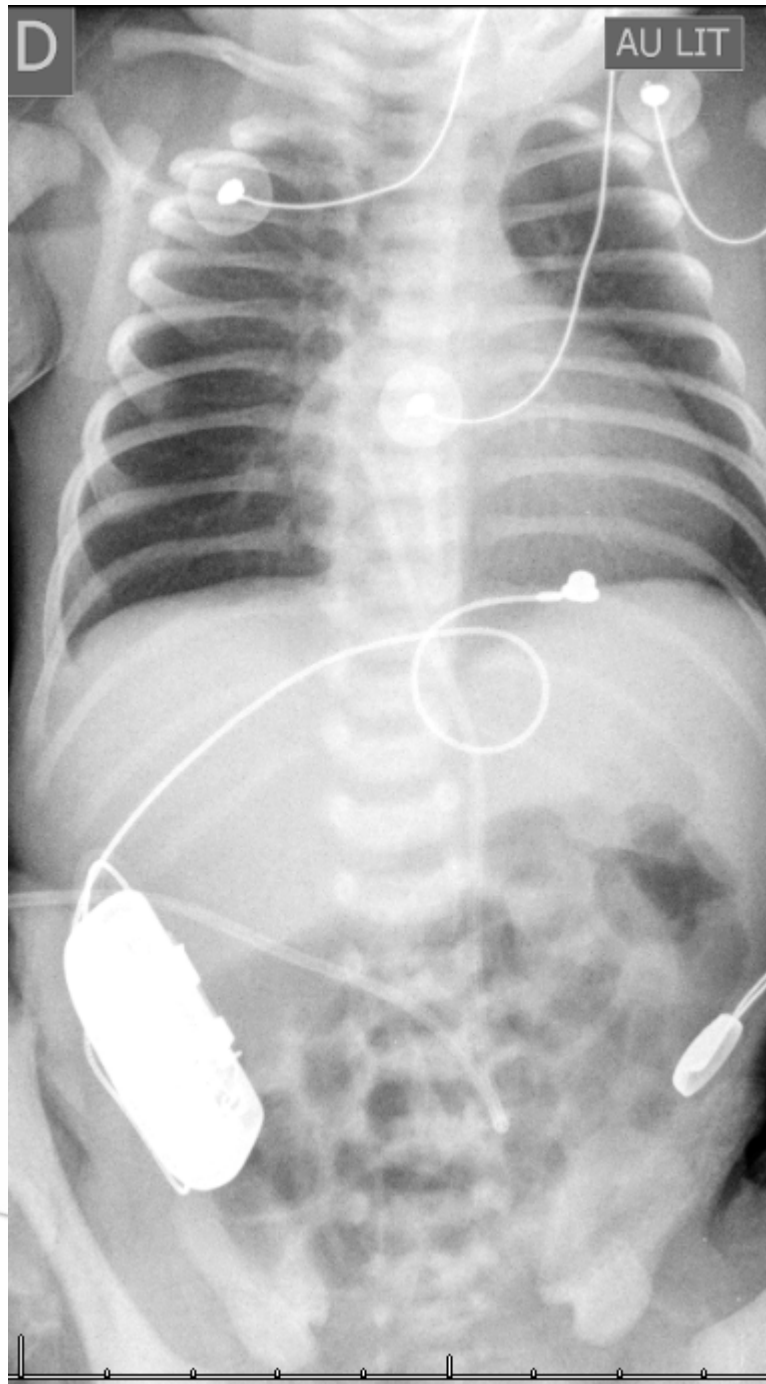


B Freedom from Major System- or Procedure-Related Complications



Anatomie cardiaque &
Stimulation/défibrillation
épicardique

- **Electrodes**
- Poreuse
- Diffusion de stéroïdes
- Unipolaire / bipolaire
- Seuils chroniques 0.3 – 2.5V (65% ↑ seuils)
- Boucle pour anticiper la croissance



- **Pacemaker**
- Abdominal
- « Grosse » batterie
- Sortie (8V)
- FC max 180 bpm → enfant = ↑ FC → ↑ DC



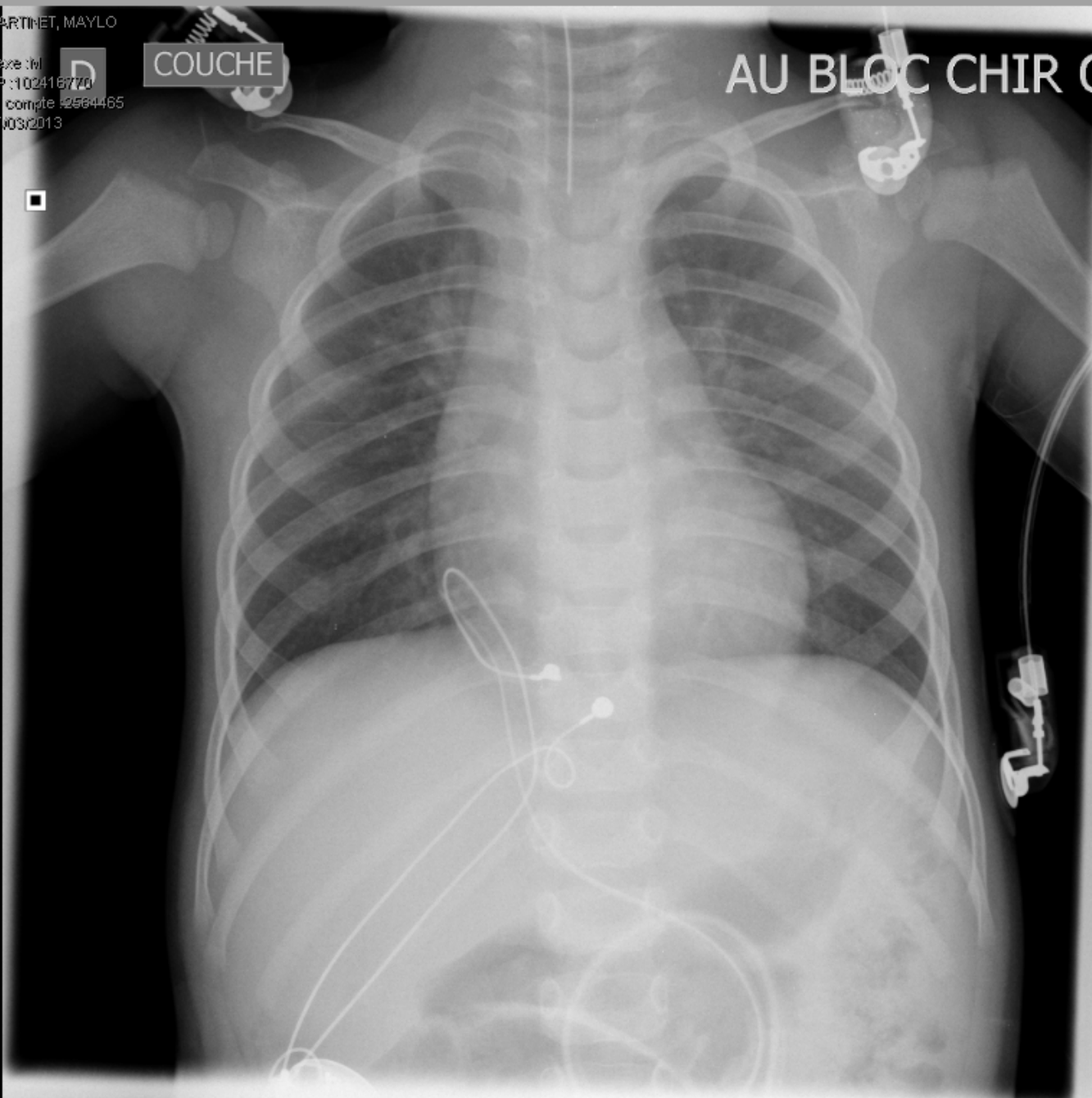
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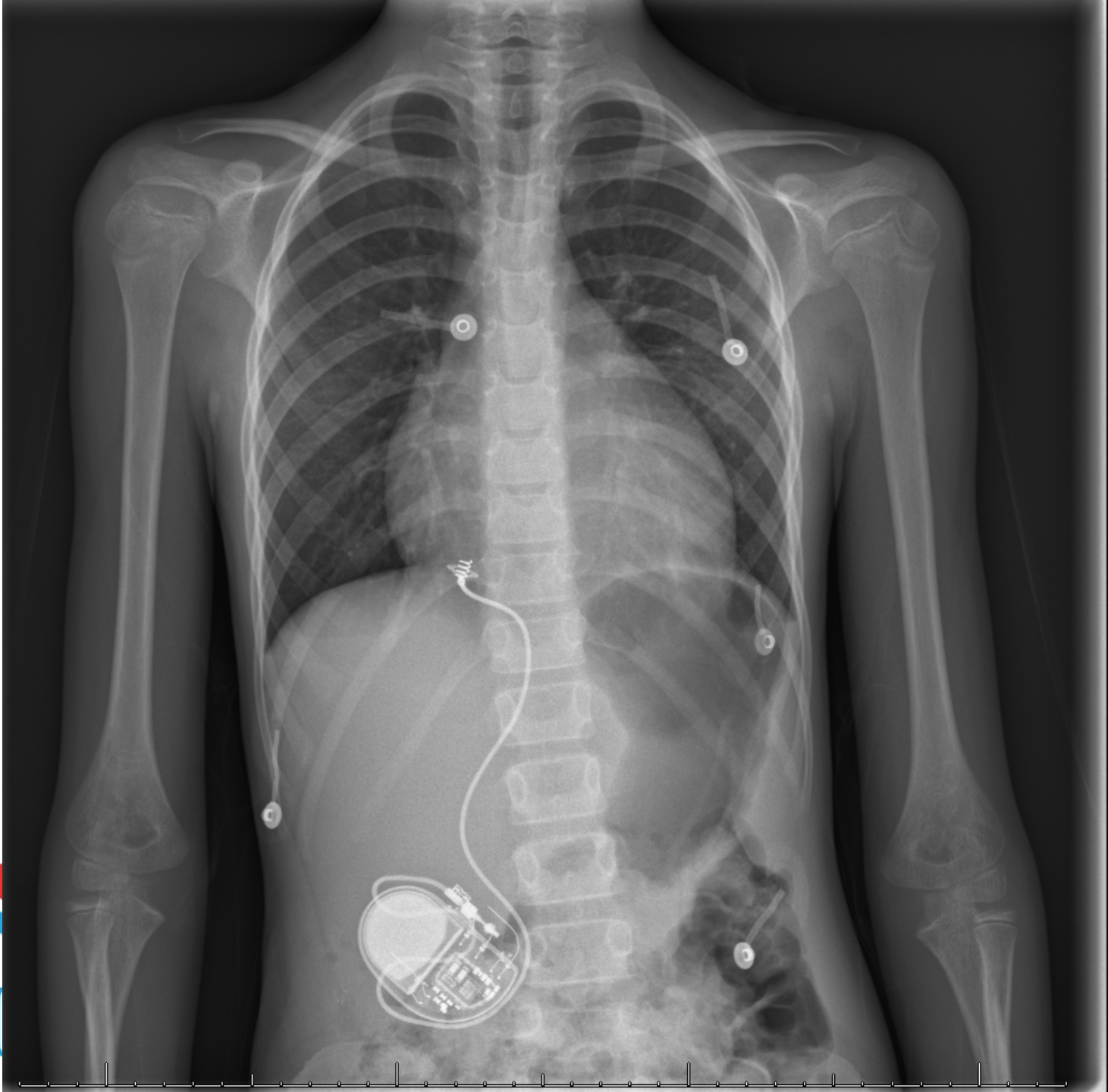
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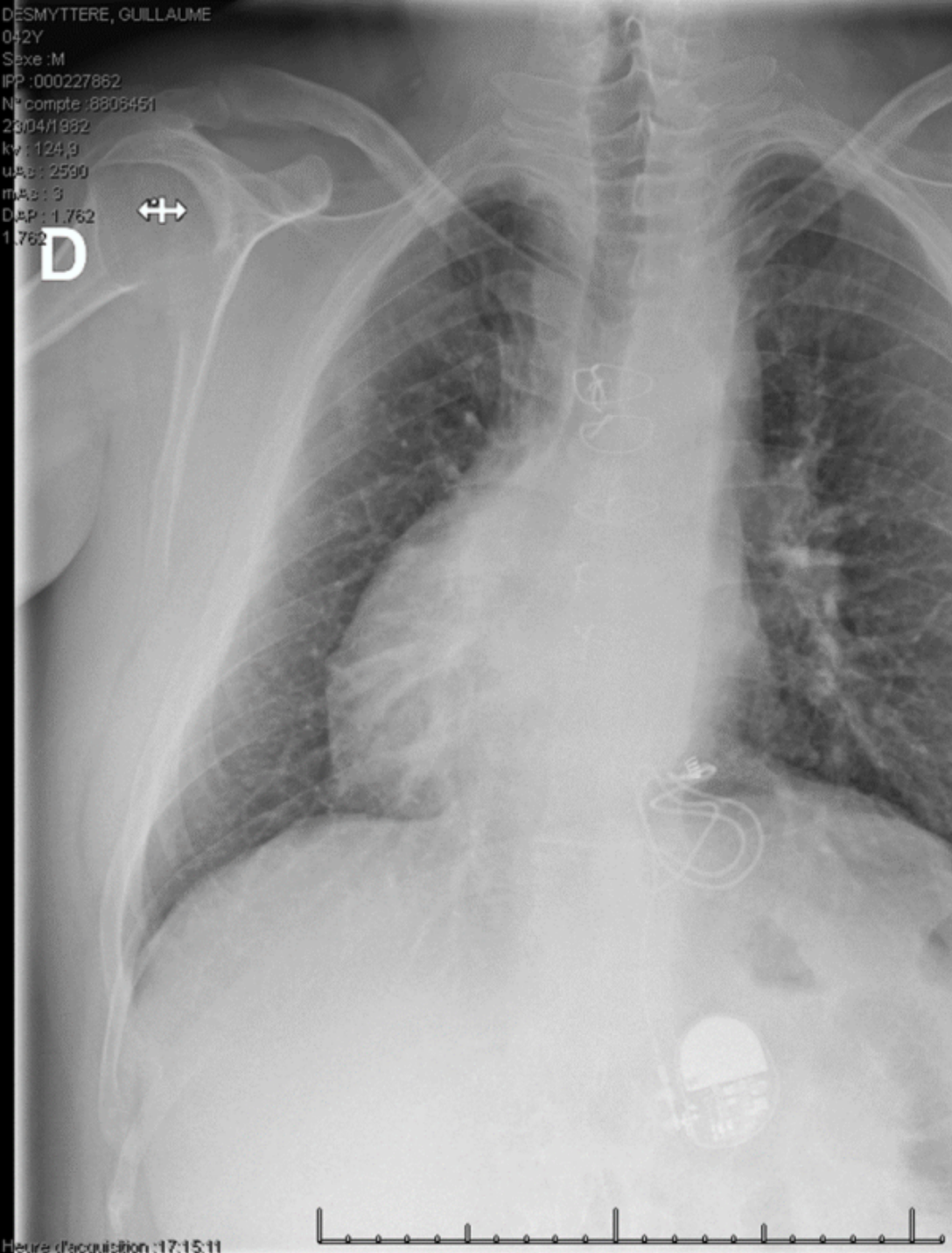
AU BLOC CHIR ORTHO

Hopital Jeanne de Flandre
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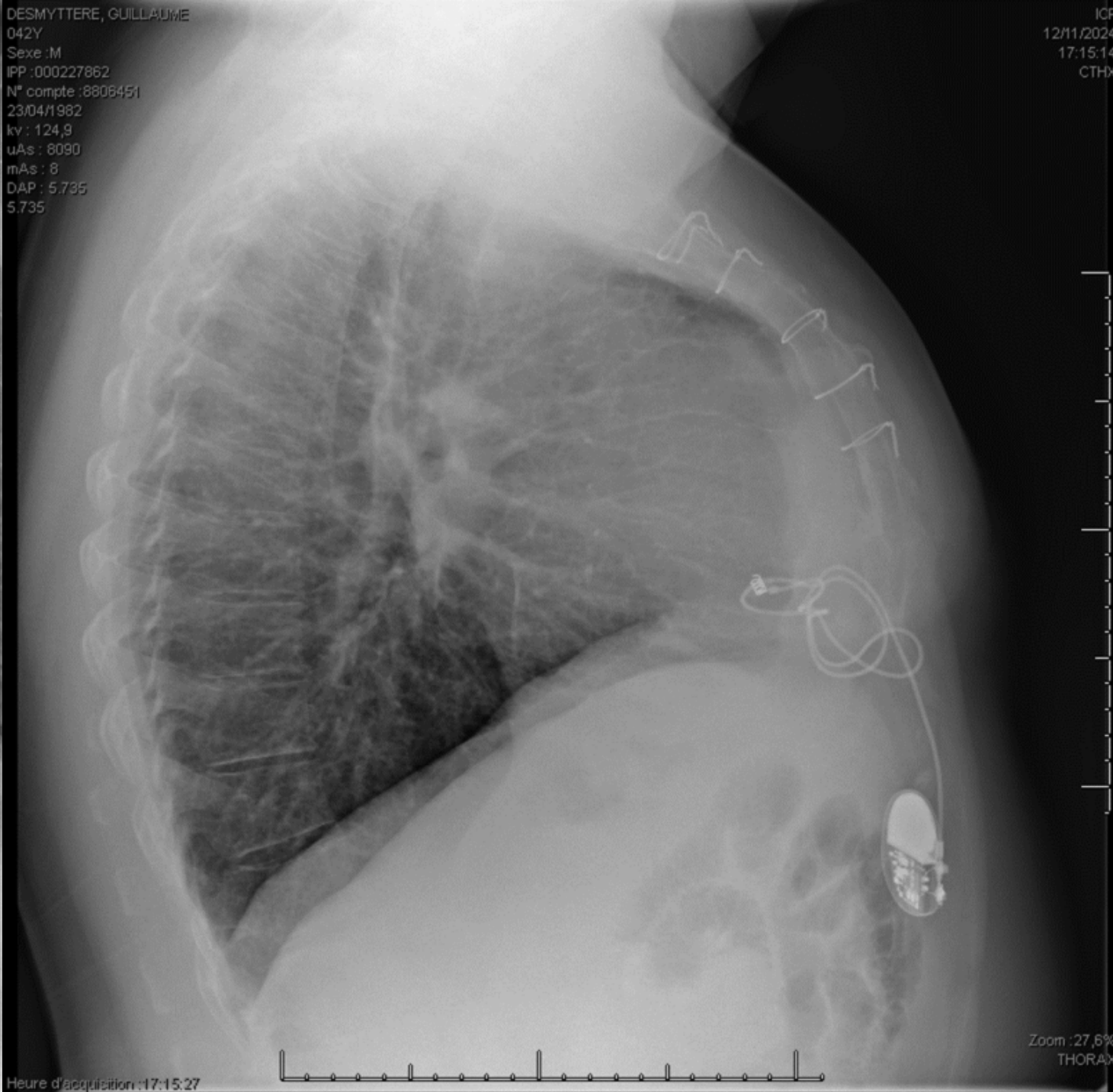




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mAs : 3
DAP : 1,762
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DESMYTTERE, GUILLAUME
042Y
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23/04/1982
kv : 124,9
uAs : 8090
mAs : 8
DAP : 5,735
5,735



ICP
12/11/2024
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THORAX

Focus sur anatomie cardiaque pour comprendre stimulation & défibrillation

Take Home Messages

- ◎ **La rythmologie est une discipline qui PEC tout type de TDR et de conduction**
- ◎ Bien connaitre l'anatomie cardiaque et la physiologie du tissu nodal est indispensable
- ◎ **La stimulation cardiaque a pour but de corriger les troubles de conduction** (de + en + de la manière la plus physiologique possible)
- ◎ **La défibrillation cardiaque a pour but de corriger les troubles du rythme ventriculaire et de prévenir la MSC**