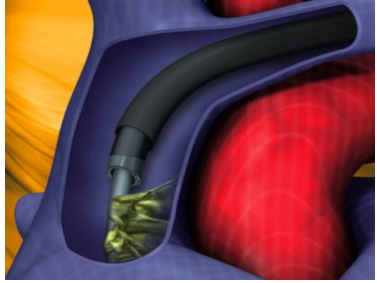


Extraction de matériel : Son développement Son avenir

ACCA/Nice Novembre 2024

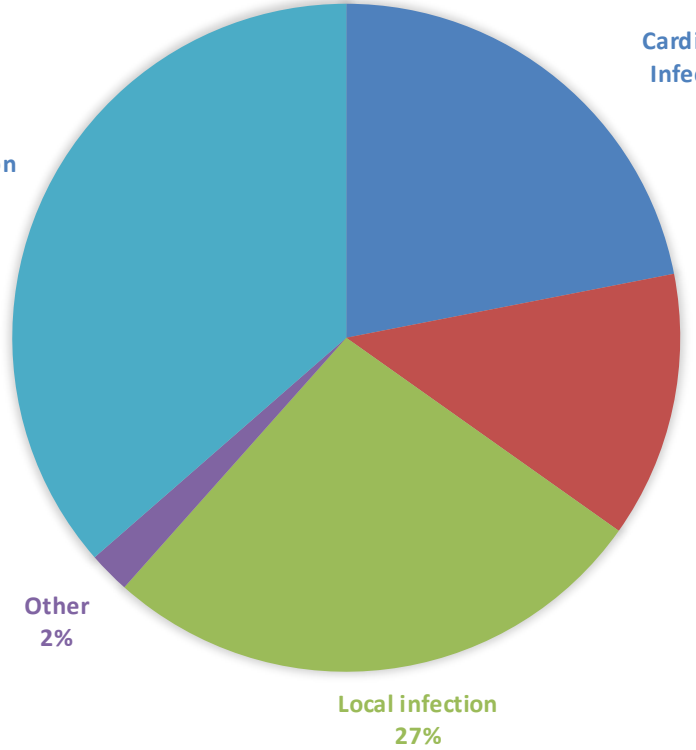
Pascal DEFAYE/ CHU Grenoble Alpes/ France

CHU GRENOBLE ALPES

UGA Université Grenoble Alpes

When to refer for lead extraction : Grenoble University Hospital

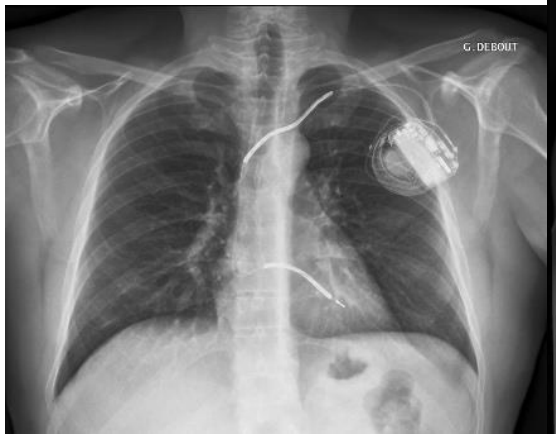
36%

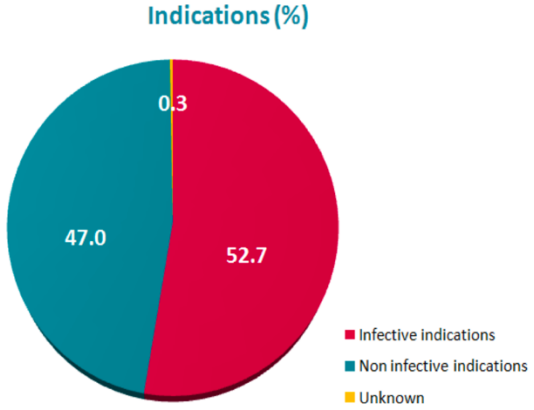


64%

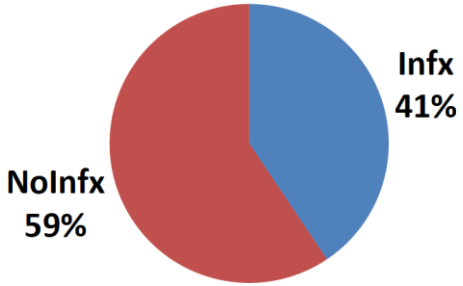
Extraction indications
2002-2022
520 patients
Dwelling time >2 years

Extraction indications





Electra , EHJ 2017



ProMet study, Starck C, Europace 2020

When to refer for lead extraction : Grenoble University Hospital

Population :
20 years
2002-2022
Dwelling time>2 years
520 patients

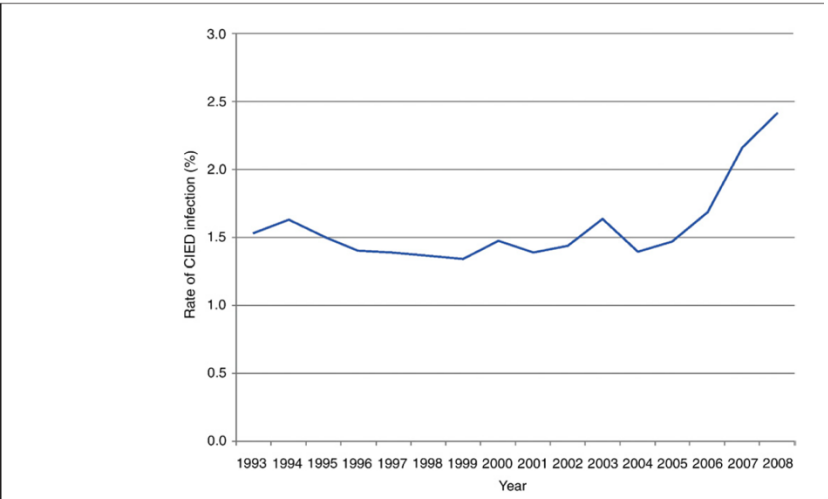
Age (mean±SD)	68±15 yo
Men	79%
BMI (Mean±SD)	27±13
LVEF>50%	48%
Creatinin	116µM/l
Diabetis	22%
Prosthetic valve	6%
Pace maker	48%
- VVI	12%
- DDD	74%
- CRT-P	13%
ICD	52%
- VVI	26%
-DDD	35%
- CRT-D	40%
Origin	
- Grenoble U H(%)	48
- Other centers(%)	52
Dwelling time (months)	60,5(extreme : 372)

Risk factors for infections

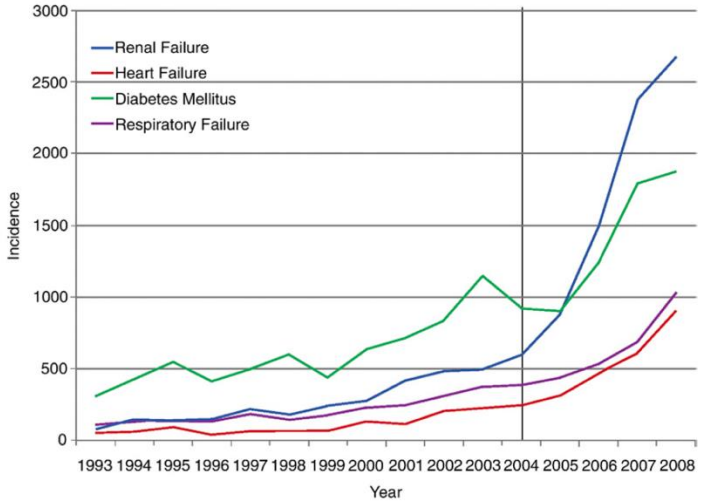
16-Year Trends in the Infection Burden for Pacemakers and Implantable Cardioverter-Defibrillators in the United States

1993 to 2008

Arnold J. Greenspon, MD,* Jasmine D. Patel, PHD,†‡ Edmund Lau, MS,†‡ Jorge A. Ochoa, PHD,‡
Daniel R. Frisch, MD,* Reginald T. Ho, MD,* Behzad B. Pavri, MD,* Steven M. Kurtz, PHD†‡
Philadelphia, Pennsylvania



Rate of CIED Infection



Incidence of Comorbidities in Patients With CIED Infection

Greenspon A, JACC 2011; 58:1001-6

16-Year Trends in the Infection Burden for Pacemakers and Implantable Cardioverter-Defibrillators in the United States

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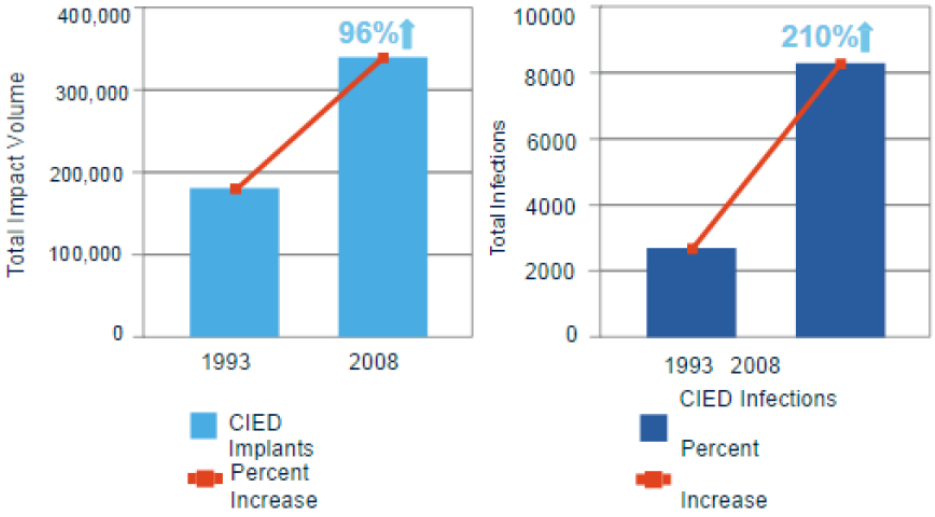
Philadelphia, Pennsylvania

Infections increasing at faster rate than implants



Contributing factors for increase :

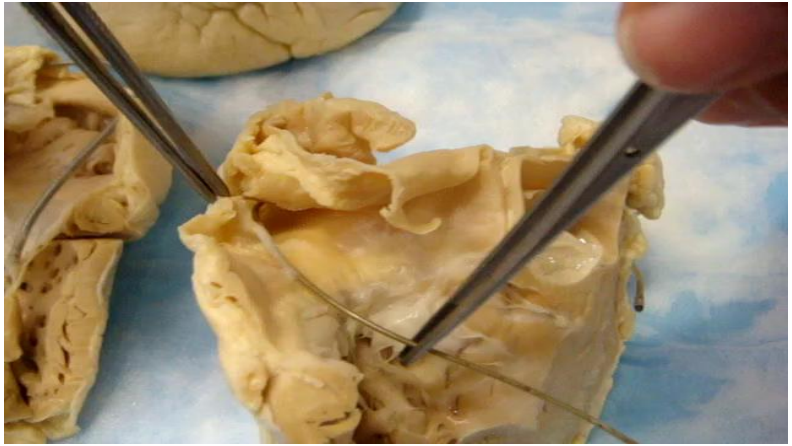
- ***Older pts receiving devices***
- ***More pts comorbidities***
- ***Longer procedures***
- ***Changing mix of CIEDs***
- ***Increasing number of replacements /upgrades***
- ***Revisions***
- ***More resistant S aureus coag-***
- ***Staph species (e.g. S epidermidis)***

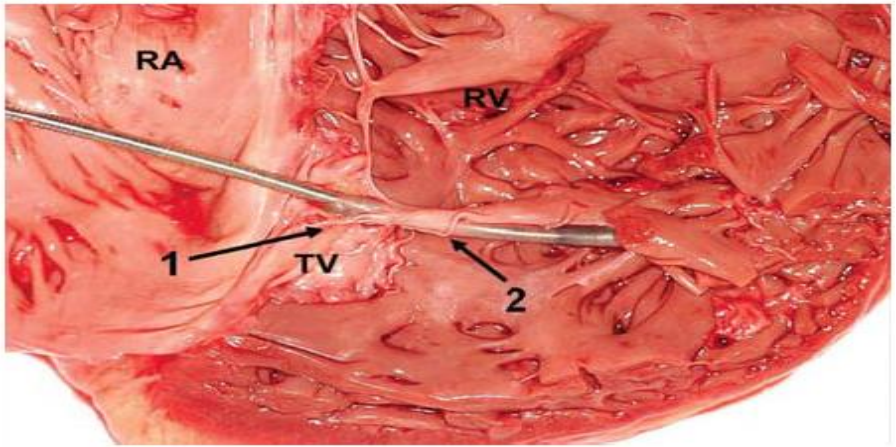
CIED implants and infections between 1993-2008

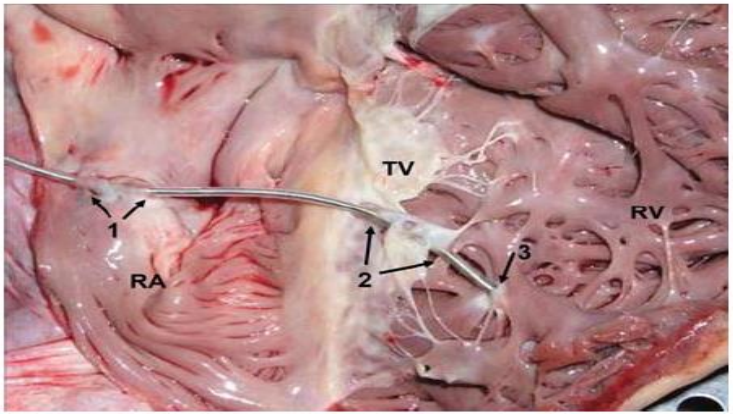
Greenspon A, JACC 2011; 58:1001-6

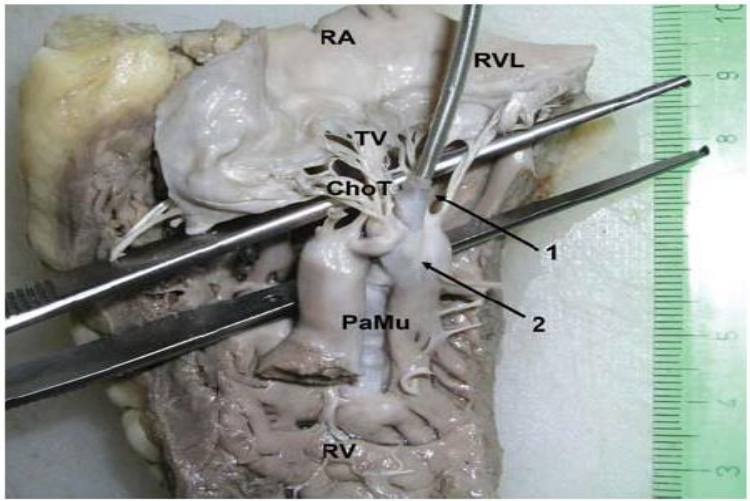
Autopsy and clinical context in deceased patients with implanted pacemakers and defibrillators: intracardiac findings near their leads and electrodes

Miroslav Novak*, Petr Dvorak, Pavel Kamaryt, Bronislava Slana, and Jolana Lipoldova









Europace 2009; 11, 1510–1516

When to refer to lead extraction : infections

2017 HRS expert consensus statement on cardiovascular implantable electronic device lead management and extraction

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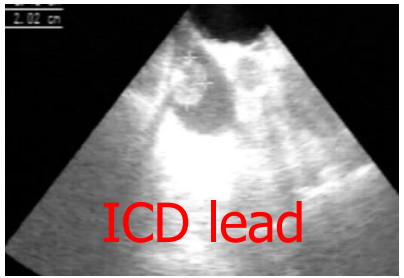
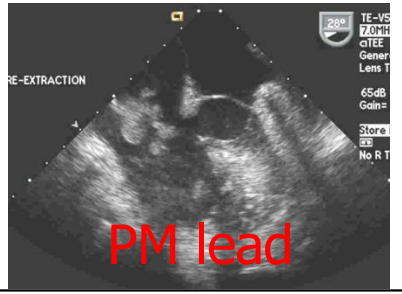




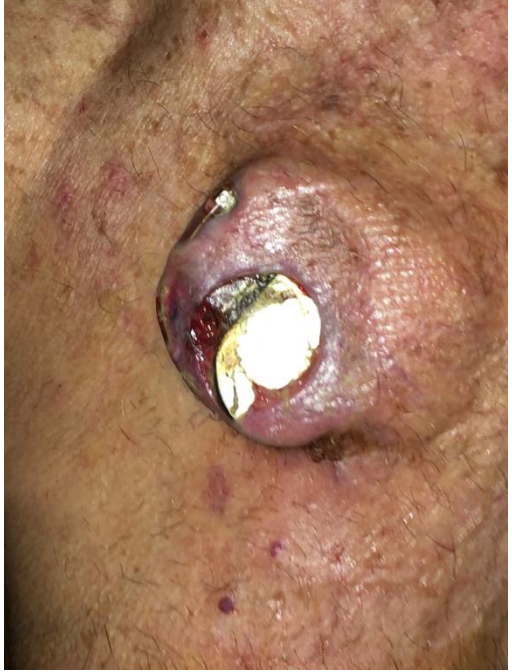
I	B-NR	**Complete device and lead removal is recommended for all patients with definite CIED system infection.**	169–171

Early diagnosis of CIED infection and performing lead extraction within 3 days of diagnosis is associated with lower in-hospital mortality.[169] A multivariate analysis found a 7-fold increase in 30-day mortality if the CIED was not removed. Although CIED removal resulted in fatal complications, the mortality associated with a delay in removal was even higher.[170] Therefore, CIED-associated infections are the strongest indication for complete CIED system removal and should not be delayed, regardless of the timing of the start of antimicrobial therapy.[1,171]

I	B-NR	**Complete device and lead removal is recommended for all patients with valvular endocarditis without definite involvement of the lead(s) and/or device.**	153,169

Complete CIED removal should be performed when patients undergo valve replacement or repair for infective endocarditis, because the CIED could serve as a nidus for relapsing infection and subsequent seeding of the surgically treated heart valve.[153]
A recent study has shown that complete CIED removal appears curative for patients with CIED infection in the presence of prosthetic heart valves and thus might prevent repeat valve surgery.[169]

Heart Rhythm, December 2017



Erosion of any part of the CIED indicates contamination of the entire system, and complete device removal should be performed

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When to refer to lead extraction : infections

I	B-NR	**Complete device and lead removal is recommended for patients with persistent or recurrent bacteremia or fungemia, despite appropriate antibiotic therapy and no other identifiable source for relapse or continued infection.**	153,165

Persistent or relapsing bacteremia or fungemia after a course of appropriate antibiotic therapy when there is no other identified source for bacteremia or fungemia suggests CIED and lead infection. In this scenario, the retained intravascular leads are very likely to be the source of infection. Complete removal of hardware is recommended to eradicate the infection.[153,165]

Heart Rhythm, December 2017

ESC European Society of Cardiology
Europace (2020) 22, 515–516
doi:10.1093/europace/euz246

European Heart Rhythm Association (EHRA) international consensus document on how to prevent, diagnose, and treat cardiac implantable electronic device infections—endorsed by the Heart Rhythm Society (HRS), the Asia Pacific Heart Rhythm Society (APHRS), the Latin American Heart Rhythm Society (LAHRS), International Society for Cardiovascular Infectious Diseases (ISCVID) and the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS)

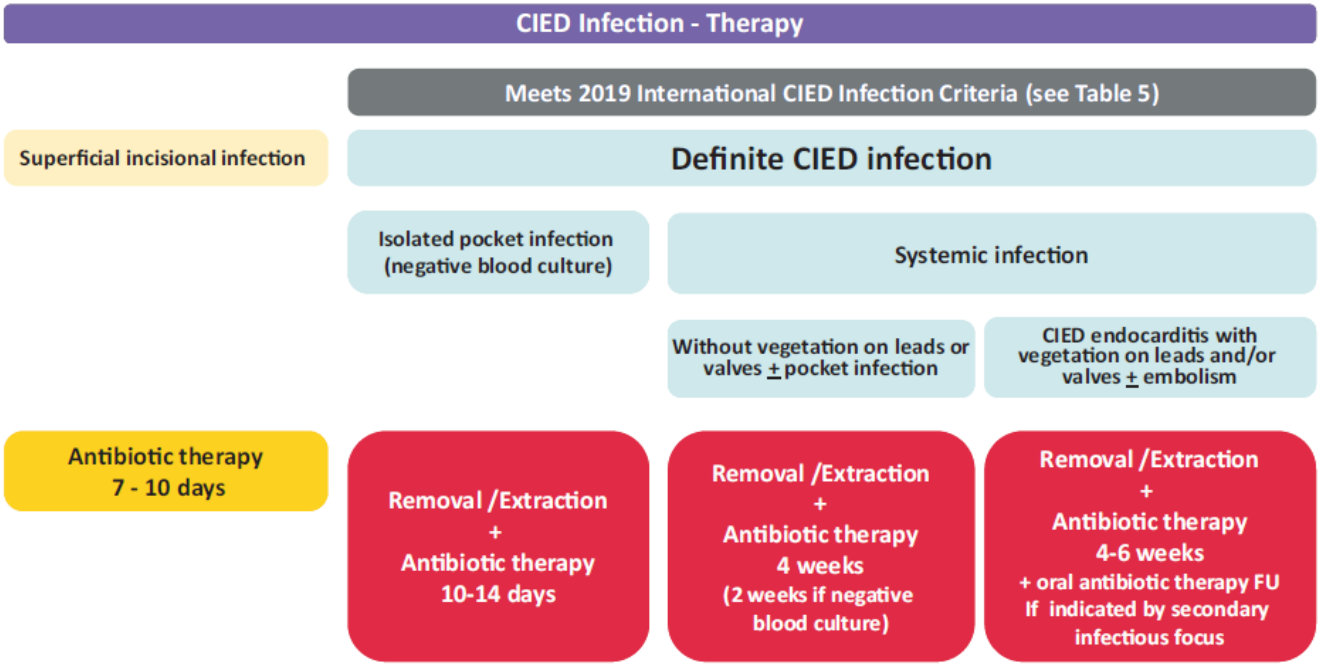
Carina Blomström-Lundqvist (Chair)[1]*, Vassil Traykov (Co-Chair)[2], Paola Anna Erba[3], Haran Burri[4], Jens Cosedis Nielsen[5], Maria Grazia Bongiorni[6], Jeanne Poole (HRS representative)[7], Giuseppe Boriani[8], Roberto Costa (LAHRS representative)[9], Jean-Claude Deharo[10], Laurence M. Epstein (HRS representative)[11], Laszlo Saghy[12], Ulrika Snygg-Martin (ESCMID and ISCVID representative)[13], Christoph Starck (EACTS representative)[14], Carlo Tascini (ESCMID representative)[15], and Neil Strathmore (APHRS representative)[16]

Table 8 Recommendations for device and lead removal

Consensus statement	Statement class	Scientific evidence coding
In patients with definite CIED infection (systemic and local), complete device removal is recommended (including abandoned leads, epicardial leads, and lead fragments)	♥	O
After diagnosis of CIED infection, the device removal procedure should be performed without unnecessary delay (ideally within 3 days)	♥	O
The recommended technique for device system removal is percutaneous, transvenous extraction technique. Epicardial leads require surgical removal	♥	O
Complete CIED removal is indicated in bacteraemia or fungaemia with *S. aureus*, CoNS, *Cutibacterium* spp., and *Candida* spp	♥	E
In bacteraemia with alpha- or beta-haemolytic *Streptococcus* spp. and *Enterococcus* spp., a complete CIED removal may be performed as first-line treatment or in case of recurrent/continued bacteraemia despite appropriate antibiotic therapy as a second step therapy	♥	E
In case of bacteraemia with non-pseudomonal/Serratia Gram-negative bacteria or *Pneumococcus* spp., CIED removal should be performed in the case of recurrent/continued bacteraemia despite appropriate antibiotic therapy when there is no other identifiable source for recurrence or continued infection	♥	E
Complete CIED removal is recommended in patients with infective endocarditis with or without definite involvement of the CIED system	♥	E

Europace 2020

If CIED infection what are the recommendations?



Blomström-Lundqvist. EP Europace 2020;22:515-549

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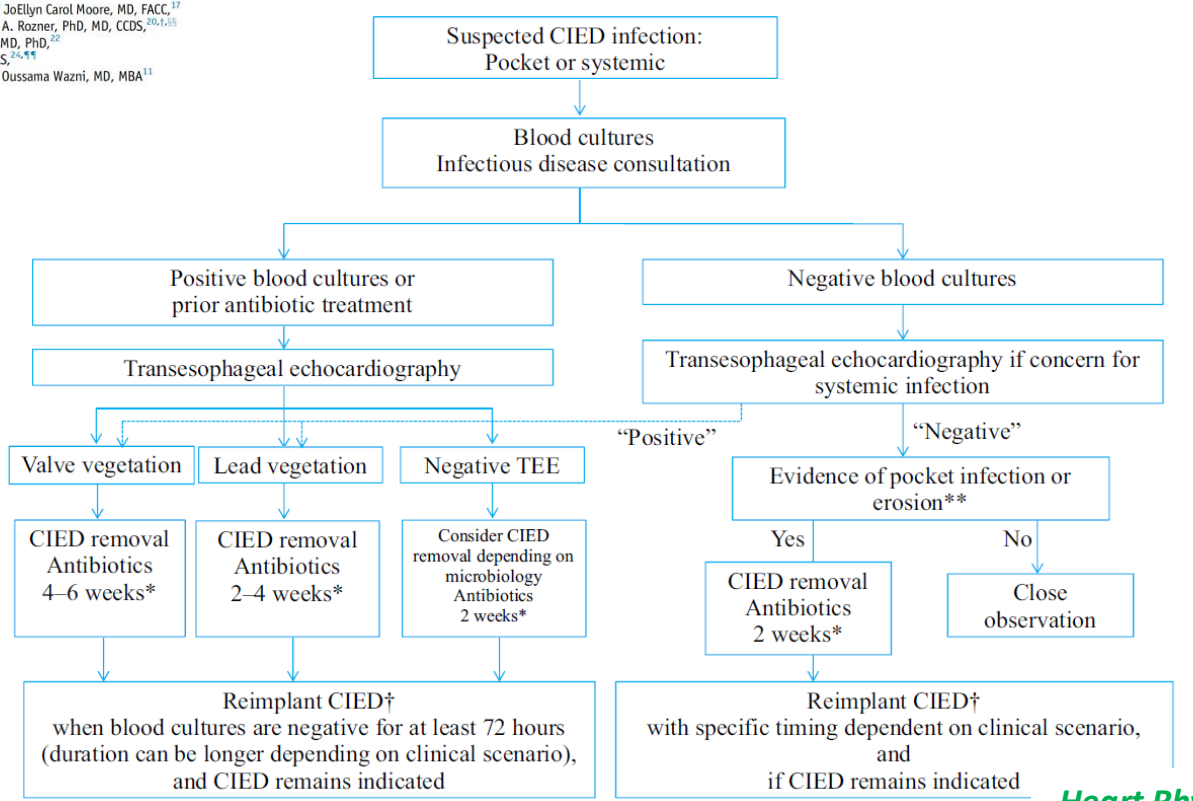
If CIED infection what are the recommendations?



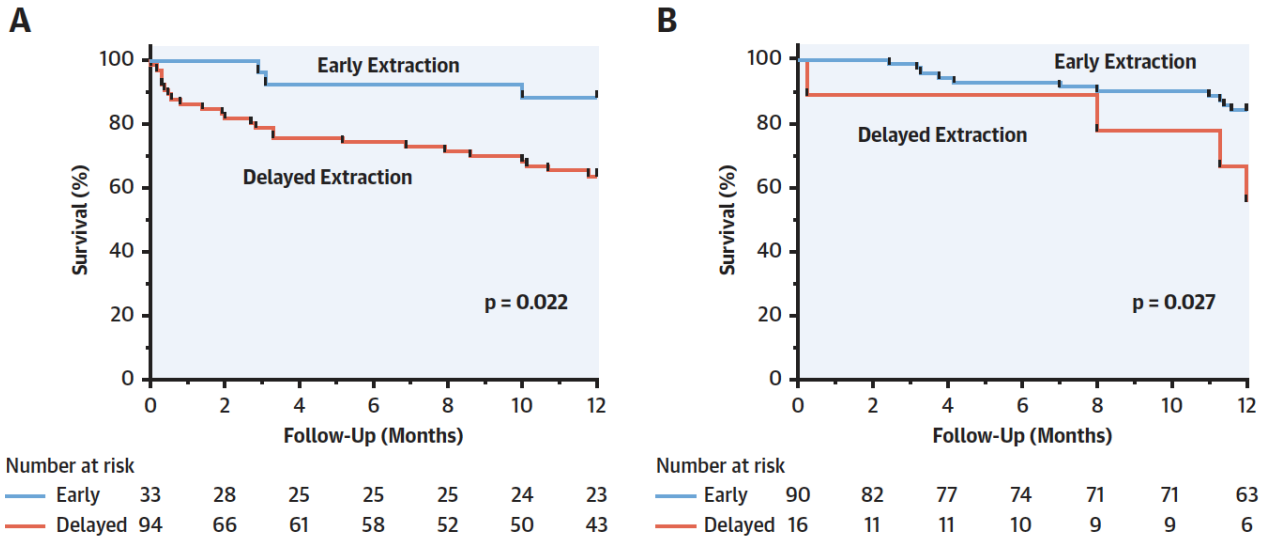
Heart Rhythm 2017;14: 503-51

Early Versus Delayed Lead Extraction in Patients With Infected Cardiovascular Implantable Electronic Devices

Andrew Y. Lin, MD,[a] Tatiana Saul, MD,[a] Omar M. Aldaas, MD,[a] Florentino Lupercio, MD,[a] Gordon Ho, MD,[a] Travis Pollema, DO,[b] Victor Pretorius, MBChB,[b] Ulrika Birgersdotter-Green, MD[a]

Kaplan-Maier 1 year survival of pts undergoing early vs delayed CIED extraction

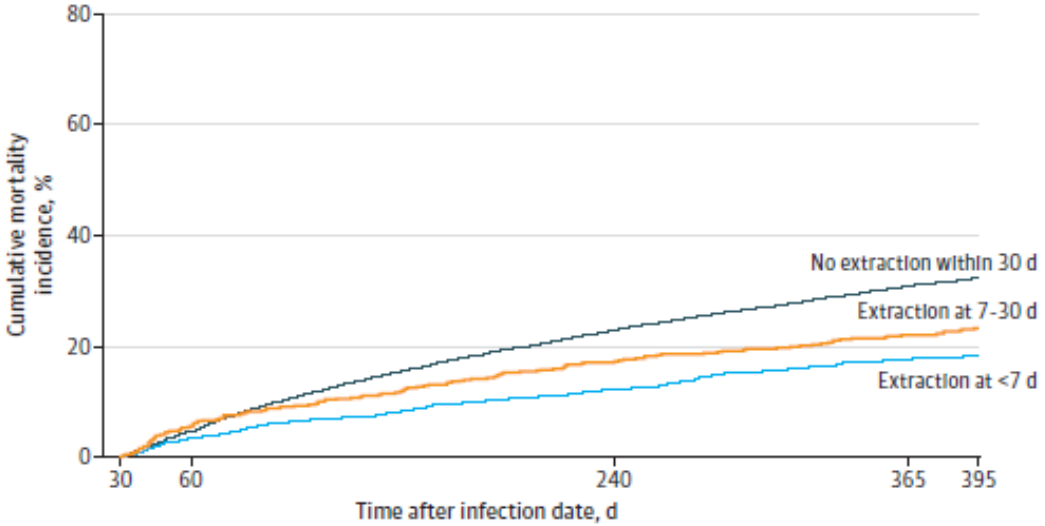
< or > 7 days



Patients with **(A)** bacteremia and **(B)** isolated pocket infection. Patients with delayed cardiovascular implantable electronic device extraction have lower survival rate at 1 year.

J Am Coll Cardiol EP 2021;7:755–63

Lead extraction and mortality among patients with CIEDs infection



No. at risk					
No extraction within 30 d	8777	8307	6288	5377	5199
Extraction at <7 d	1475	1415	1199	1056	1036
Extraction at 7-30 d	580	542	445	388	373

Outcomes are restricted to patients with at least 30 days of follow-up after cardiac implantable electronic device infection.

Pokorney. JAMA Cardiol 2023:8:1165-73

EDITORIAL COMMENT

Lead Extraction of Infected Cardiovascular Implantable Devices

The Sooner, the Better?*

Pascal Defaye, MD,[a,b] Adrien Carabelli, MD[a,b]

One should prompt cardiologists to optimize diagnosis, avoid transfer delays, and minimize waiting times before an extraction procedure.

J Am Coll Cardiol EP 2021; 7: 764-7

Low Utilization of Lead Extraction Among Patients With Infective Endocarditis and Implanted Cardiac Electronic Devices

Christopher T. Sciria, MD,[a,b] Edward V. Kogan, MD,[a] Ari G. Mandler, MD,[a] Ilhwan Yeo, MD, PhD,[a] Matthew S. Simon, MD,[c] Luke K. Kim, MD,[a] James E. Ip, MD,[a] Christopher F. Liu, MD,[a] Steven M. Markowitz, MD,[a] Bruce B. Lerman, MD,[a] George Thomas, MD,[a] Jim W. Cheung, MD[a]

Low utilization of TLE in CIEDS infections

- Low utilization of TLE in these patients
  - Between 2016 to 2019 :11.5%
    - Increase 7.6% in 2016 to 14.9% in 2016
- Reduction in mortality with TLE OR: 0.47 ; 95% CI: 0.37-0.6

FIGURE 2 Outcomes With CIEDs and Infective Endocarditis

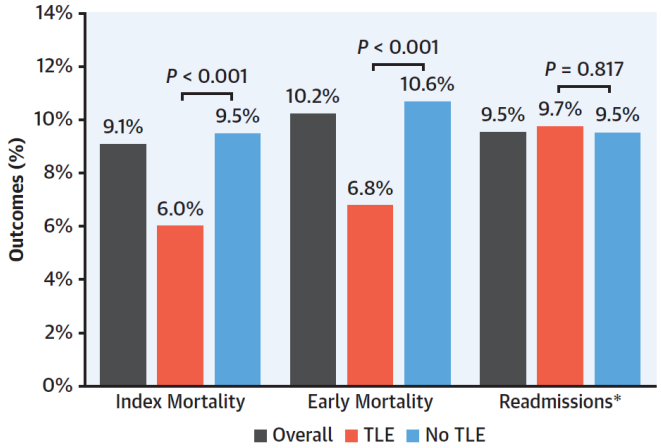
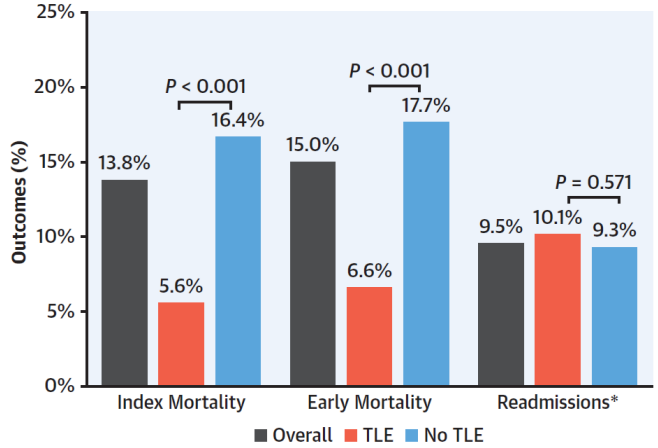


FIGURE 3 Outcomes With CIEDs and *S. aureus* Endocarditis



J Am Coll Cardiol 2023; 81: 1714-25

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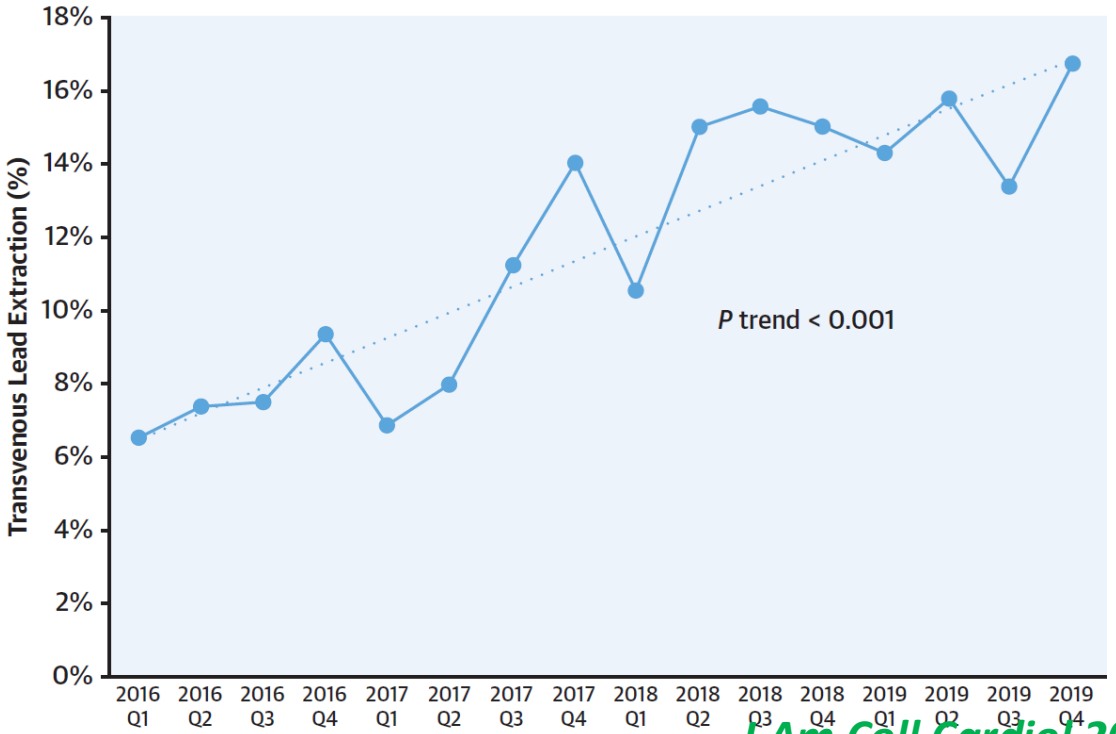
Low utilization of TLE in CIEDS infections

FIGURE 1 National Trends in TLE and Removal



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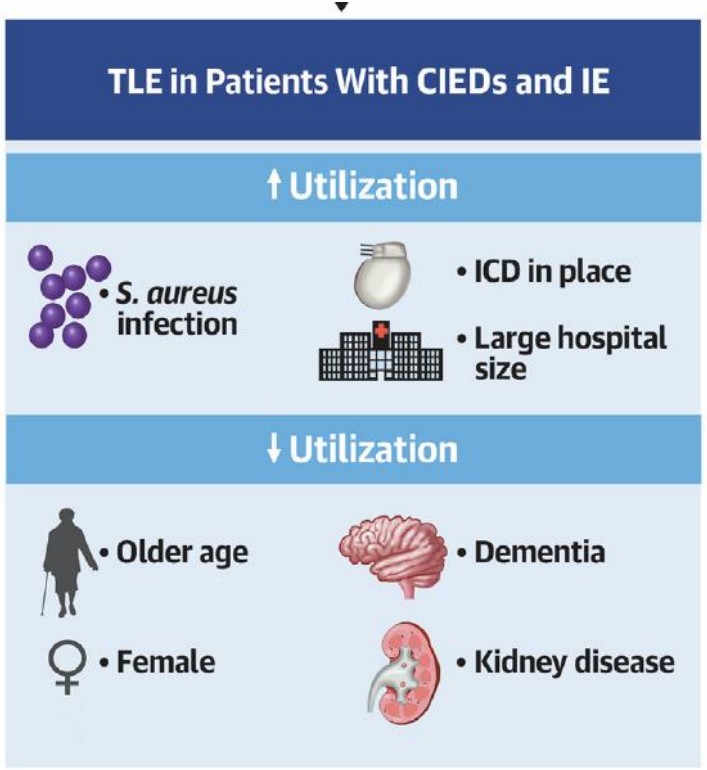
Factors of underutilization of TLE in CIEDs infections



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When to refer to lead extraction : chronic pain

IIa	C-EO	**Device and/or lead removal can be useful for patients with severe chronic pain at the device or lead insertion site or believed to be secondary to the device, which causes significant patient discomfort, is not manageable by medical or surgical techniques, and for which there is no acceptable alternative.**

Chronic pain at the device site or lead insertion site is an infrequent indication for lead extraction.[187,188] The scope of this problem has not been well defined and is likely multifactorial, ranging from indolent infection to musculoskeletal conditions.[117,189–193] An individualized treatment plan is clearly necessary, but removal of the device and lead extraction are reasonable for patients with severe chronic pain in which alternative management strategies are not available or have failed.

Very rare indication , unusual

Heart Rhythm, December 2017

When to refer to lead extraction : thrombosis/vascular access

2017 HRS expert consensus statement on cardiovascular implantable electronic device lead management and extraction

Fred M. Kusumoto, MD, FHRS, FACC (Chair),[1] Mark H. Schoenfeld, MD, FHRS, FACC, FAHA, CCDS (Vice-Chair),[2] Bruce L. Wilkoff, MD, FHRS, CCDS (Vice-Chair),[3] Charles I. Berul, MD, FHRS,[4,*] Ulrika M. Birgersdotter-Green, MD, FHRS,[5] Roger Carrillo, MD, MBA, FHRS,[6] Yong-Mei Cha, MD,[7] Jude Clancy, MD,[7] Jean-Claude Deharo, MD, FESC,[8] Kenneth A. Ellenbogen, MD, FHRS,[9] Derek Exner, MD, MPH, FHRS,[10] Ayman A. Hussein, MD, FACC,[11] Charles Kennergren, MD, PhD, FETCS, FHRS,[12,†] Andrew Krahn, MD, FRCPC, FHRS,[13] Richard Lee, MD, MBA,[14,‡] Charles J. Love, MD, CCDS, FHRS, FACC, FAHA,[15,¶] Ruth A. Madden, MPH, RN,[11] Hector Alfredo Mazzetti, MD,[16,#] JoEllyn Carol Moore, MD, FACC,[17] Jeffrey Parsonnet, MD,[18,**] Kristen K. Patton, MD,[19,11] Marc A. Rozner, PhD, MD, CCDS,[20,†,‡‡] Kimberly A. Selzman, MD, MPH, FHRS, FACC,[21] Morio Shoda, MD, PhD,[22] Komandoor Srivathsan, MD,[23] Neil F. Strathmore, MBBS, FHRS,[24,¶¶] Charles D. Swerdlow, MD, FHRS,[25] Christine Tompkins, MD,[26] Oussama Wazni, MD, MBA[11]

Heart Rhythm, December 2017

I	C-EO	**Lead removal is recommended for patients with clinically significant thromboembolic events attributable to thrombus on a lead or a lead fragment that cannot be treated by other means.**

Clinically significant thromboembolic events related to transvenous leads occur infrequently, but have been reported and are of particular concern in patients with intracardiac shunts.[194–196]

I	C-EO	**Lead removal is recommended for patients with SVC stenosis or occlusion that prevents implantation of a necessary lead.**

Lead-induced venous thrombosis can occur early or late after implantation of a transvenous pacemaker.[197] Thrombosis can cause an occlusion of the SVC, making placement of additional transvenous leads difficult. Under these circumstances, removal of an existing lead is recommended to gain access and allow for placement of the necessary lead.

I	C-EO	**Lead removal is recommended for patients with planned stent deployment in a vein already containing a transvenous lead, to avoid entrapment of the lead.**

Percutaneous stent implantation has now become first-line treatment for pacemaker-induced SVC syndrome.[197,198] Existing leads should be removed prior to stent placement, thus preventing entrapment of these leads behind the stent.

I	C-EO	**Lead removal as part of a comprehensive plan for maintaining patency is recommended for patients with SVC stenosis or occlusion with limiting symptoms.**

Although lead-related venous thrombosis occurs relatively commonly, the incidence of pacemaker-induced SVC syndrome has been reported to be less than 0.1%.[197,198] However, patients who do become symptomatic might have debilitating symptoms requiring treatment. Lead removal and subsequent stent placement have emerged as the most effective treatment and should be part of the overall treatment strategy.

IIa	C-LD	**Lead removal can be useful for patients with ipsilateral venous occlusion preventing access to the venous circulation for required placement of an additional lead.**	[199,200]

In the context of a device upgrade or requirement of an additional lead, venous access can become an issue due to venous occlusion of the desired venous access point. Management options include contralateral lead implantation with tunneling across the chest, extraction of a redundant lead, or subclavian venoplasty. An individualized approach should be taken based on operator and center expertise. Use of extraction as a first-line approach to device upgrades for patients with venous occlusion is well described and can be a useful strategy in experienced centers.[199,200]

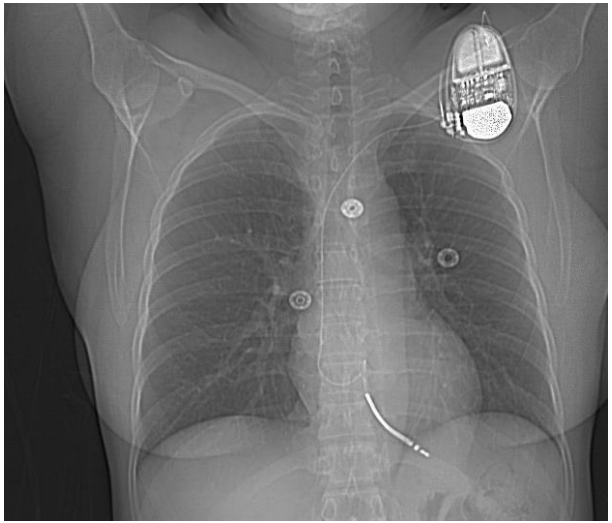
Pacemaker/ICD associated Superior Vena Cava Syndrome

- ***Not so rare***
- **Mrs G… Isabelle, born in 1969**
  - **Erythema of the face**
  - **Progressive swelling of the face and arms**
  - **Edema of the face, neck, both arms,**
  - **Distented jugular veins**
  - **Dizziness with position change**
  - **Impossibility to practice sport : running**
  - **VVI ICD 20 years before for ARVD?? (no MRI)**

    VT during tennis game

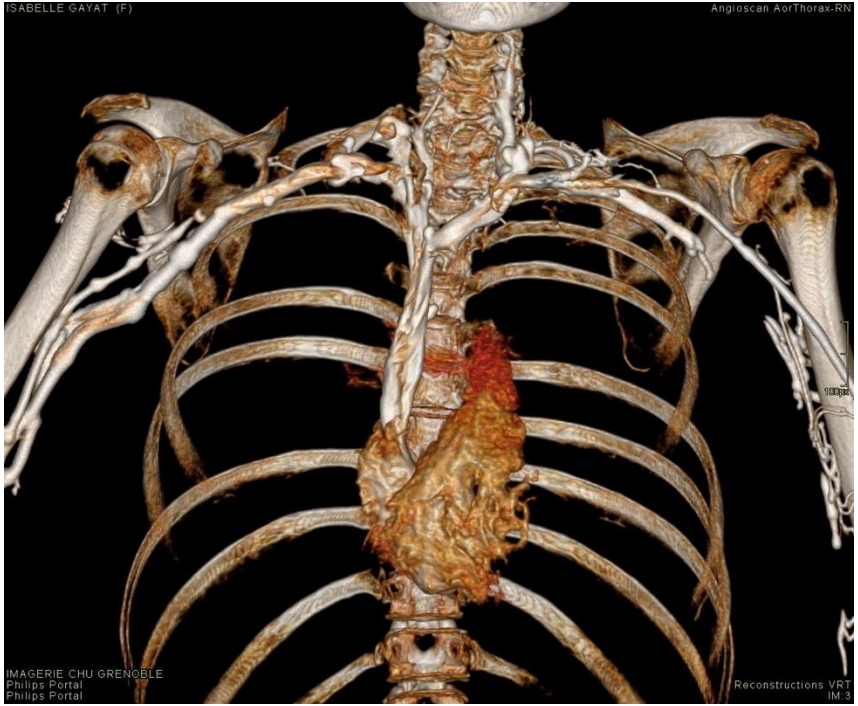
Retrospectively : benign infundibular VT…

Pacemaker/ICD associated Superior Vena Cava Syndrome



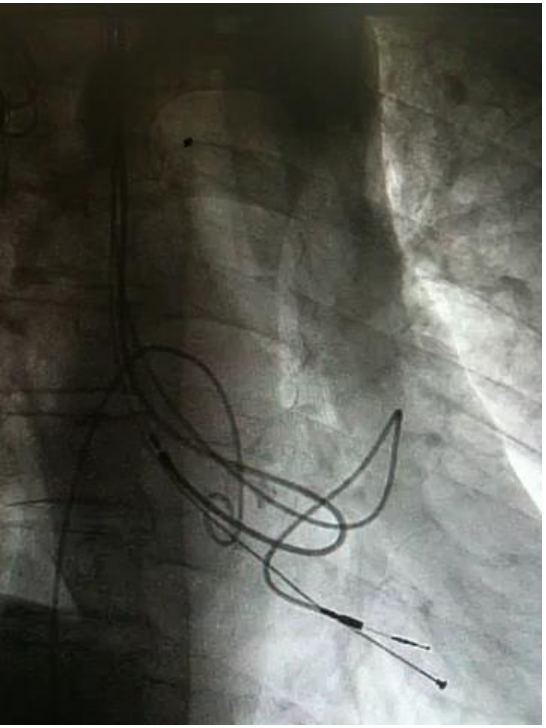
Mrs G Isabelle,

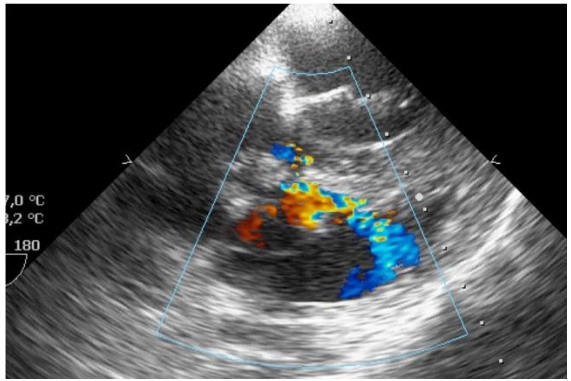
- ICD lead implanted in 2007
- CT venography : occlusion of the upper SVC
- Lead extraction Laser 16 F January 2017

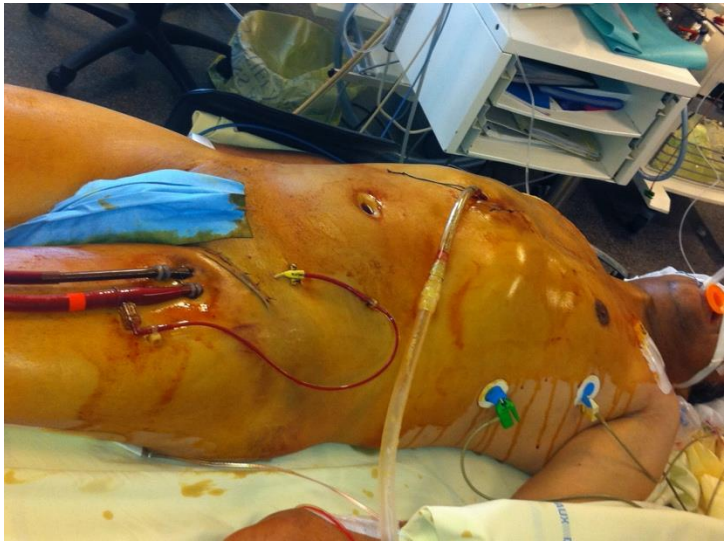


CT venography / 4 years later
Her symptoms have totally resolved

Mr S Guy, severe tricuspid stenosis with right HF due to redondant leads implanated 20 y before





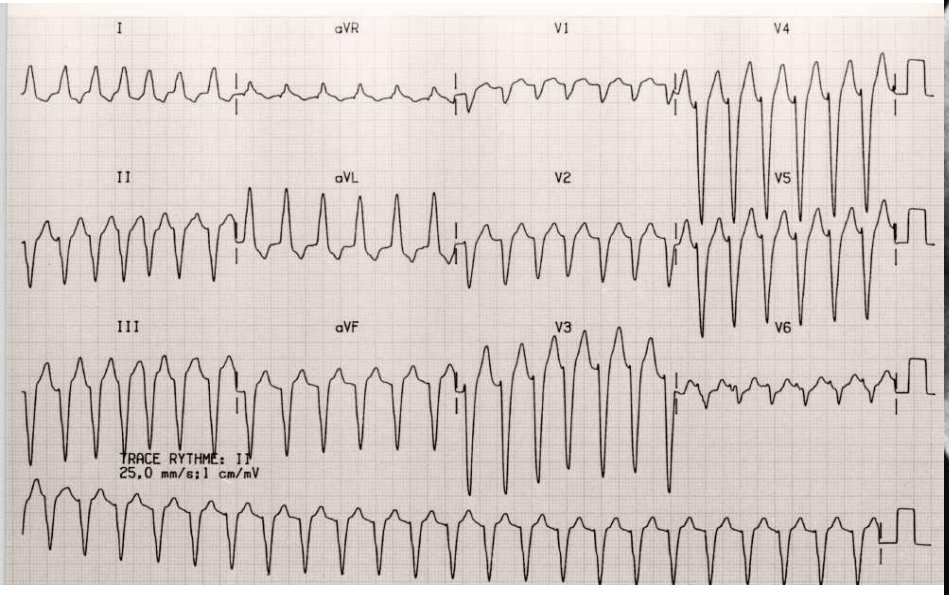


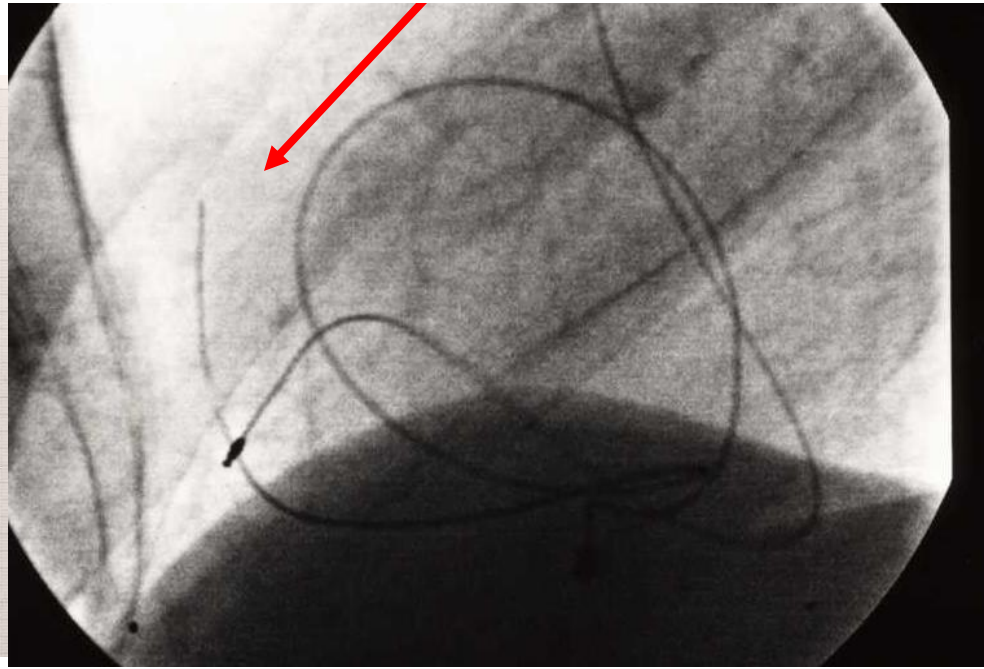
Extraction under ECMO

Alive 14 years after without symptoms, not reimplanted
Tricuspid valve replacement 2024

I	C-EO	**Lead removal is recommended for patients with life-threatening arrhythmias secondary to retained leads.**

There are reports in the literature of refractory ventricular arrhythmias that occurred after an RV lead placement that resolved with extraction.[201]





Very rare indication

Heart Rhythm, December 2017

2017 HRS expert consensus statement on cardiovascular implantable electronic device lead management and extraction

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When to refer to lead extraction : non functional leads

IIa

IIa	C-LD	**Lead removal can be useful for patients if a CIED implantation would require more than four leads on one side or more than five leads through the SVC.**	110,193, 200

Analysis of extraction registries has reported higher complication rates with extraction when there are large numbers of leads that need to be removed.[200] Studies have reported increased shoulder pain and other complications in patients with higher numbers of leads from the same shoulder.[110,193]

Heart Rhythm, December 2017

Lead Abandonment or Lead Extraction?

Weighing the Risks*

Anne M. Gillis, MD

JACC EP 2017; 10-1

FRAGILE: FRench Attitude reGistry in case of ICD LEad replacement

Christine Alonso [1]*, Christelle Marquie[2], Pascal Defaye[3], Nicolas Clementy[4], Pierre Mondoly[5], Nicolas Sadoul[6], Serge Boveda[7], Françoise Hidden-Lucet[8], Antoine Dompnier[9], Antoine Da Costa[10], Eloi Marijon[11], Christophe Leclercq[12], Guillaume Caudron[13], Olivier Piot[14], and Jean-Claude DEHARO[15]; On behalf of "groupe Rythmologie—Stimulation cardiaque de la société française de cardiologie"

- Prospective registry,
- 552 pts/ 32 centers : idem % extracted and abandoned leads.
- Decision to extract or abandon lead mainly influenced by operator experience in LE, patient's age, comorbidities, and lead dwelling time.

- **No significant difference in early and 2 years outcomes.**

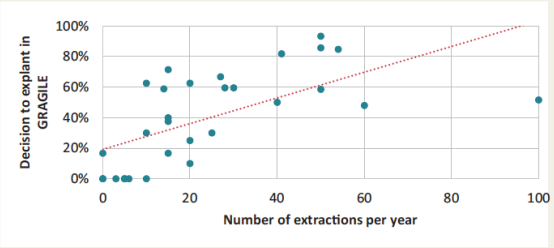


Figure 2 Correlation between the annual number of extractions in a centre and its percentage of extraction in the FRAGILE registry ($Rho_{Spearman}$ = 0.725, P<0.001). FRAGILE, FRench Attitude reGistry

Table 3 Early complications

	Abandonment	Extraction
Total	19	20
Death	0	1
Tamponade	1	0
Venous injury	0	3
Transfusion	0	3
Other (with no need for reintervention)[a]	18	17

[a]Pocket haematoma, lead dislodgment (other than the explanted RV lead), fever, pneumothorax, heart failure decompensation, and pericardial effusion.

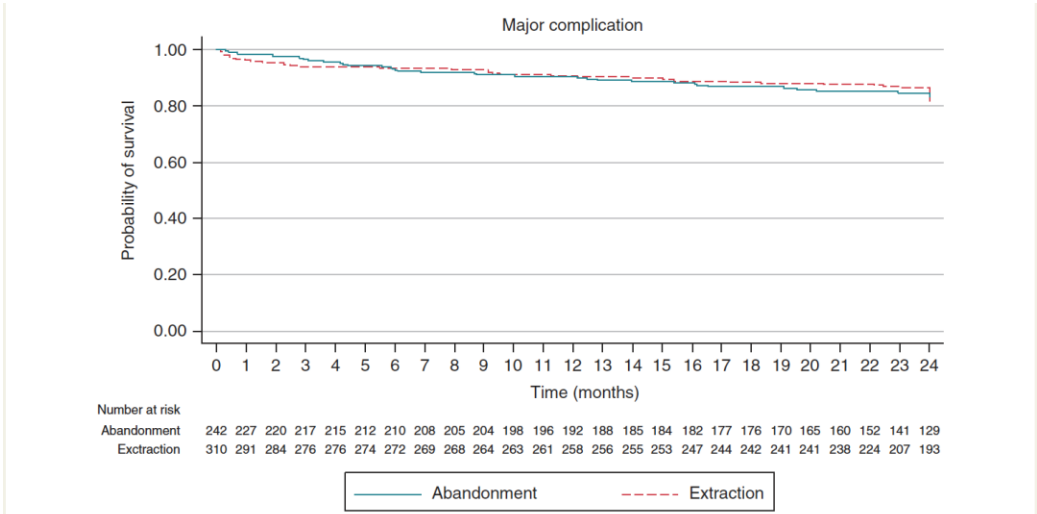
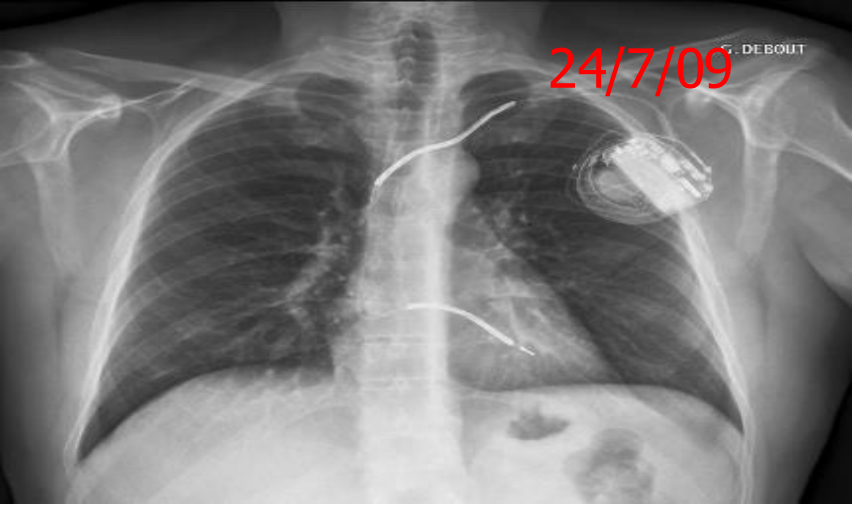
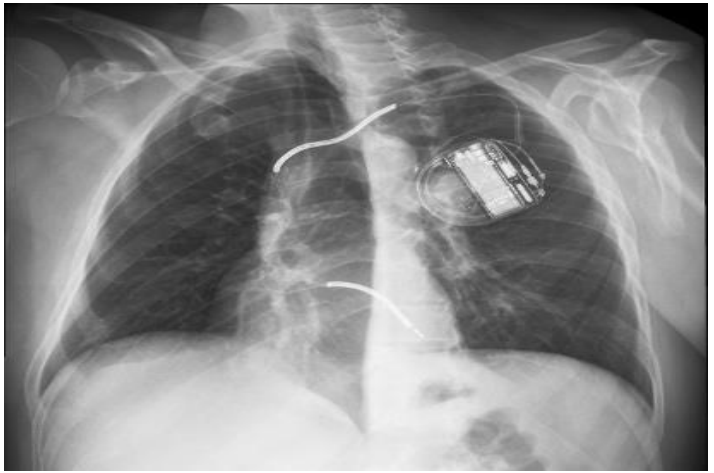
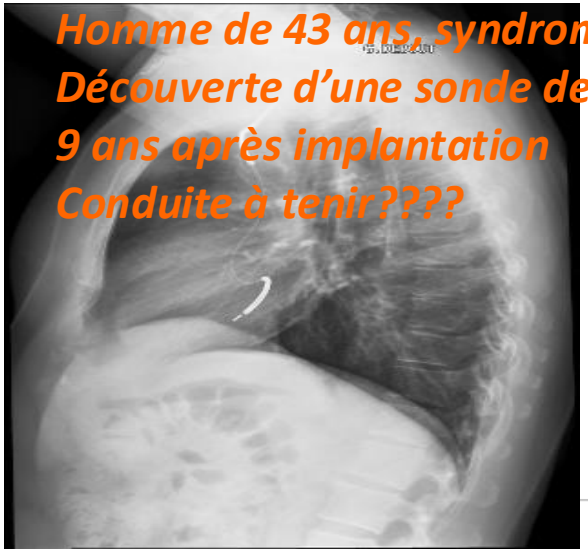


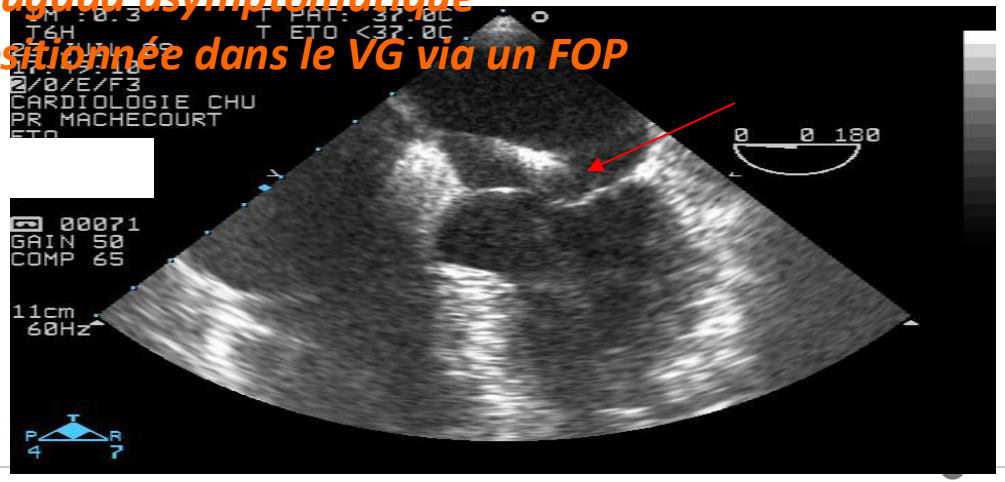
Figure 3 Kaplan-Meier freedom of major complication in patients with abandoned lead vs patients with extracted lead





Homme de 43 ans, syndrome de Brugada asymptomatique
Découverte d'une sonde de DAI positionnée dans le VG via un FOP
9 ans après implantation
Conduite à tenir????





Defaye P et al. Eur J of Cardiothor Surg 2010

Après extraction chirurgicale par vidéo - thoracoscopie

Résultat final après extraction transveineuse du coil qq sem. plus tard…

Superior approach

Indications

- Leads possibly grasped from the PM/ICD pocket
- Vascular occlusion and need for reimplantation

Advantages

- PM/ICD pocket needs to be open anyway
- Allows use of powered sheath
- High rate of success
- Quick procedure

Disadvantages

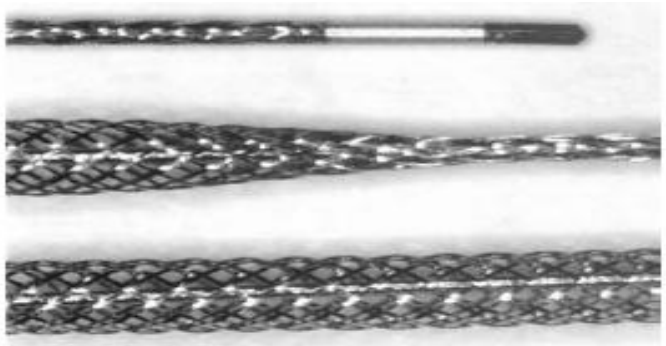
- You must pass a sheath through the SVC +++
- Powered sheath more expensive

Extraction techniques : superior approach

- Locking stylet techniques :

-locked in distal tip of the lead
-provide a stable traction platform
-Straighten the lead, allow use of external sheath

- Cook® : Liberator



- Vascomed® : VascoExtor

Spectranetics LLD® +++

Superior approach : Dilatation and countertraction sheath

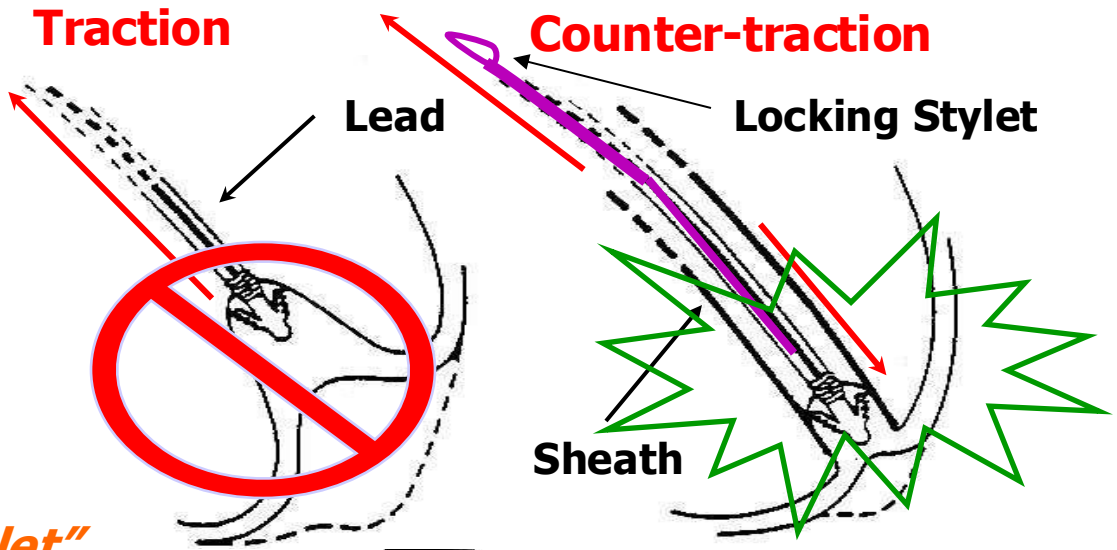
mechanical sheath : *ablates scar tissue holding the lead traction limited to a small diameter*

® Teflon sheaths

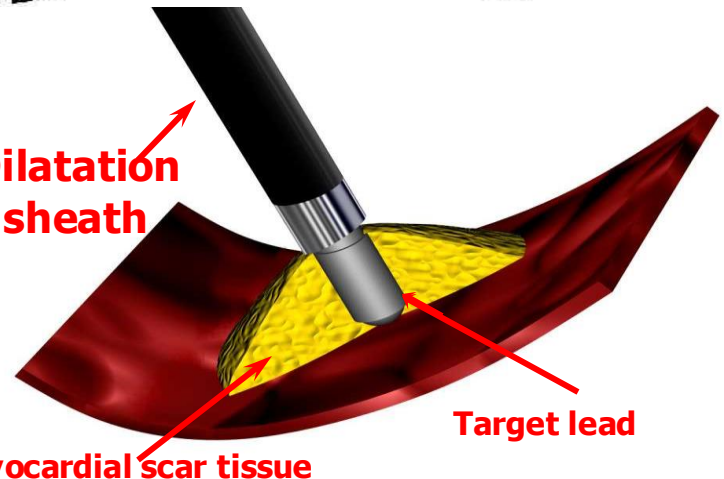
Polypropilene sheaths

Spectranetics® SightRail

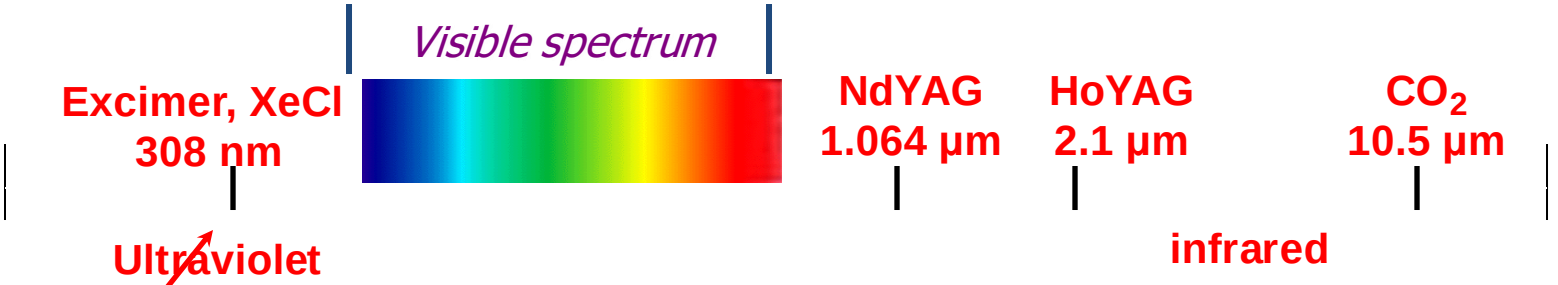
polypropilene: 8,5 to 13 F



Mandrin type "locking stylet"
Et gaine de contre-traction



Ultraviolet vs. Infrared

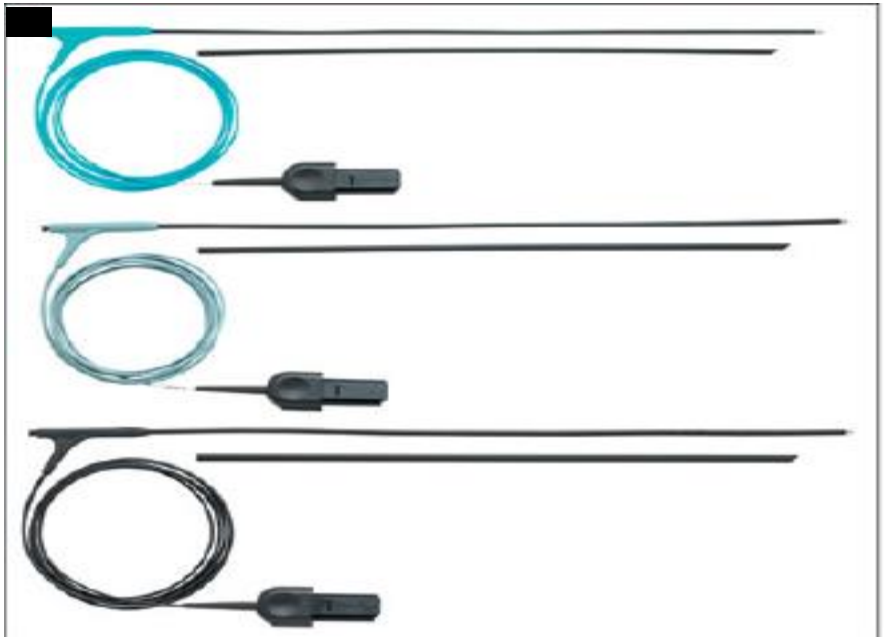


CVX 300 produces cool laser light in the invisible spectrum

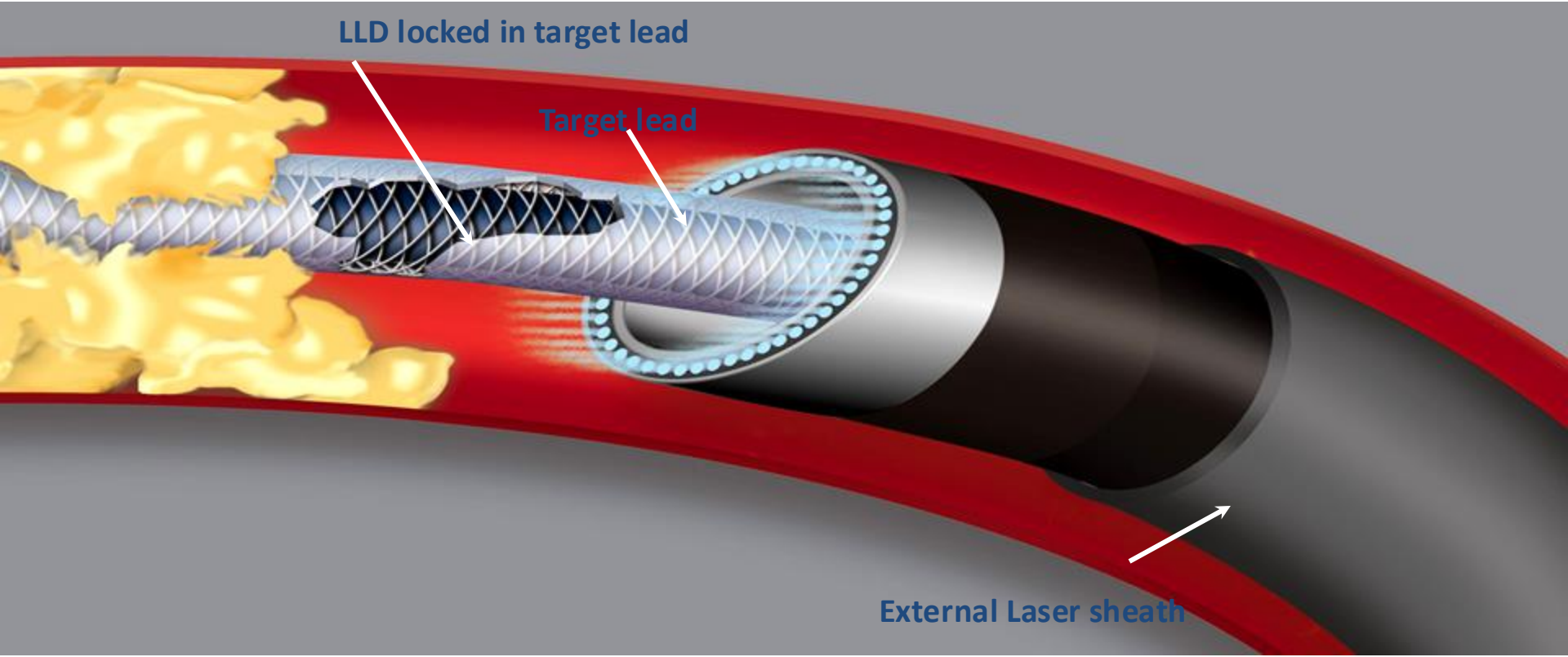
- The Excimer is a cool cutting laser (50°C) with a wavelength of 308 nm.
- The energy is emitted from the tip of a flexible sheath and is absorbed by proteins and lipids,
- 64% of the energy is absorbed at a tissue depth of 0.06 mm, 95% at 0,18 mm

Laser sheath size

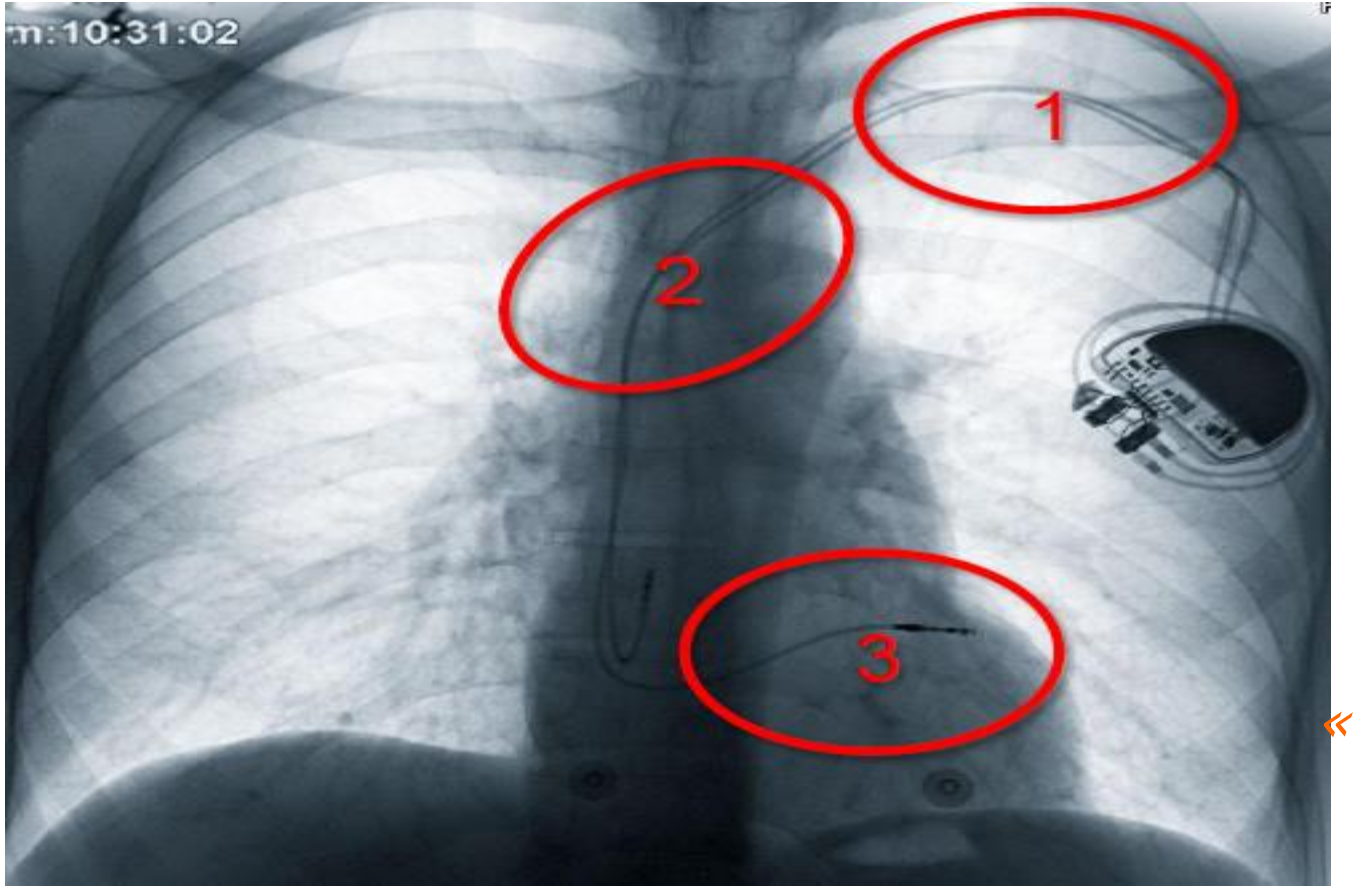
16F, 14F, 12F



Gaine Laser et Locking stylet LLD

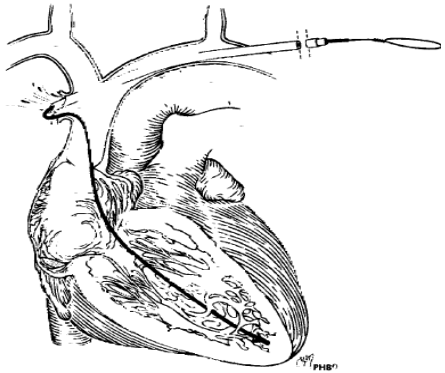


3 difficult areas for « powered sheath » : Laser



1. The entrance under the clavicula and into the subclavian

2. The brachiocephalica/ cava superior angle



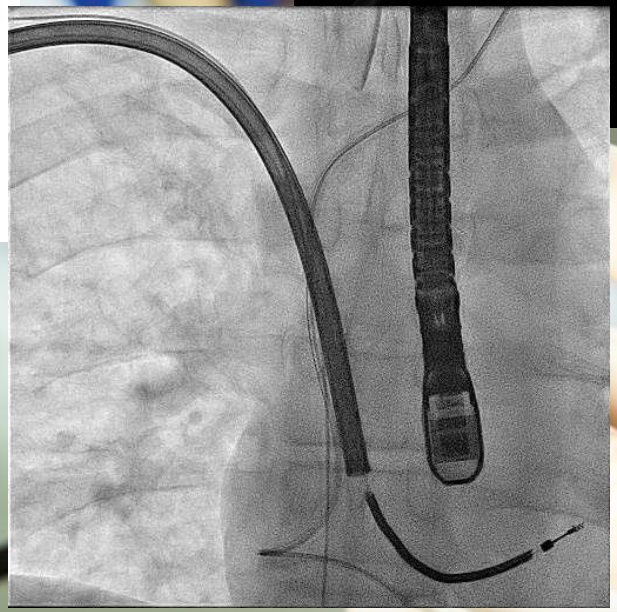
« Round the corner… »

3. Liberating the tip

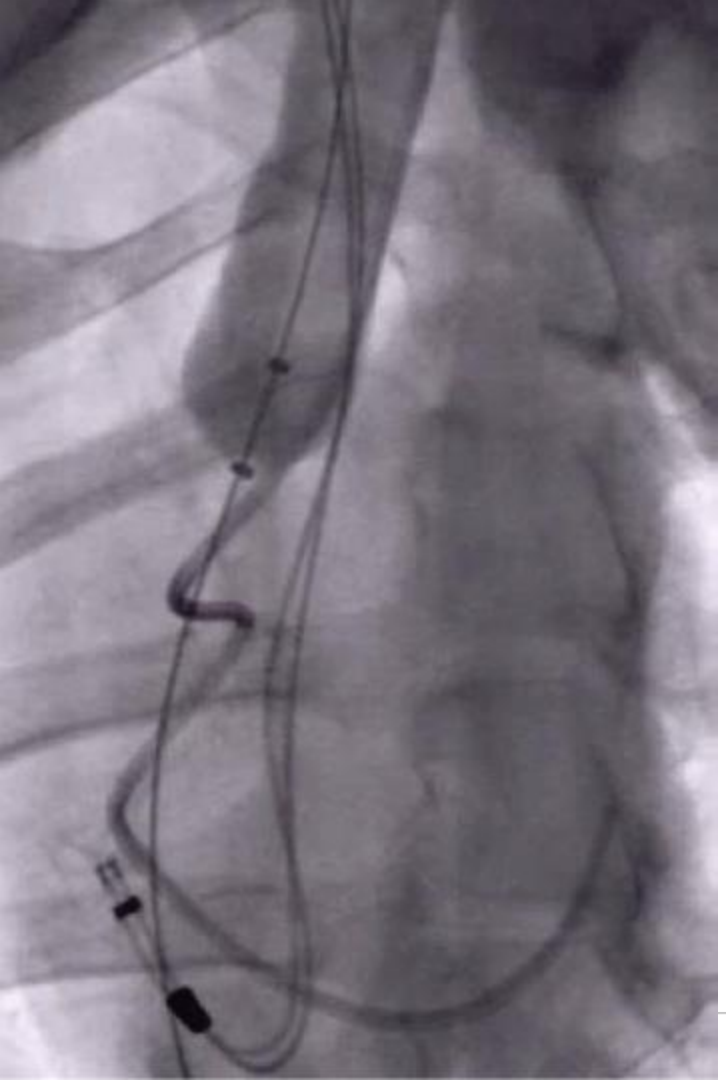
TightRail™
ROTATING MECHANICAL DILATOR SHEATH

9F, 11F, 13F internal

Bi-directionnal rotation
287° clockwise
287° counterclockwise



TightRail Mini™



Bridge Occlusion balloon

- Low pressure, compliant balloon designed to conform to the SVC

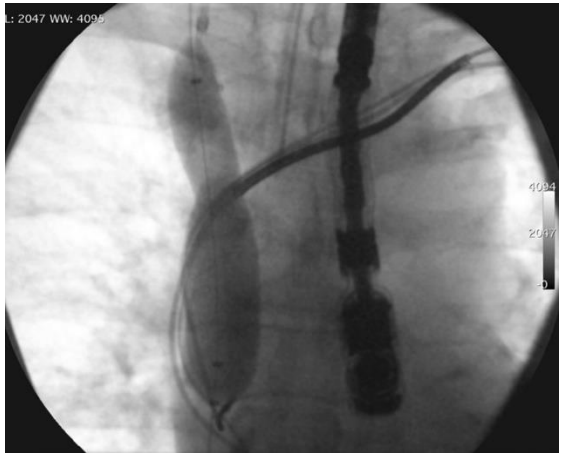
- The Balloon can be deployed in less than two minutes via a pre-placed guidewire

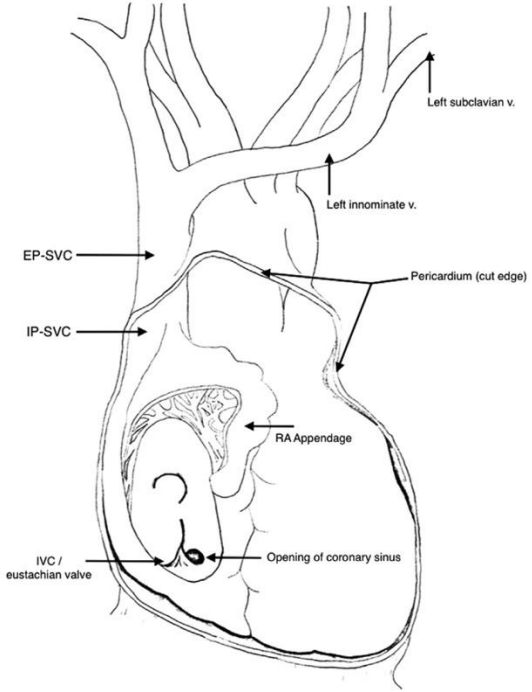
- Maintains acceptable hemostasis for at least 30 mn

Compliant endovascular balloon reduces the lethality of superior vena cava tears during transvenous lead extractions

Ryan Azarrafiy, BA,* Darren C. Tsang, BS,* Thomas A. Boyle, BS,*
Bruce L. Wilkoff, MD, FHRS,† Roger G. Carrillo, MD, MBA, FHRS*

Reports from July 1,2016, to December 31
FDA Database





Inflated bridge balloon

Repaired SVC

Heart Rhythm 2017;14:1400–1404

ORIGINAL ARTICLE

Endovascular Occlusion Balloon for Treatment of Superior Vena Cava Tears During Transvenous Lead Extraction

A Multiyear Analysis and an Update to Best Practice Protocol

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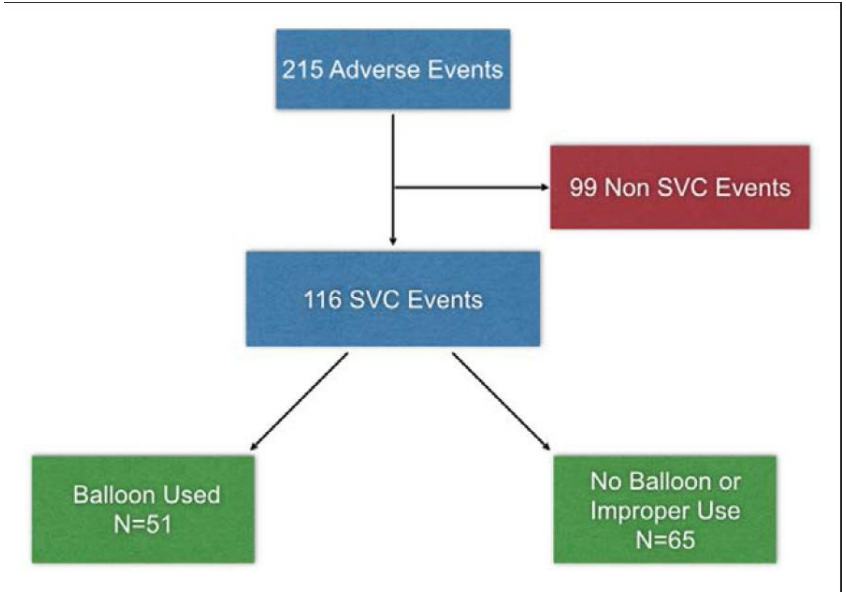
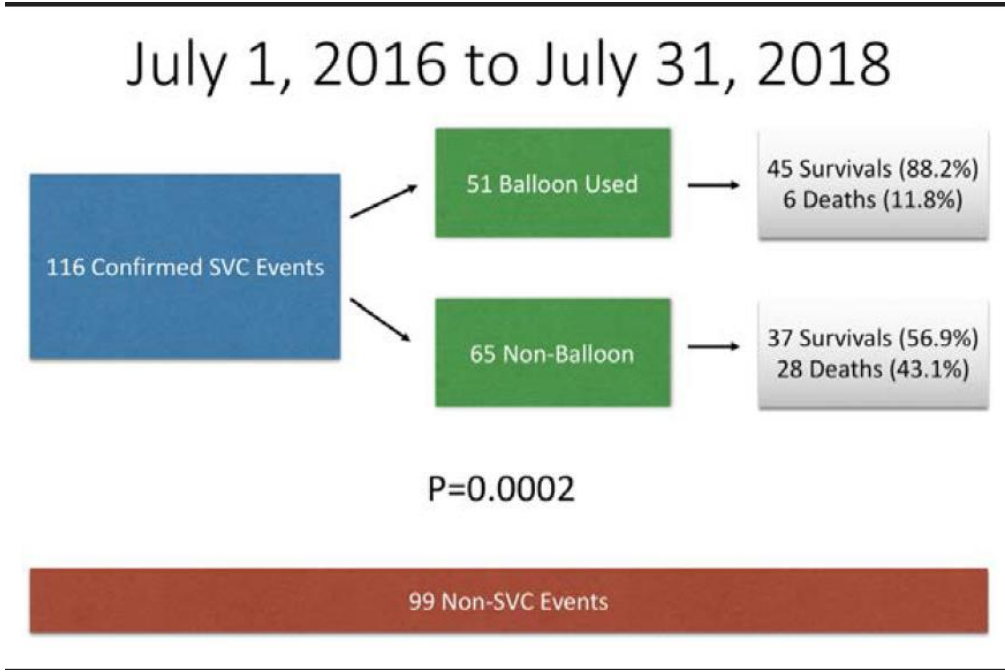
MBA





Circ Arrhythm Electrophysio 2019;12:e007266.

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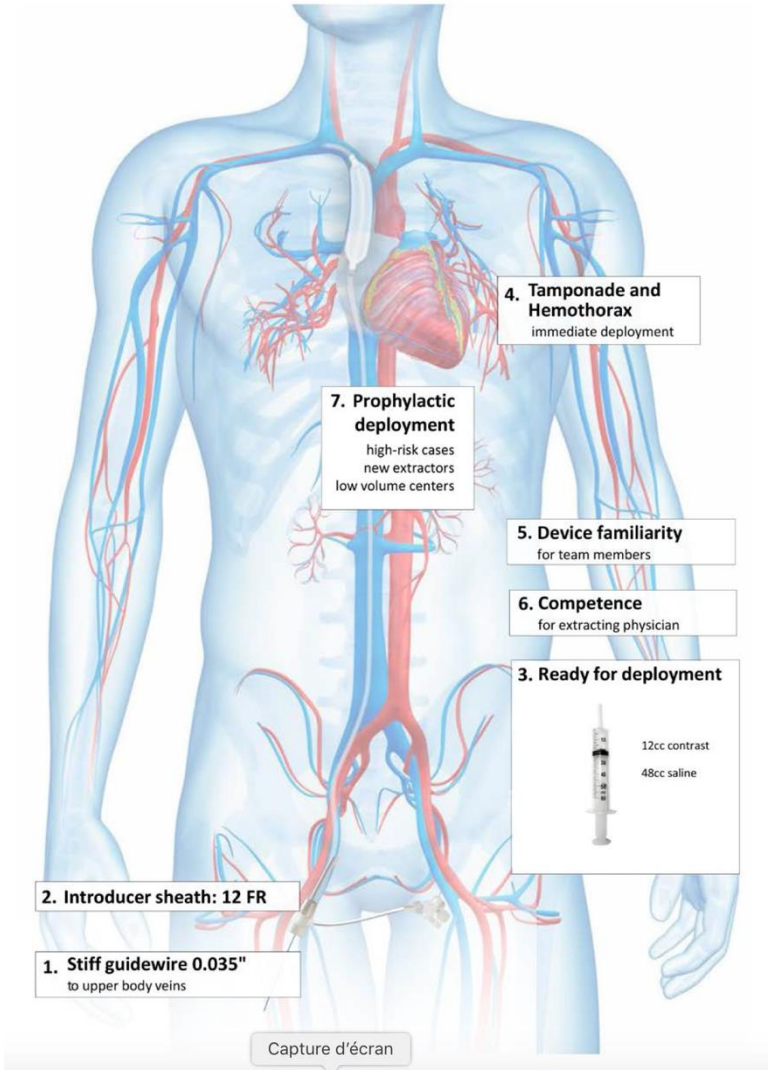
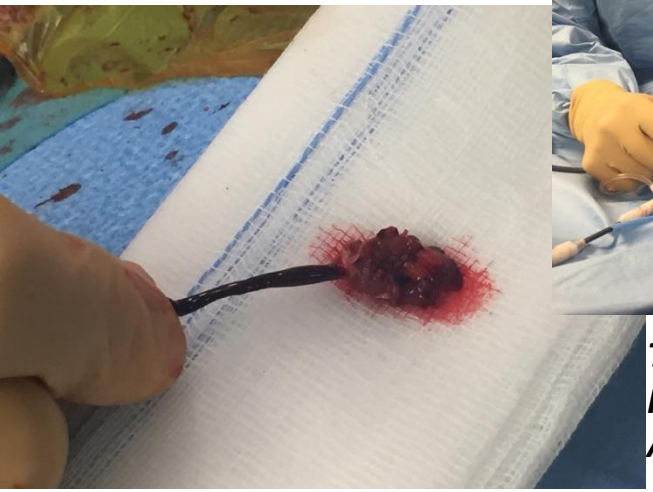
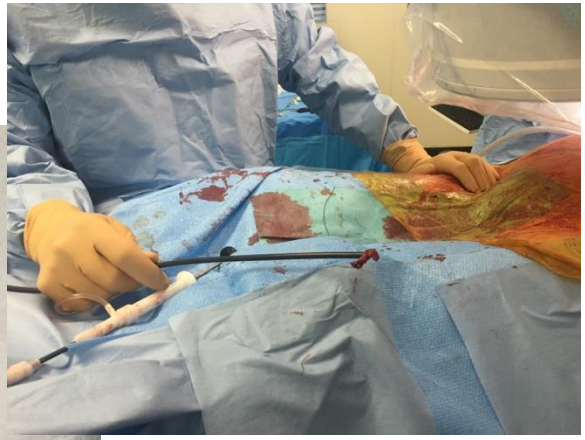
Summary of best practices for endovascular occlusion balloon use.

Circ Arrhythm Electrophysiol. 2019;12:e007266.

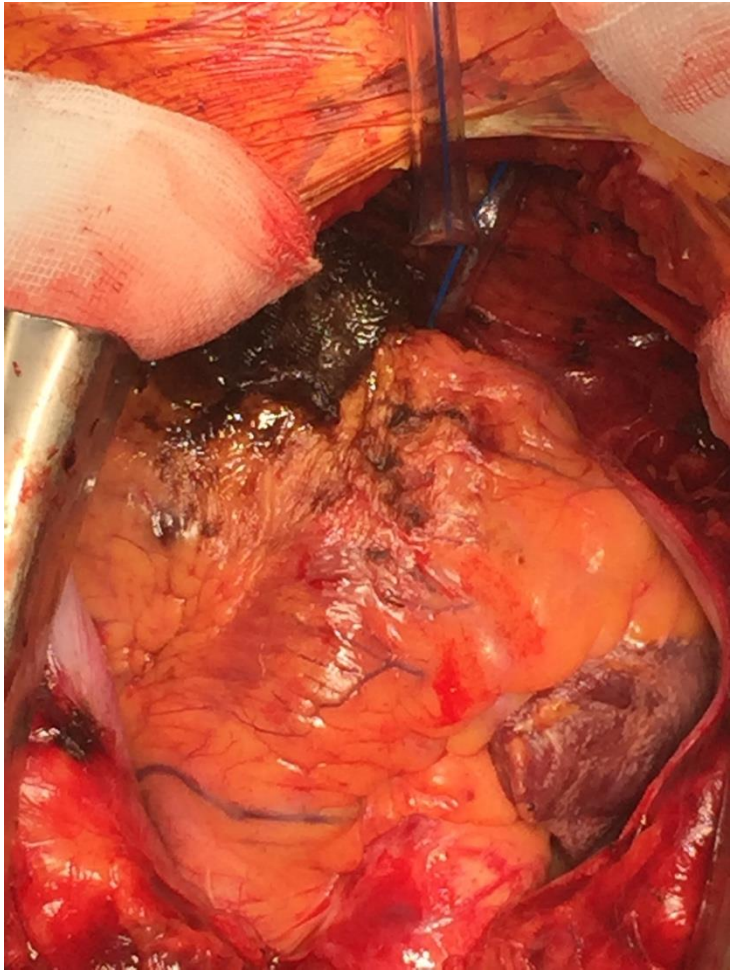


Safe removal of leads/avoid severe complications





Tamponnade
Immediate surgery
After pericardial puncture



October 2015
RV lead extraction (VDD) (1995)
Femoral approach
Needle eye's snare®

Alive
Complete extraction

Femoral approach

Indications

- Impossibility to grasp the lead from the pocket
- Lead abandonned and cut
- Doubt +++ for an intravascular course

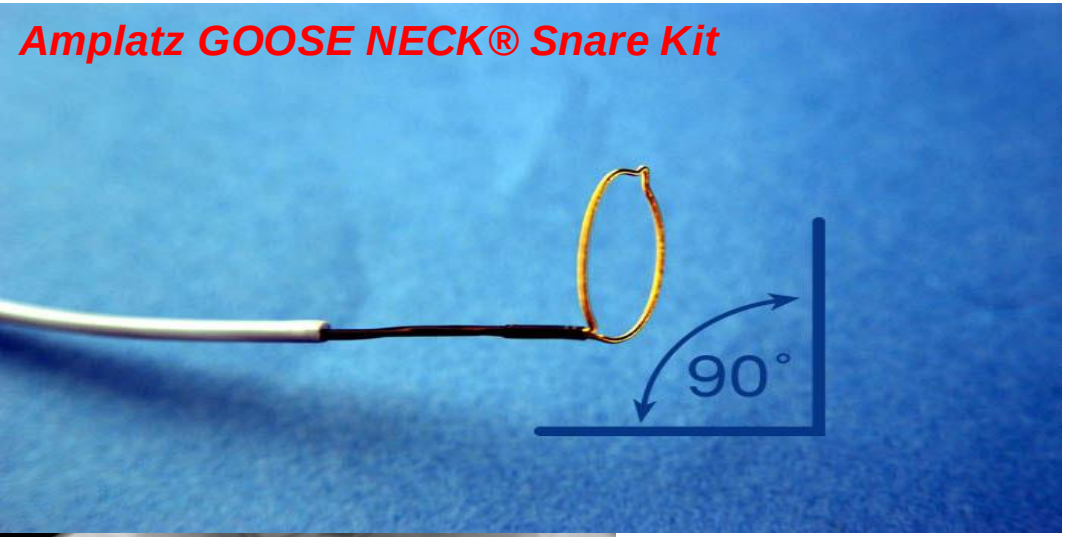
Advantages

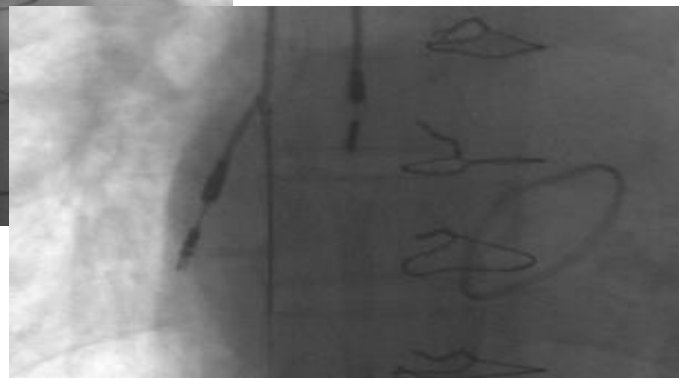
- Less risky for SVC?? Pulling force more linear with the SVC
- Useful for extraction of lead fragment

Disadvantages

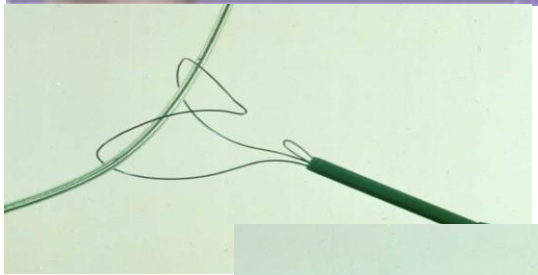
- Requires 2 sites : superior and femoral
- No powered sheath approved
- Less frequent complete extraction : Remnants of leads ++ in the RV (counter-traction more difficult)
- Long procedure (X ray consumming)

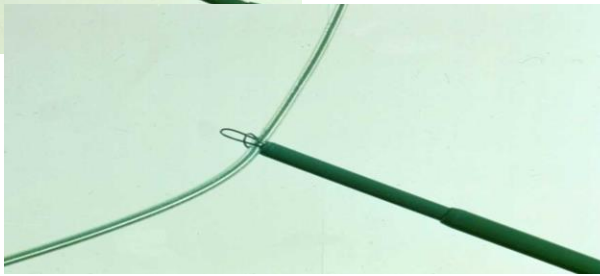
Amplatz GOOSE NECK® Snare Kit





Needle's Eye® Snare

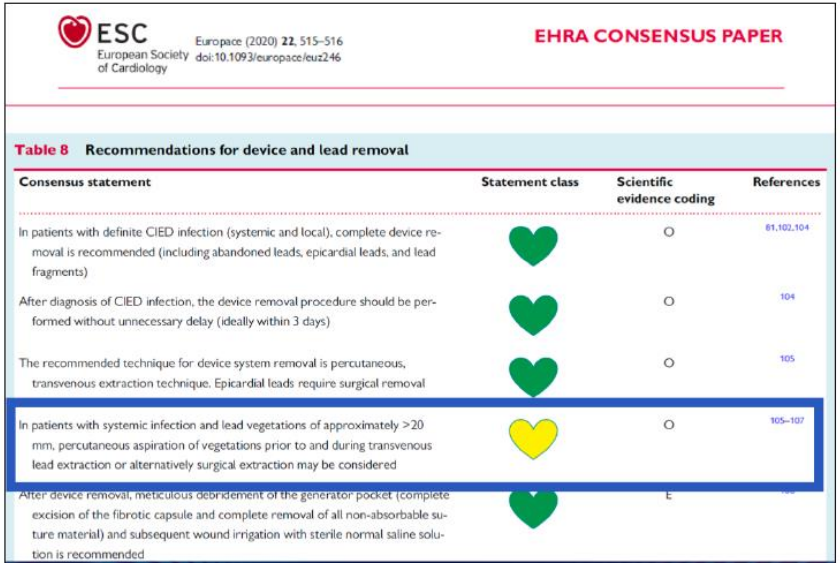




Patient de 69 ans: embolie de la partie distale de la sonde V dans l'AP droite

New techniques for large vegetations avoiding open chest surgery

- **EHRA consensus: Vegetations > 20 mm open chest surgery**
- **HRS consensus: vegetations > 25 mm open chest**

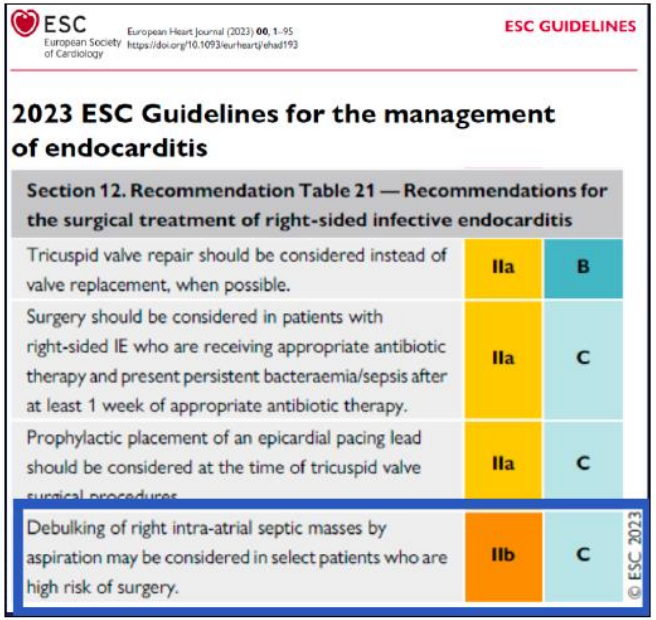


ESC European Society of Cardiology — Europace (2020) 22, 515–516 doi:10.1093/europace/euz246

EHRA CONSENSUS PAPER

Table 8 Recommendations for device and lead removal

Consensus statement	Statement class	Scientific evidence coding	References
In patients with definite CIED infection (systemic and local), complete device removal is recommended (including abandoned leads, epicardial leads, and lead fragments)		O	81,102,104
After diagnosis of CIED infection, the device removal procedure should be performed without unnecessary delay (ideally within 3 days)		O	104
The recommended technique for device system removal is percutaneous, transvenous extraction technique. Epicardial leads require surgical removal		O	105
In patients with systemic infection and lead vegetations of approximately >20 mm, percutaneous aspiration of vegetations prior to and during transvenous lead extraction or alternatively surgical extraction may be considered		O	105–107
After device removal, meticulous debridement of the generator pocket (complete excision of the fibrotic capsule and complete removal of all non-absorbable suture material) and subsequent wound irrigation with sterile normal saline solution is recommended		E	



ESC European Society of Cardiology — European Heart Journal (2023) 00, 1–95 https://doi.org/10.1093/eurheartj/ehad193

ESC GUIDELINES

2023 ESC Guidelines for the management of endocarditis

Section 12. Recommendation Table 21 — Recommendations for the surgical treatment of right-sided infective endocarditis		
Tricuspid valve repair should be considered instead of valve replacement, when possible.	IIa	B
Surgery should be considered in patients with right-sided IE who are receiving appropriate antibiotic therapy and present persistent bacteraemia/sepsis after at least 1 week of appropriate antibiotic therapy.	IIa	C
Prophylactic placement of an epicardial pacing lead should be considered at the time of tricuspid valve surgical procedures	IIa	C
Debulking of right intra-atrial septic masses by aspiration may be considered in select patients who are high risk of surgery.	IIb	C

© ESC 2023

Trans-catheter aspiration using extracorporeal circuit

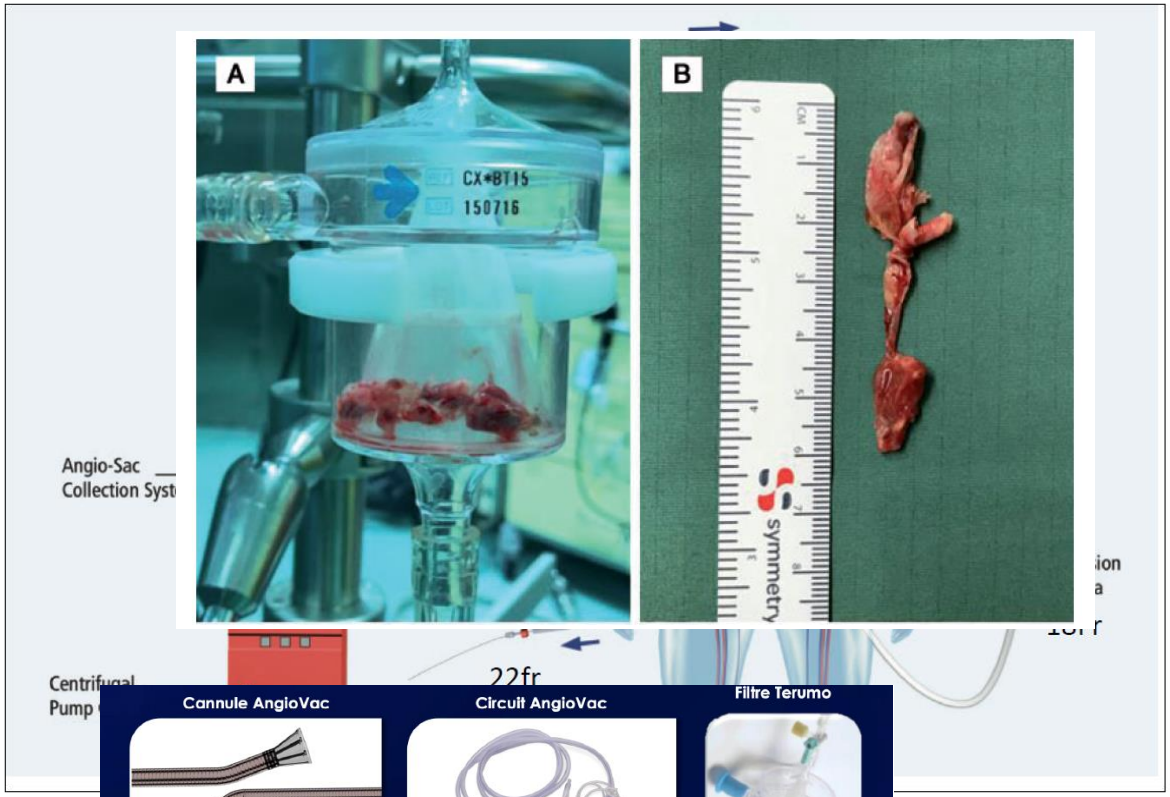
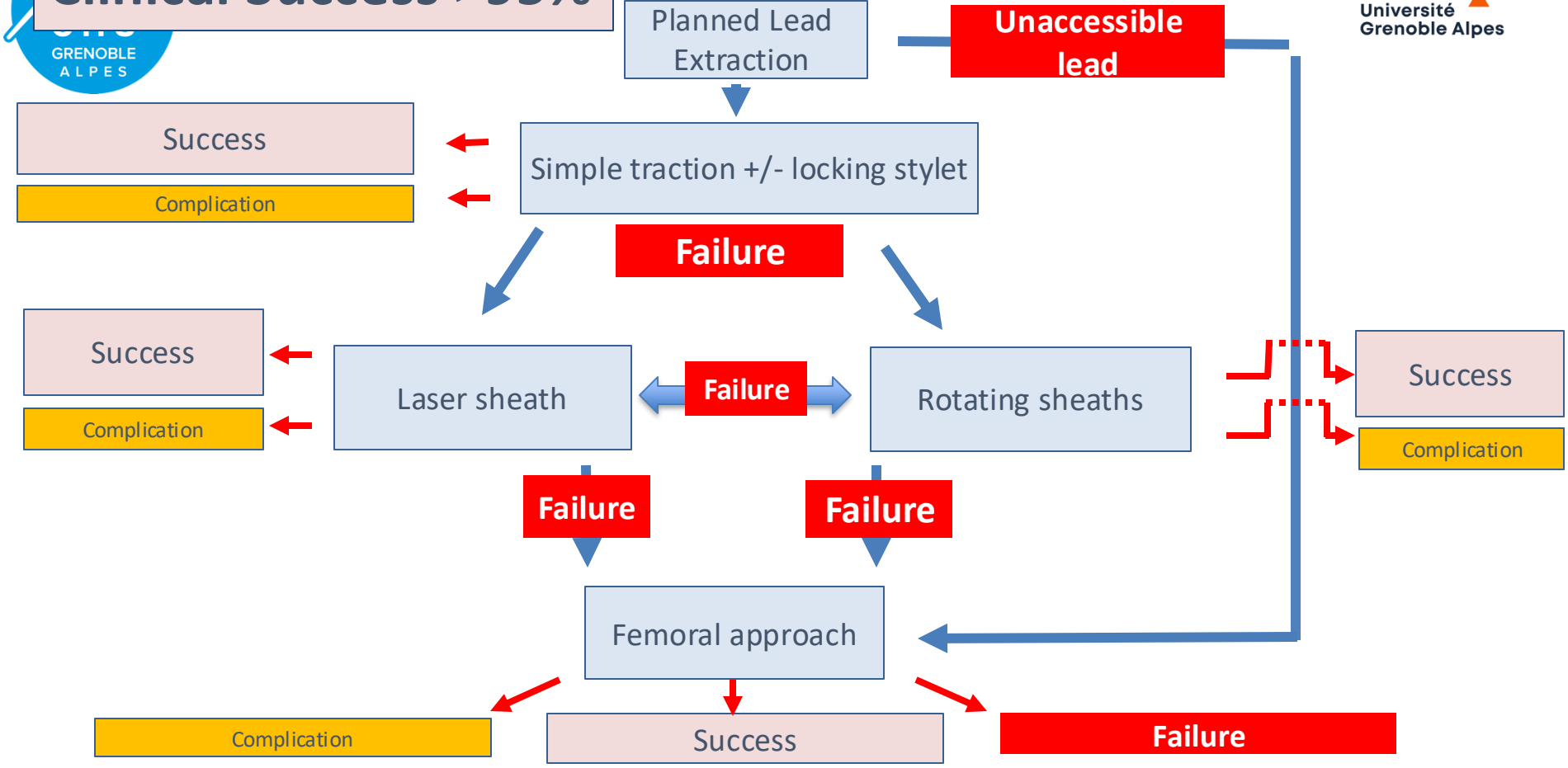


Table 2 **Procedural data and outcomes**

Configuration extracorporeal circuit	
Veno-venous	101 (100%)
Femoro-femoral	98 (97.0%)
Right internal jugular-femoral	3 (3.0%)
Mean heparin dose per patient (IU)	17 296 (3000–40 000)
Mean intraoperative ACT (s)	379.8 (172–917)
Mean extracorporeal circuit perfusion time (min)	30.2 ± 18.3
Outcome percutaneous aspiration procedure	
Complete procedural success	95 (94.0%)
Partial success	5 (5.0%)
Failure	1 (1.0%)
Major complications (device related)	3 (3.0%)
Extraction devices	
No extraction tools used	38 (15.4%)
Locking stylet	158 (64.0%)
Compression coil	149 (60.3%)
Polypropylene extraction sheath	3 (1.2%)
Powered rotational extraction sheath	140 (56.7%)
Evolution RL (Cook Medical, USA)	139 (56.3%)
Tightrail (Spectranetics, USA)	1 (0.4%)
Laser sheath (Spectranetics, USA)	14 (5.7%)
Femoral/internal jugular snare	13 (5.3%)
Outcome TLE procedure	
Complete procedural success (leads)	245 (99.2%)
Clinical success (leads)	247 (100%)
TLE related major complications (patients)	2 (2.0%) (2 TLE related high grade TR)
Mortality	
30-day mortality	3 (3.0%)

Clinical Success >95%



The European Lead Extraction ConTRolled (ELECTRa) study: a European Heart Rhythm Association (EHRA) Registry of Transvenous Lead Extraction Outcomes

Maria Grazia Bongiorni[1]*, Charles Kennergren[2], Christian Butter[3], Jean Claude Deharo[4], Andrzej Kutarski[5], Christopher A. Rinaldi[6], Simone L. Romano[1], Aldo P. Maggioni[7,8], Maryna Andarala[7], Angelo Auricchio[9], Karl-Heinz Kuck[10], and Carina Blomström-Lundqvist[11], on behalf of ELECTRa Investigators†

3555 patients

ELECTRa

European Lead Extraction ConTrolled Registry

73 centers in 19 European countries

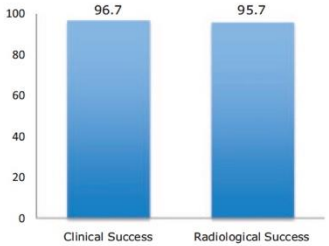
3510 patients with 6493 leads

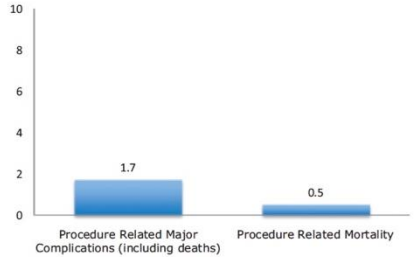
75.7% pacing leads & 24.3% ICD leads

Transvenous Lead Extractions Indications

52.8% infective & 47.3 % non-infective

OUTCOMES





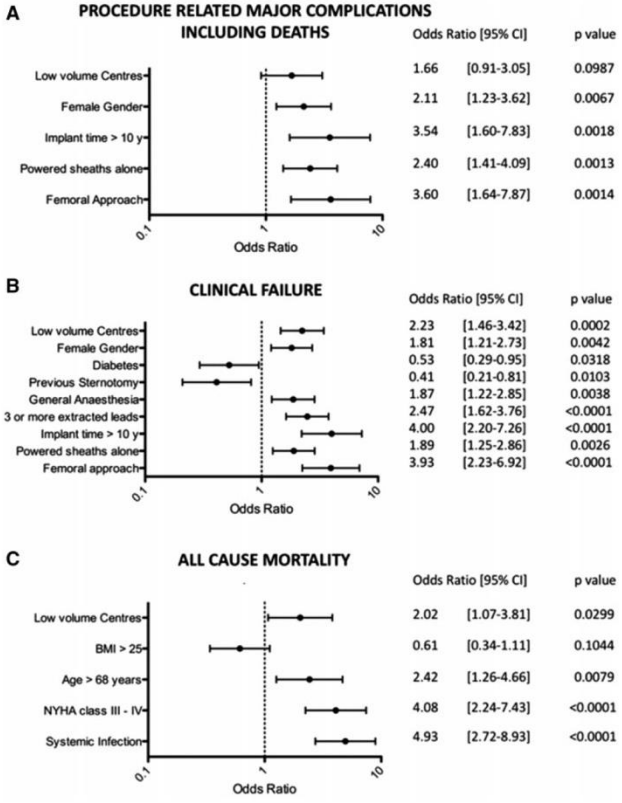


Figure 2 Predictors of procedure related major complications, clinical outcomes and overall mortality.

European Heart Journal 2017; 38, 2995–3005

The European Lead Extraction ConTRolled (ELECTRa) study: a European Heart Rhythm Association (EHRA) Registry of Transvenous Lead Extraction Outcomes

Maria Grazia Bongiorni[1]*, Charles Kennergren[2], Christian Butter[3], Jean Claude Deharo[4], Andrzej Kutarski[5], Christopher A. Rinaldi[6], Simone L. Romano[1], Aldo P. Maggioni[7,8], Maryna Andarala[7], Angelo Auricchio[9], Karl-Heinz Kuck[10], and Carina Blomström-Lundqvist[11], on behalf of ELECTRa Investigators[†]

3555 patients

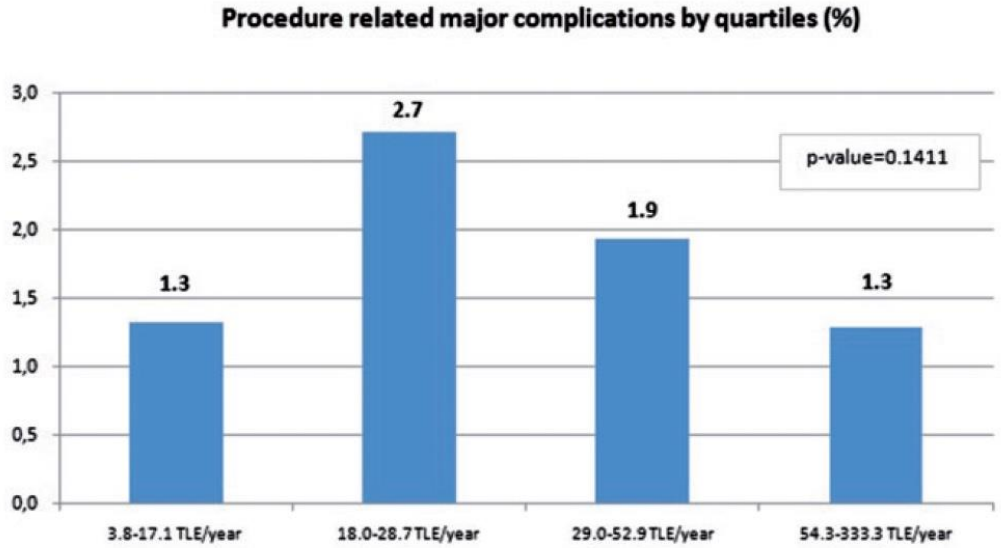


Figure 3 Histograms presentation of procedure related major complications rates stratified for procedures/year per centres in quartiles (figures given on the X axis represent median values).

European Heart Journal 2017; 38, 2995–3005

Pathways for training and accreditation for transvenous lead extraction: a European Heart Rhythm Association position paper

EHRA POSITION PAPER

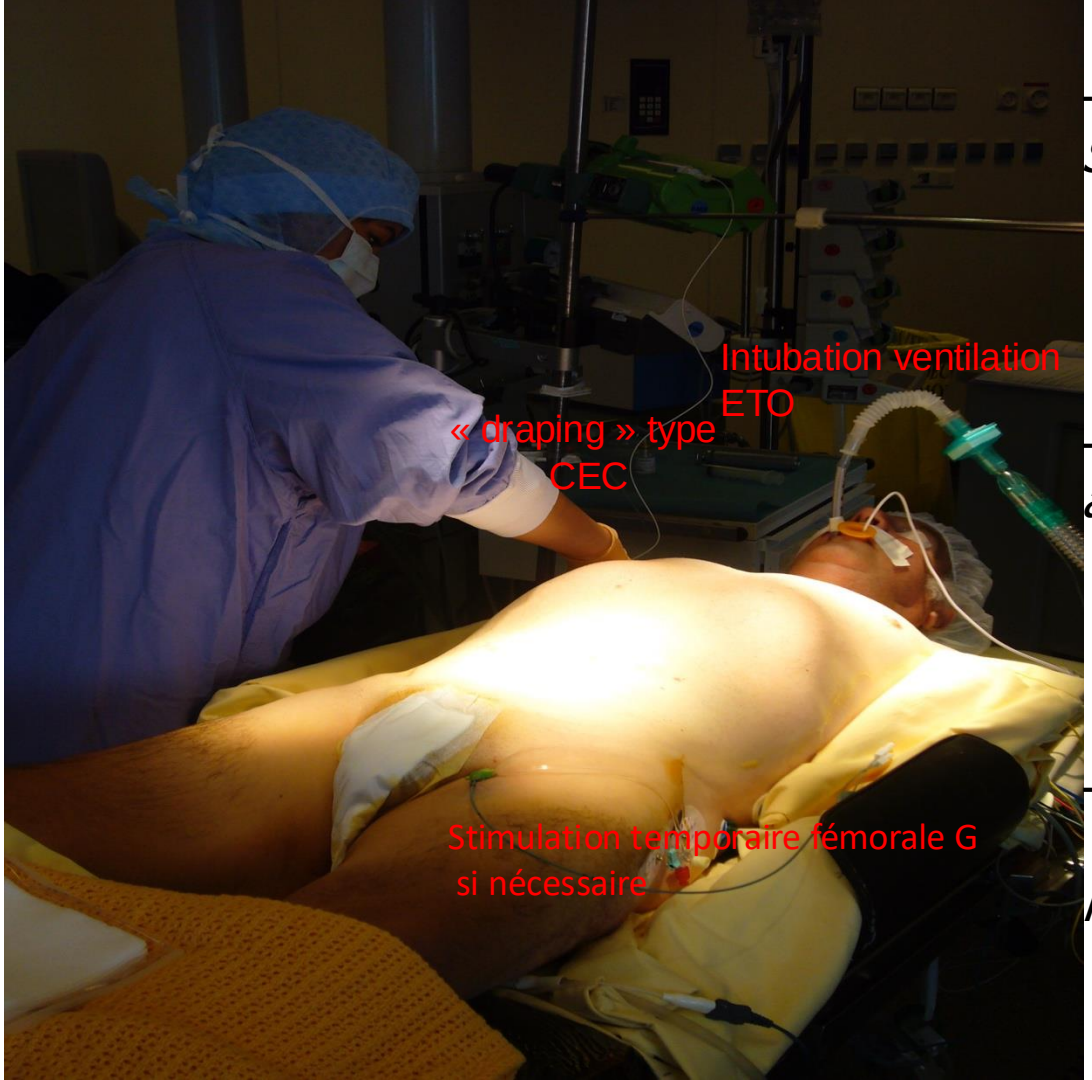
Authors (EHRA Task Force Members): J.C. Deharo (France) (chairperson)[1*], M.G. Bongiorni (Italy) (co-chairperson)[2], A. Rozkovec (UK)[3], F. Bracke (Netherlands)[4], P. Defaye (France)[5], I. Fernandez-Lozano (Spain)[6], P.G. Golzio (Italy)[7], B. Hansky (Germany)[8], C. Kennergren (Sweden)[9], A.S. Manolis (Greece)[10], P. Mitkowski (Poland)[11], and E.S. Platou (Norway)[12]

External reviewers: C. Love (US)[13], and B. Wilkoff (US)[14]

Recommandations on minimum training and volume for lead extractor operators and centres

Lead extraction status	Minimum number of leads	Minimum number of procedures	Additional requirements
Trainee	40 leads under supervision: 10 ICD leads, 10 leads > 6 years old	30 10 with ≥ 2 leads	Full qualification in CIED implantation
Primary operator (trained)	20/year	15/year	
Supervisor trainer	75 total	30/year	
Non-training centre	20/year	15/year	1 primary operator
Training centre		30/year	1 supervisor trainer

Europace 2012 14, 124–134



- *Patients stimulo-dépendants: Stimulation temporaire mise en place avant l'extraction par voie veineuse fémorale G*

- *PM temporaire accessible facilement pendant la procédure (possibilité de déplacement et nécessité de repositionnement rapide)*

- *Mise en place du Kit de préparation « bridge balloon » , Guide 0,035 Fémoral D jusqu'à V jug D*

Pathways for training and accreditation for transvenous lead extraction: a European Heart Rhythm Association position paper

Authors (EHRA Task Force Members): J.C. Deharo (France) (chairperson)[1*], M.G. Bongiorni (Italy) (co-chairperson)[2], A. Rozkovec (UK)[3], F. Bracke (Netherlands)[4], P. Defaye (France)[5], I. Fernandez-Lozano (Spain)[6], P.G. Golzio (Italy)[7], B. Hansky (Germany)[8], C. Kennergren (Sweden)[9], A.S. Manolis (Greece)[10], P. Mitkowski (Poland)[11], and E.S. Platou (Norway)[12]

Recommandations on personnel and roles :

❑ Cardiac surgery support :

-A CT surgeon must be immediatly available in less than 5/10 minutes : *Delays> 5-10 minutes are associated with increased mortality*

- CT surgeon aware of the procedure mandatory

- CT surgeon aware of LM complications

❑ Anesthesia support :

-Lead extraction should be performed in an OR or a cath lab with general anaesthesia or sedation

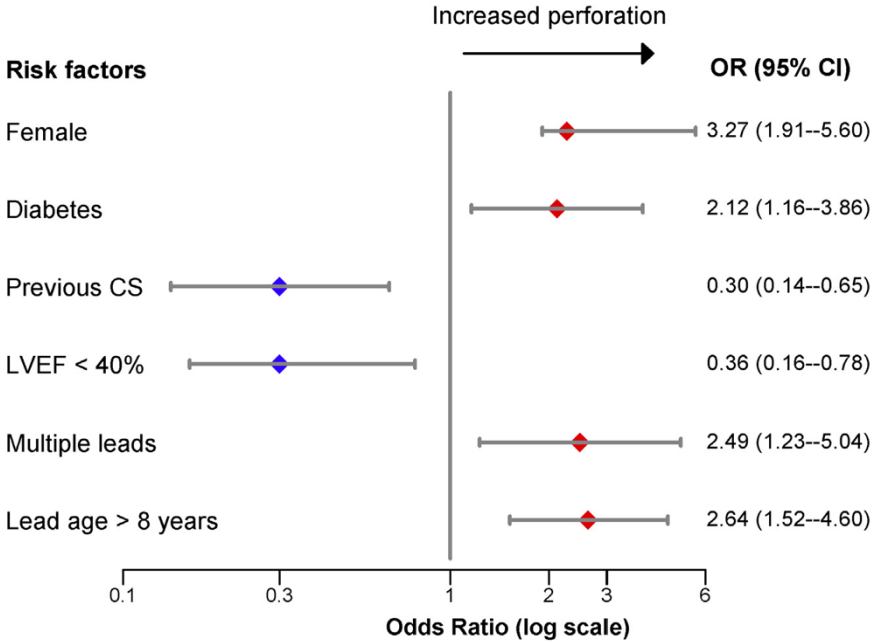
- Ability to perform an open-heart surgery is mandatory

Europace 2012; 14, 124–134

Predictors of perforation during lead extraction: Results of the Canadian Lead ExtrAction Risk (CLEAR) study

Jamil Bashir, MD,* Arthur J. Lee, MD, MPH,* Francois Philippon, MD, FHRS,†
Blandine Mondesert, MD,‡ Andrew D. Krahn, MD, FHRS,*
Mouhannad M. Sadek, MD, FHRS,§ Derek Exner, MD, FHRS,¶ Melissa Pak, MSc, RN,*
Jean Francois Legare, MD,‖ Shahzad Karim, MD,* Lynn Fedoruk, MD,*
Defen Peng, PhD,* Robert J. Cusimano, MD,** Ratika Parkash, MD, MSc,‖
G. Frank O. Tyers, MD, FHRS,* Jason Andrade, MD*

Retrospective multicenter study, Canada
2325 consecutive patients/4527 leads



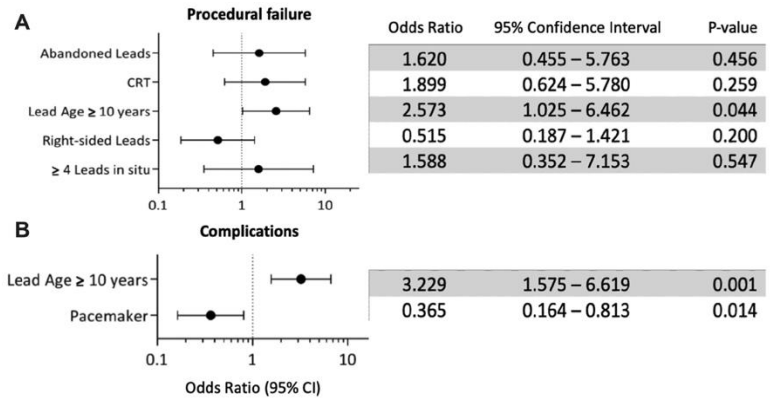
Risk factors affecting perforation during TLE

Heart Rhythm 2022;19:1097–1103

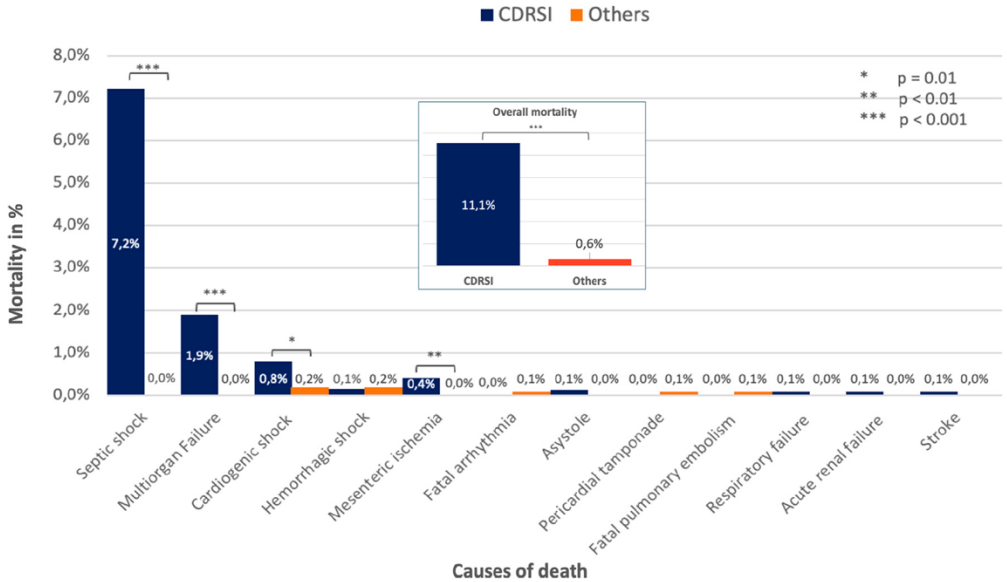
Transvenous lead extraction in patients with systemic cardiac device–related infection—Procedural outcome and risk prediction: A GALLERY subgroup analysis

Da-Un Chung, MD,* Heiko Burger, MD,† Lukas Kaiser, MD,* Brigitte Osswald, MD,‡ Volker Bärsch, MD,§ Herbert Nägele, MD,‖ Michael Knaut, MD,¶ Hermann Reichenspurner, MD, PhD,#** Nele Gessler, MD,*** Stephan Willems, MD,*** Christian Butter, MD,†† Simon Pecha, MD,#**1 Samer Hakmi, MD,*1 on behalf of the GALLERY investigators

GermAn Laser Lead Extraction RegistrY



	Odds Ratio	95% Confidence Interval	P-value
Abandoned Leads	1.620	0.455 – 5.763	0.456
CRT	1.899	0.624 – 5.780	0.259
Lead Age ≥ 10 years	2.573	1.025 – 6.462	0.044
Right-sided Leads	0.515	0.187 – 1.421	0.200
≥ 4 Leads in situ	1.588	0.352 – 7.153	0.547
Lead Age ≥ 10 years	3.229	1.575 – 6.619	0.001
Pacemaker	0.365	0.164 – 0.813	0.014



Multivariate analysis

CDRSI : cardiac device–related systemic infection

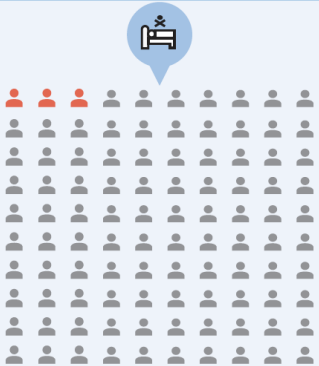
Heart Rhythm 2023;20:181–189

Causes of Early Mortality After Transvenous Lead Removal

Justin Z. Lee, MD,[a] Min-Choon Tan, MD,[a] Suganya Karikalan, MBBS,[a] Abhishek J. Deshmukh, MD,[b] Dan Sorajja, MD,[a]
Arturo Valverde, MD,[a] Komandoor Srivathsan, MD,[a] Luis Scott, MD,[a] Fred M. Kusumoto, MD,[c]
Paul A. Friedman, MD,[b] Samuel J. Asirvatham, MD,[b] Siva K. Mulpuru, MD,[b] Yong-Mei Cha, MD[b]

Early mortality after TLE

Early Mortality (30 Days)

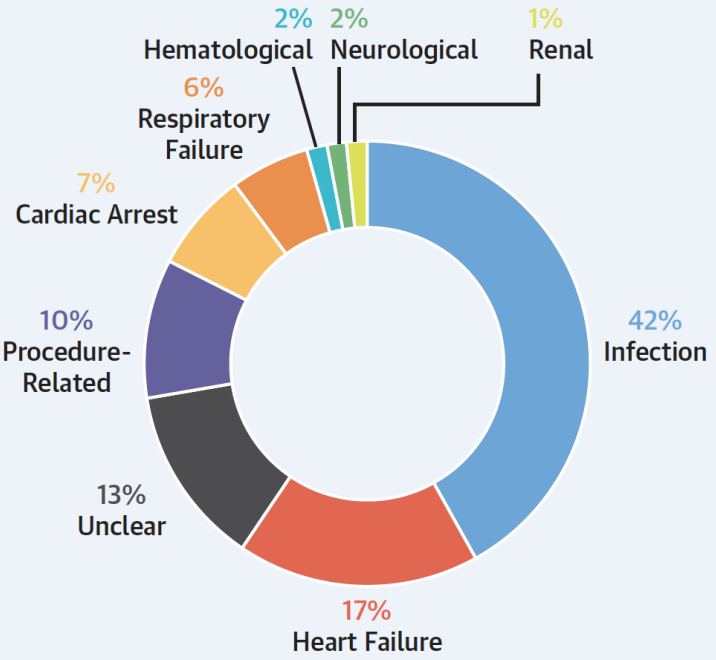


3%

Procedure-Related Early Mortality

0.3%

Causes of Early Mortality



J Am Coll Cardiol EP 2022;8:1566–1575

Causes of Early Mortality After Transvenous Lead Removal

Justin Z. Lee, MD,[a] Min-Choon Tan, MD,[a] Suganya Karikalan, MBBS,[a] Abhishek J. Deshmukh, MD,[b] Dan Sorajja, MD,[a] Arturo Valverde, MD,[a] Komandoor Srivathsan, MD,[a] Luis Scott, MD,[a] Fred M. Kusumoto, MD,[c] Paul A. Friedman, MD,[b] Samuel J. Asirvatham, MD,[b] Siva K. Mulpuru, MD,[b] Yong-Mei Cha, MD[b]

Description causes of TLE related mortality

No.	Procedure	Year	Age, y	Sex	Cause of Mortality and Description	Procedural Details	Days After Procedure
1	Extraction of DC-ICD with the use of laser	2014	35	Male	SVC tear	Bridge balloon was deployed. Sternotomy was performed but failed to control bleeding	0
2	Extraction of CRT-D with the use of laser	2017	78	Female	Innominate vein tear	Bridge balloon was deployed. Sternotomy was performed but failed to control bleeding	0
3	Extraction of DC-ICD with the use of laser	2005	79	Female	Cardiac tamponade caused by RV perforation	Pericardiocentesis was performed but failed due to clotted blood. Sternotomy was performed; hypotension persisted despite prolonged open cardiac massage and successful tear repair	0
4	Extraction of RV lead with the use of laser	2017	75	Male	Cardiac tamponade caused by RV perforation and SVC tear	Sternotomy was performed, and tear was repaired. Persistent mediastinal bleeding despite another emergent sternotomy	1
5	Extraction of DC-ICD with the use of laser	2015	60	Female	SVC tear complicated with postprocedural stroke	Sternotomy was performed, and bleeding was under control. No bridge balloon deployed	7
6	Extraction of DC-ICD with mechanical sheath	2013	70	Male	Retroperitoneal hemorrhage caused by femoral artery injury	Hypotension and right groin hematoma after the procedure. Puncture site was identified in external iliac-common femoral artery. Vascular repair was successful, but condition deteriorated	7
7	Explant of DC-PM with simple traction	2012	76	Female	Delayed cardiac tamponade due to RV perforation after lead explant	Successful explantation of DC-PM. No pericardial effusion on immediate postprocedural echocardiogram	11

J Am Coll Cardiol EP 2022;8:1566–1575

High success and safety of TLE using excimer laser sheaths in more than 1700 patients: a meta-analysis

- From April 1, 2016 to March 31, 2021.
- Results: 17 articles
  - 6 prospective studies
  - 11 retrospective studies

- 1,729 patients/ 2,887 leads:
- 38.5% of leads : infection.
- ICDs : 47.9%
- 2.3 ± 0.3 leads/patients
- Lead dwell time = 7.9 ± 3.0 years

- TLE procedure success rate per patient : 96.8%
  per lead : 96.6%
- Procedure-related death : 0.08%
- Most common complications :
  - pericardial effusion or tamponade (n=21),
  - hematoma (n=20)
  - cardiovascular injuries (n=18).

CA Rinaldi, M Biffi, I Diemberger, P Defaye, E Sizto, YR Gao, LM Epstein, R Carrillo, non published

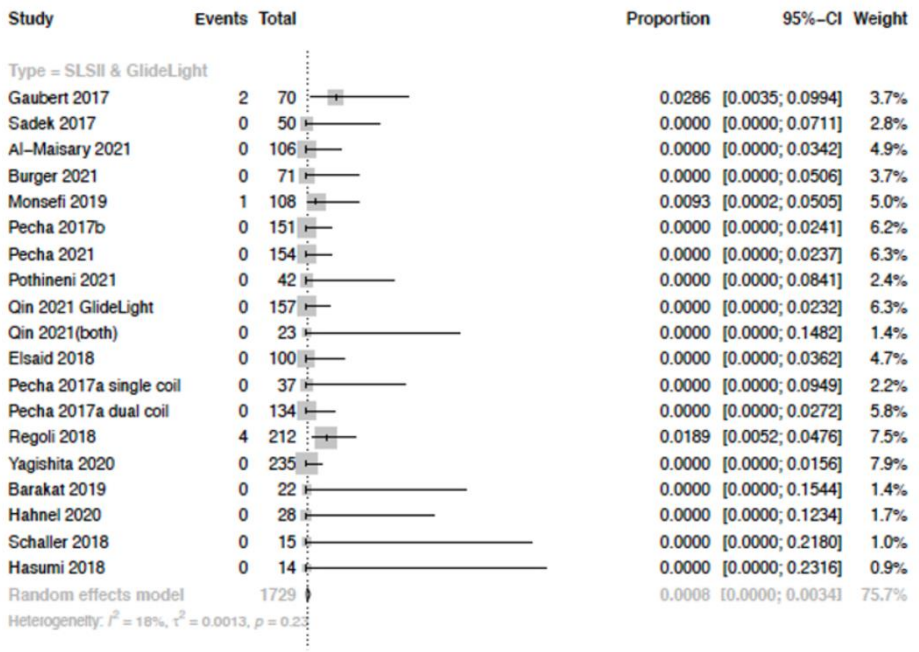
High success and safety of TLE using excimer laser sheaths in more than 1700 patients: a meta-analysis

Table 1. Outcomes of Lead Extraction Using Excimer Laser Sheaths

Variables[a]	SLS II & GlideLight Weighted Ave.% (#Event/#Sample), 95% CI (L-U)
Procedure-related death rate	**0.08%** (7/1,729, 17 studies), [0.00% - 0.34%]
Procedure success per patient	**96.8%** (1,440/1,505, 15 studies), [94.9% - 98.2%]
Clinical success per patient	**98.3%** (989/1,010, 9 studies), [97.4% - 99.0%]
Procedure success per lead	**96.6%** (1,447/1,501, 6 studies), [95.1% - 97.7%]

[a]The weighted average of the rate was obtained by performing a random-effects, inverse-variance-weighting meta-analysis using arcsine-square-root transformation.

Figure 1. Mortality Rate Forest Plot



Conclusion:

TLE utilizing the excimer laser sheath has high success and low mortality rates

CA Rinaldi, M Biffi, I Diemberger, P Defaye, E Sizto, YR Gao, LM Epstein, R Carrillo, non published data

Results of the Patient-Related Outcomes of Mechanical lead Extraction Techniques (PROMET) study: a multicentre retrospective study on advanced mechanical lead extraction techniques

Christoph T. Starck [1,2,3]*, Elkin Gonzalez[4], Omar Al-Razzo[4], Patrizio Mazzone[5], Peter-Paul Delnoy[6], Alexander Breitenstein[7], Jan Steffel[7], Jürgen Eulert-Grehn[1,2], Pia Lanmüller[1], Francesco Melillo[5], Alessandra Marzi[5], Manav Sohal[8], Giulia Domenichini[8], and Mark M. Gallagher[8]

Rotational tools/Evolution™

- **1552 leads (in 992 patients)**
- **Median dwell time : 106 months were extracted.**
- **Complete success was obtained for 95.2% of leads**
- **Procedural mortality rate of 0.4%.**

Table 4 Comparison of the results of the PROMET study with other published large volume studies

	Patients/leads	Indications	Leads	Implant duration (months)	Success rates	Major complications	In-hospital mortality
PROMET study	2205/3849	46.0% infection	74.8% pacemaker leads	Mean 84.7 ± 61.8	96.5% CPS	1%	1.7% (30-day mortality)
		54.0% non-infectious	24.6% ICD leads	Median 74.0	97.0%		
			0.6% unknown	IQR (41.0–112.0)	CS		
LEXICON study	1449/2405	56.9%	70.0% pacemaker leads	Median 82.1	96.5% CPS	1.4%	1.86%
		Infection	29.2% ICD leads	IQR (0.4–356.8)	97.7%		
		43.1%	0.7% unknown		CS		
		Non-infectious					
ELECTRa study	3510/4917	52.8% infection	75.7% pacemaker leads	Mean 76.8 ± 64.8	95.7% CPS	1.7%	1.4%
		47.3% non-infectious	24.3% ICD leads	Median 60.0	96.7%		
				IQR (24.0–108.0)	CS		

Europace 2020; 22, 1103–1110

Reported m… sheaths vs. l… lead extract…

Celso L. Diaz [1], Xia…
Cara N. Pellegrini[4,5],

doi:10.1093/europace/euaa032
Published online 22 February 2020

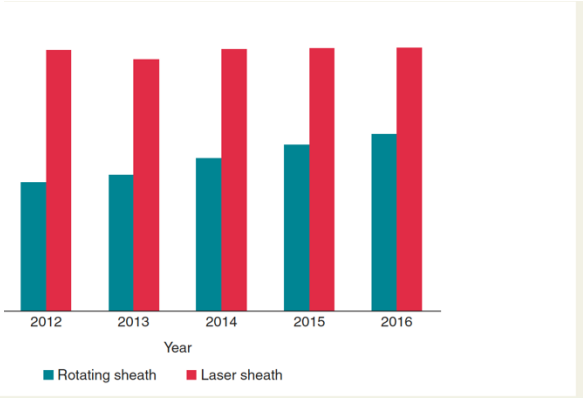
Mortality during transvenous lead extraction: is there a difference between laser sheaths and rotating sheaths?

Pascal Defaye [1]*, Igor Diemberger[2], Christopher Aldo Rinaldi[3], Samer Hakmi[4], and Eyal Nof[5]

Table 2 Cardiov… deaths associated … lead extraction

Rotating sheath extract…	
Superior vena cava	
Subclavian vein	
Inferior vena cava	
Right atrium	
Innominate vein	
Right ventricle	1 (7.7)
Unknown	3 (23)
Laser sheath extraction (*n* = 167 total deaths)	
Superior vena cava	121 (72.5)
Right atrium	42 (25.1)
Innominate vein	33 (19.8)
Subclavian vein	9 (5.4)
Coronary sinus	5 (3.0)
Right ventricle	3 (1.8)
Inferior vena cava	2 (1.2)
Unknown	16 (9.6)

latabase



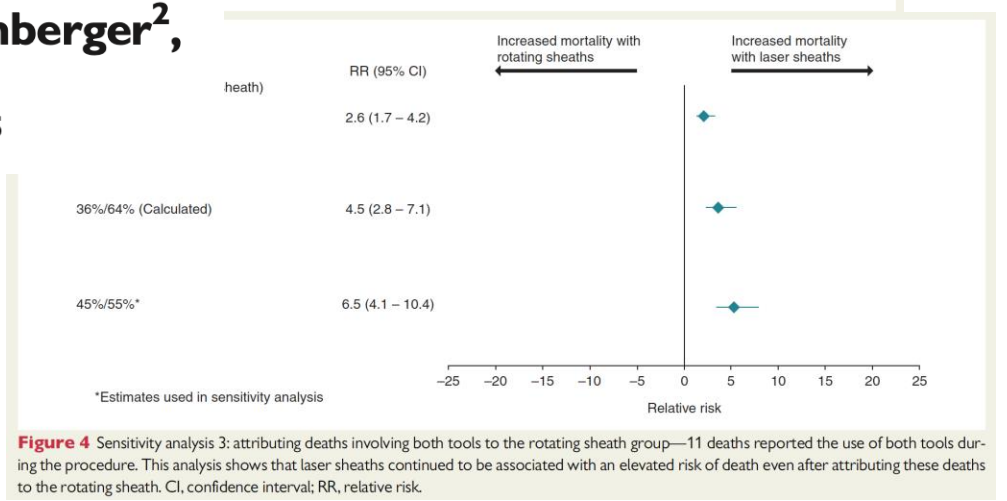
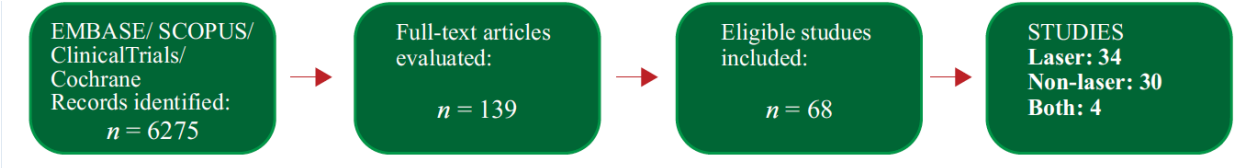


Figure 4 Sensitivity analysis 3: attributing deaths involving both tools to the rotating sheath group—11 deaths reported the use of both tools during the procedure. This analysis shows that laser sheaths continued to be associated with an elevated risk of death even after attributing these deaths to the rotating sheath. CI, confidence interval; RR, relative risk.

Europace 2019; 21, 1703–1709

Comparison of non-laser and laser transvenous lead extraction: a systematic review and meta-analysis

Zaki Akhtar [1]*, Christos Kontogiannis [1], Georgios Georgiopoulos[2,3], Christoph T. Starck [4], Lisa W.M. Leung [1], Sun Y. Lee [5], Byron K. Lee [6], Sreenivasa R. K. Seshasai [1], Manav Sohal[1], and Mark M. Gallagher [1]

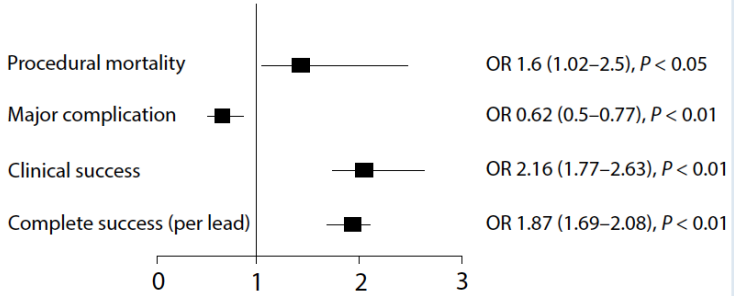


Non-laser vs. laser

- Laser increased the odds of procedural mortality comparatively to non-laser.

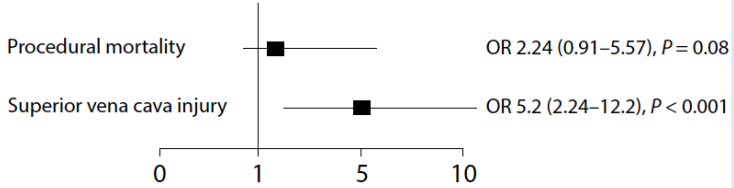
- Non-laser reduced the odds of major complication in comparison to laser.

- Non-laser increased the odds of clinical and complete success (per lead) comparatively to laser.



Rotational vs. laser

- Laser increased the odds of SVC injury in comparison to the rotational tool.



What's new?

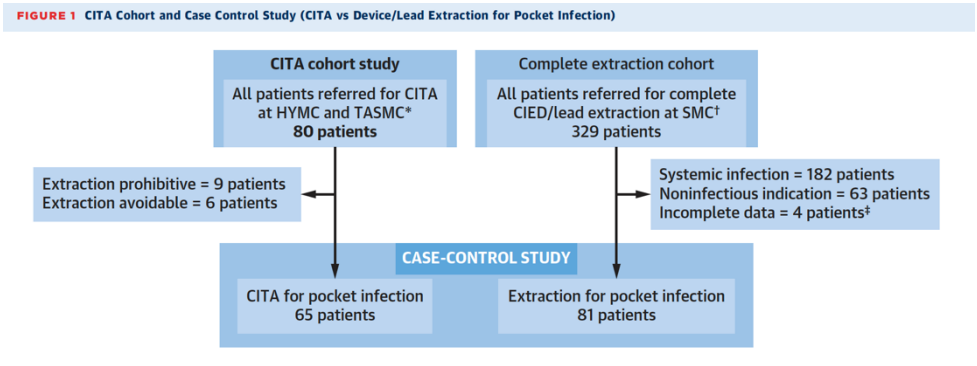
- This is the largest meta-analysis to date comparing non-laser and laser transvenous lead extraction.
- Non-laser transvenous lead extraction in comparison with laser is associated with better clinical and complete success with a lower complication risk, including superior vena cava injury and procedural mortality.
- Laser sheath extraction potentially carries a five-fold significantly greater risk of superior vena cava injury than rotational sheath extraction.
- Rotational sheath-assisted lead extraction is associated with higher clinical and complete success rate than laser.

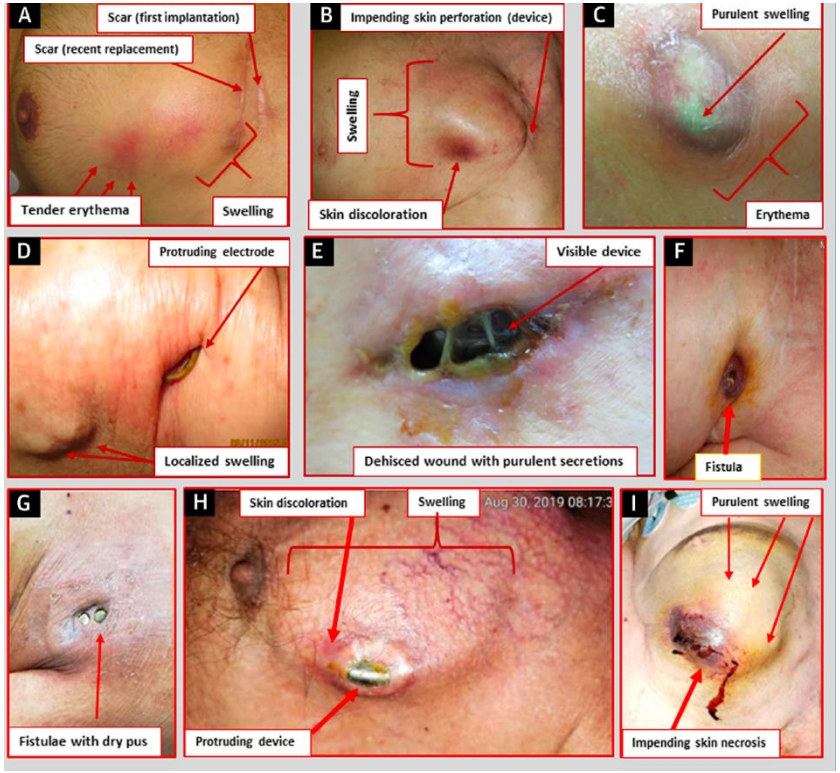
Europace 2023; 25 , 1–13

Regional Antibiotic Delivery for Implanted Cardiovascular Electronic Device Infections

Moris Topaz, MD, PhD,[a,b,*] Ehud Chorin, MD, PhD,[a,c,*] Arie Lorin Schwartz, MD,[a,c] Aviram Hochstadt, MD,[a,c] Avraham Shotan, MD,[d,e,f] Itamar Ashkenazi, MD,[g] Mark Kazatsker, MD,[d] Narin-Nard Carmel, MD,[c] Guy Topaz, MD,[c,h] Yoram Oron, PhD,[c] Gilad Margolis, MD,[a,c] Eyal Nof, MD,[c,i] Roy Beinart, MD,[c,i] Michael Glikson, MD,[c,i,j] Anna Mazo, MD,[a,c] Anat Milman, MD, PhD,[c,i] Michal Dekel, MD,[c,k] Shmuel Banai, MD,[a,c] Raphael Rosso, MD,[a,c] Sami Viskin, MD[a,c]

Continuous, In situ–Targeted, ultrahigh concentration of Antibiotics (CITA) into the infected subcutaneous device pocket





J Am Coll Cardiol 2023;81:119–133

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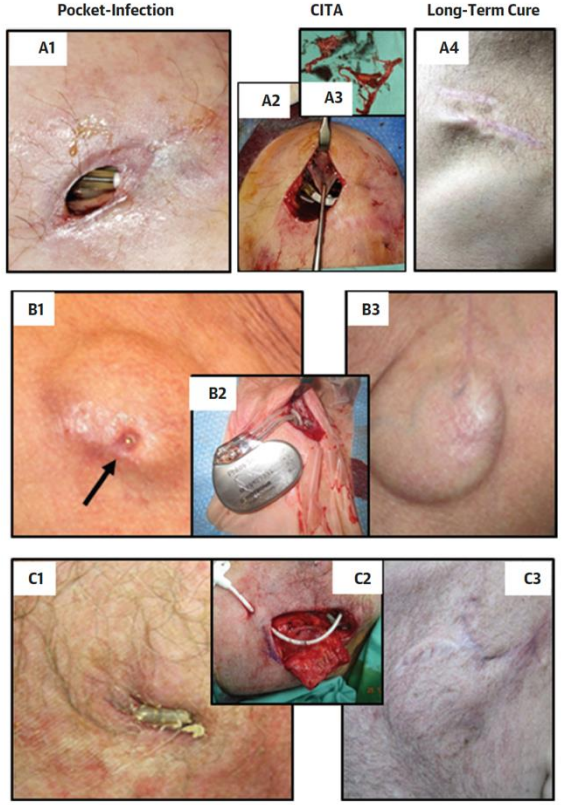
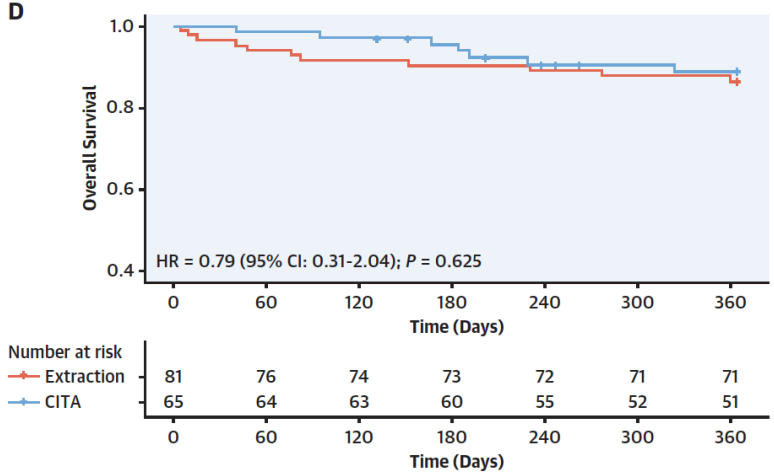
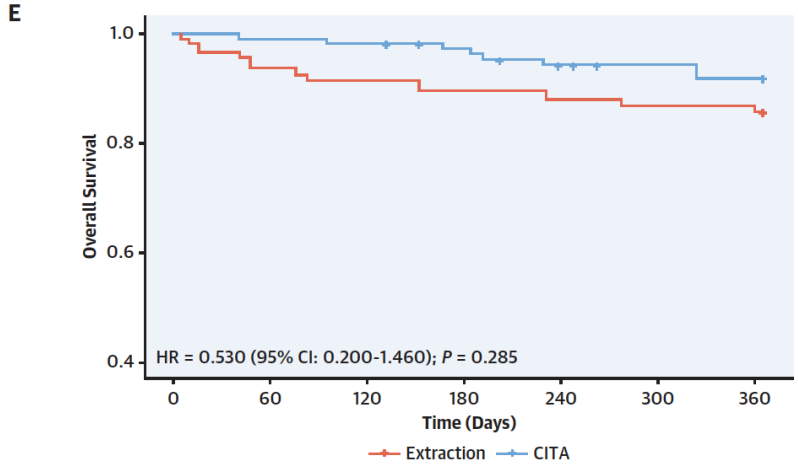


rates of serious complications after extraction :
14.8% vs 1.5% /P . 0.005

Extraction was avoided in 90.8% (59/65)





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CITA Procedure :

- **Minimally invasive surgery debridement of wound edges,**
- **Cleaning of the pocket, and eventual primary closure.**
- **Wound sealed with sponge dressing and**
- **Vacuum drainage during continuous inflow of ultrahigh concentrations of antibiotics (for 14 days)**

J Am Coll Cardiol 2023;81:119–133

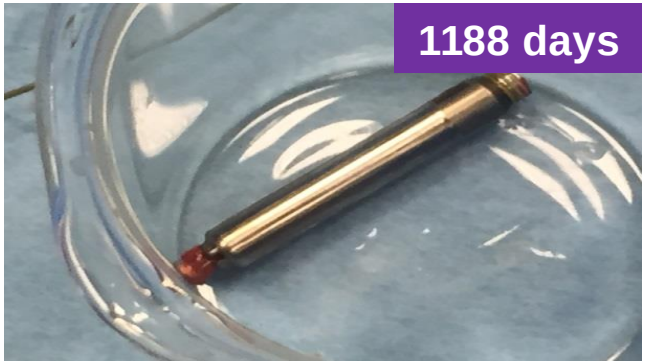
Retrieval of the Leadless Cardiac Pacemaker

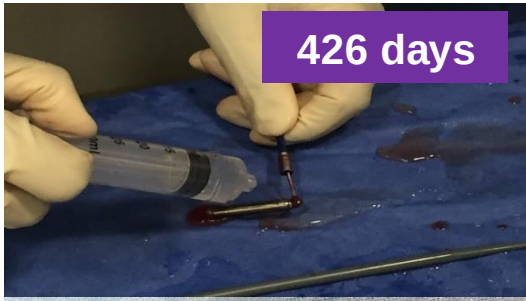
A Multicenter Experience

Vivek Y. Reddy, MD; Marc A. Miller, MD; Reinoud E. Knops, MD; Petr Neuzil, MD, PhD; Pascal Defaye, MD; Werner Jung, MD; Rahul Doshi, MD; Mark Castellani, MD; Adam Strickberger, MD; R. Hardwin Mead, MD; Harish Doppalapudi, MD; Dhanunjaya Lakkireddy, MD; Matthew Bennett, MD; Johannes Sperzel, MD

Nanostim Retrieval

Gross Pathology

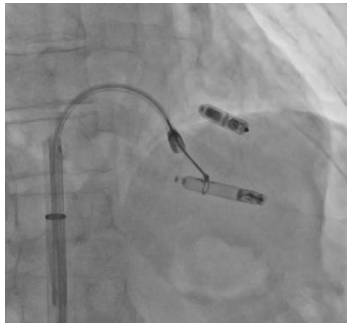


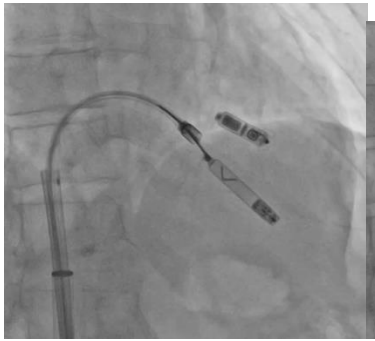


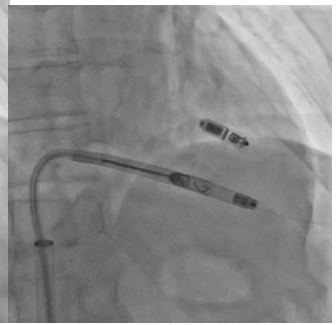
Circ Arrhythm Electrophysiol. 2016;9:e004626.

New era of extraction : leadless pacemakers extraction

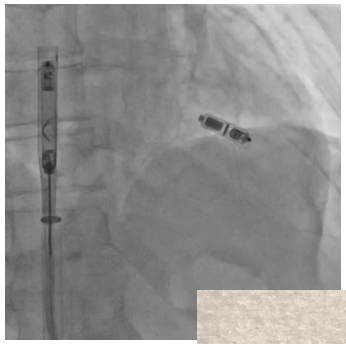
Recall of a Nanostim leadless PM (2016) after reimplantation of a Micra AV

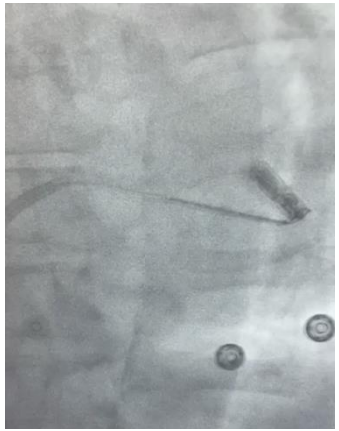






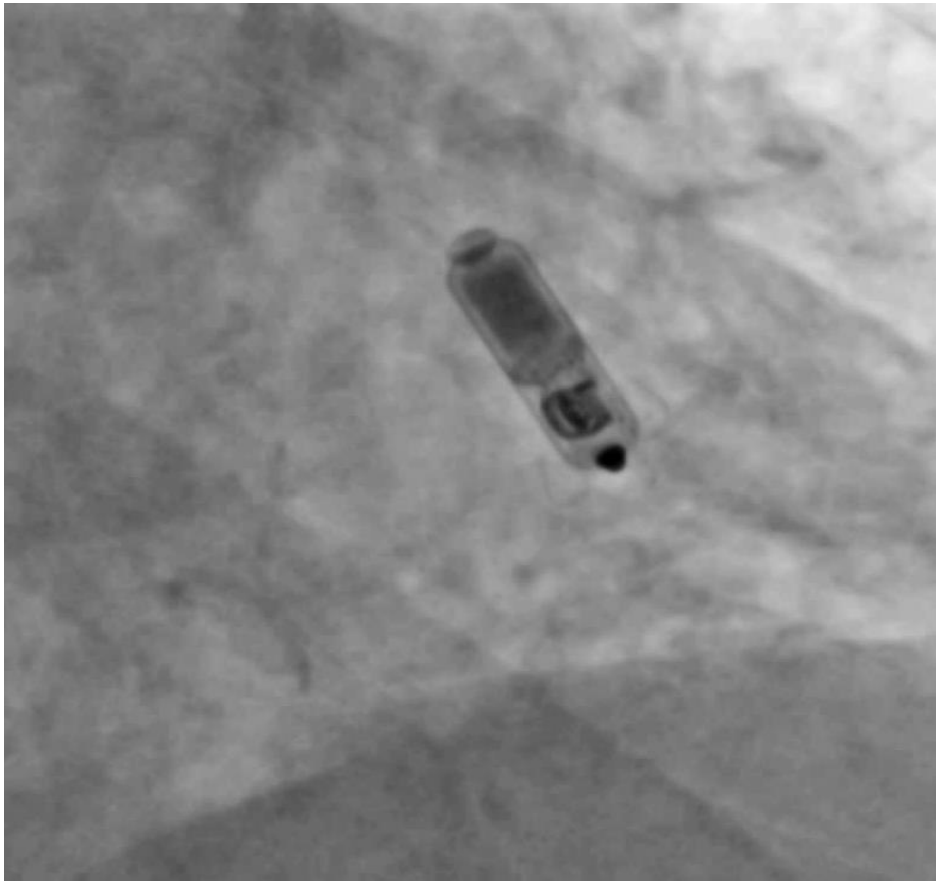
Removal of the old Nanostim™, 19/2/2021



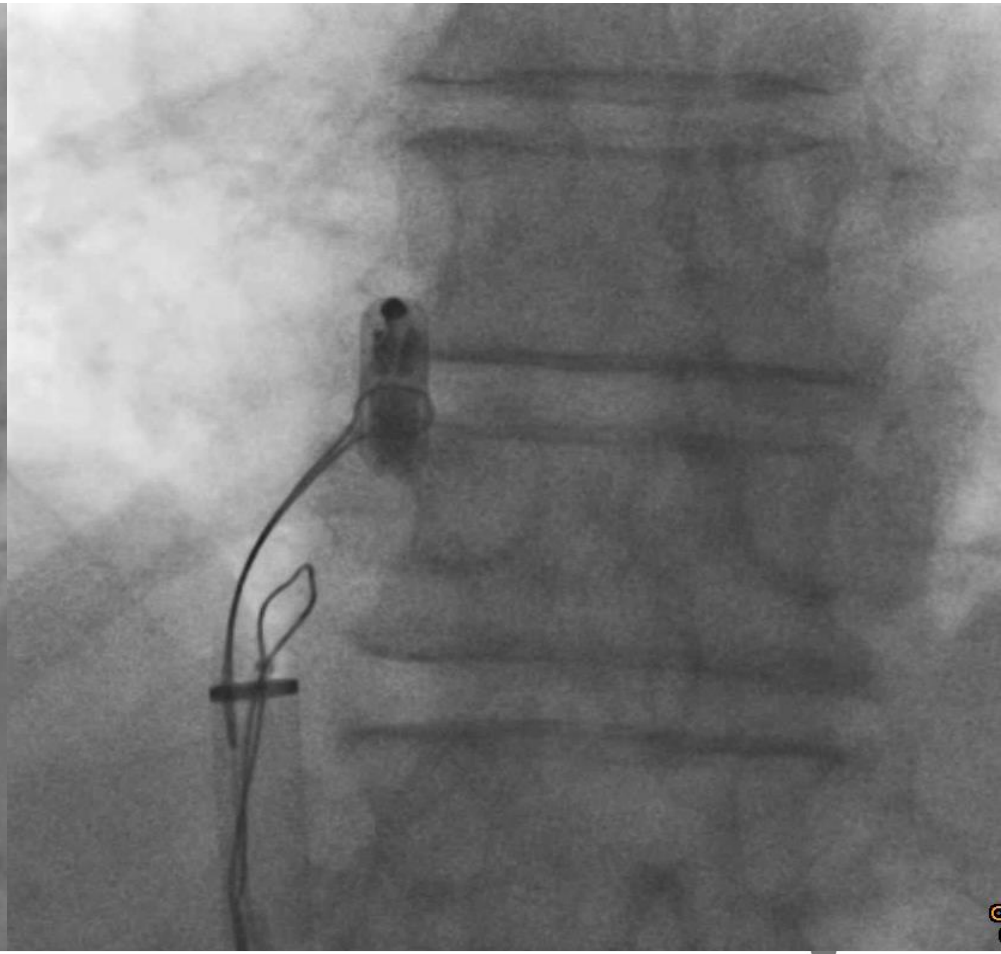


Early removal of a Micra/ February 2022

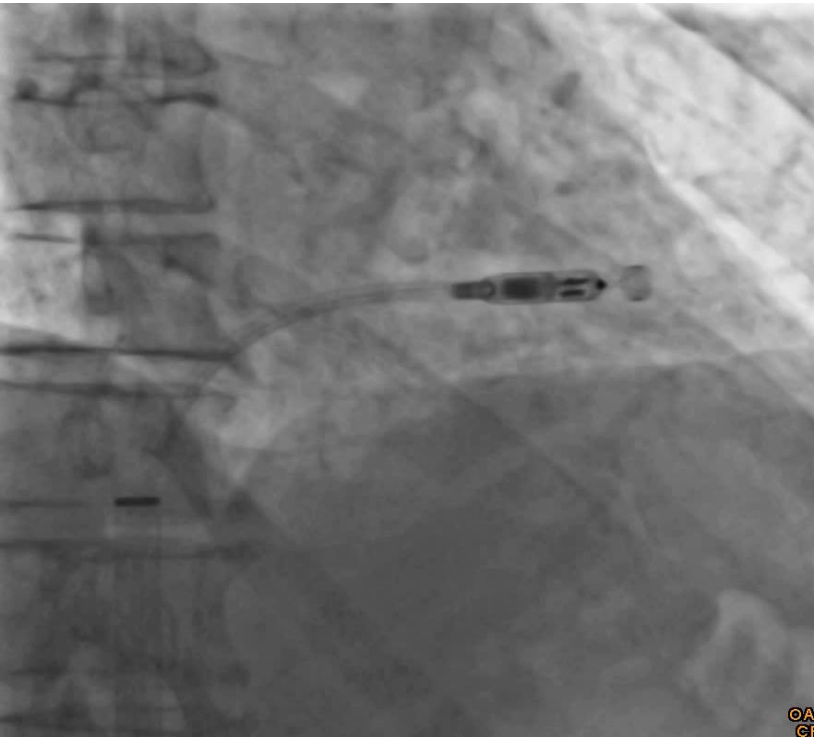
Micra Removal September 2023

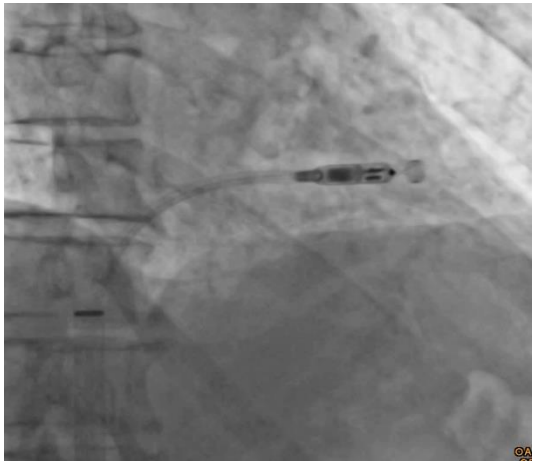


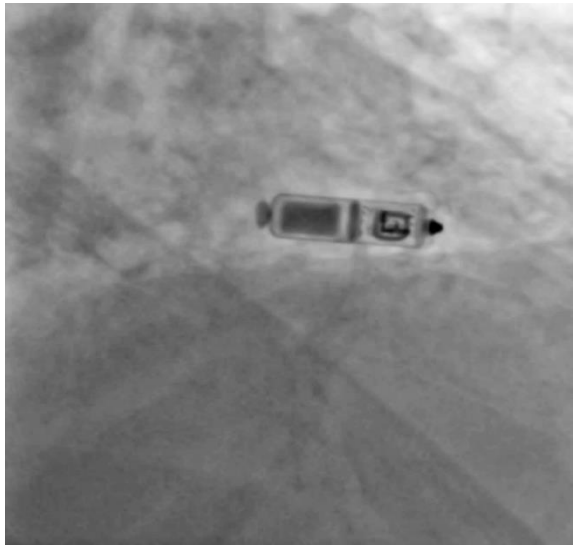
High threshold due to Micra instability



Micra Removal September 2023 and ré-implantation

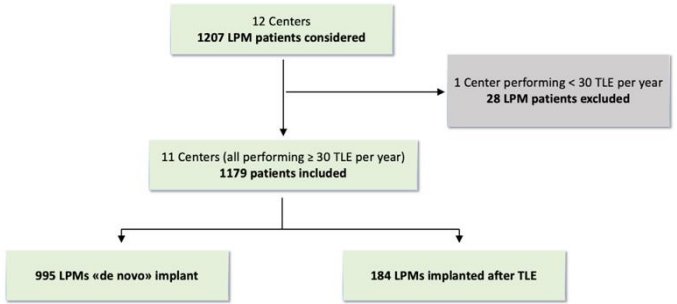


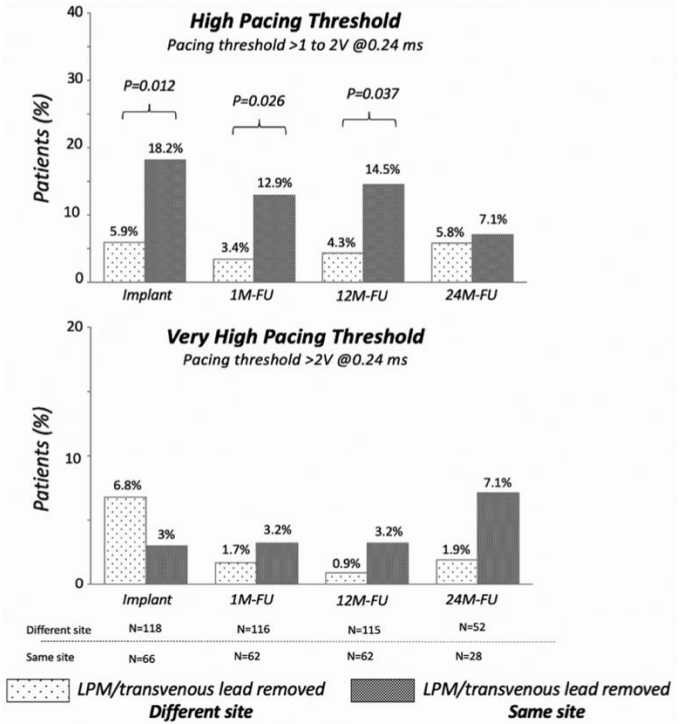




Outcomes of leadless pacemaker implantation following transvenous lead extraction in high-volume referral centers: Real-world data from a large international registry

Gianfranco Mitacchione, MD, PhD,[*†] Marco Schiavone, MD,[†‡] Alessio Gasperetti, MD,[§] Gianmarco Arabia, MD,[*] Alexander Breitenstein, MD,[‖] Manuel Cerini, MD,[*] Pietro Palmisano, MD,[¶] Elisabetta Montemerlo, MD,[#] Matteo Ziacchi, MD,[**] Simone Gulletta, MD,[††] Francesca Salghetti, MD,[*] Giulia Russo, MD,[‡‡] Cinzia Monaco, MD,[§§] Patrizio Mazzone, MD,[††] Daniel Hofer, MD,[‖] Fabrizio Tundo, MD,[§] Giovanni Rovaris, MD,[#] Antonio Dello Russo, MD,[‖‖] Mauro Biffi, MD,[**] Ennio C.L. Pisanò, MD,[‡‡] Gian Battista Chierchia, MD,[§§] Paolo Della Bella, MD,[††] Carlo de Asmundis, MD,[§§] Ardan M. Saguner, MD,[‖] Claudio Tondo, MD, PhD,[‖‖¶¶] Giovanni B. Forleo, MD, PhD,[†‡] Antonio Curnis, MD[*‡]



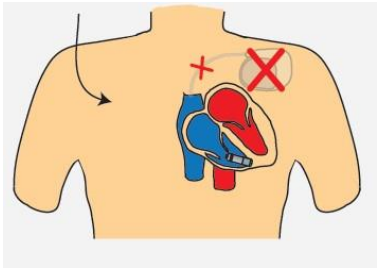


CONCLUSION LPMs showed a satisfactory safety and efficacy profile after TLE. Better electrical parameters were obtained when LPMs were implanted at a different RV location than the one where the previous transvenous RV lead was extracted.

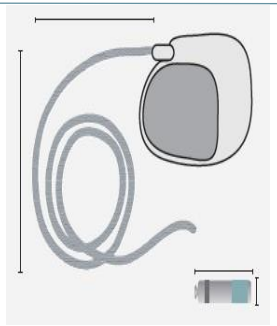
Heart Rhythm 2023

Pacemaker alternatives	ICD alternatives
VVI Coronary sinus pacing /4polar lead	Subcutaneous-ICD (S-ICD)
Epicardial VVI pacing	Extra-Vascular-ICD (EV-ICD)
VVIR leadless pacing (Micra™ or Aveir™) Next step : Aveir DR	S-ICD + leadless VVIR for ATP and pacing (Empower™)
Left ventricular leadless pacing (Wise CRT) Associated with Micra™ or Aveir™ (total leadless CRT)	ICD lead in the middle cardiac vein

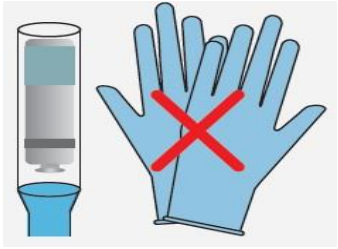
Low infection rate with leadless PM



No lead, no pocket



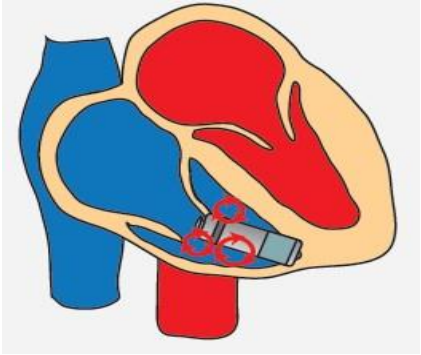
Small size



Reduced handling

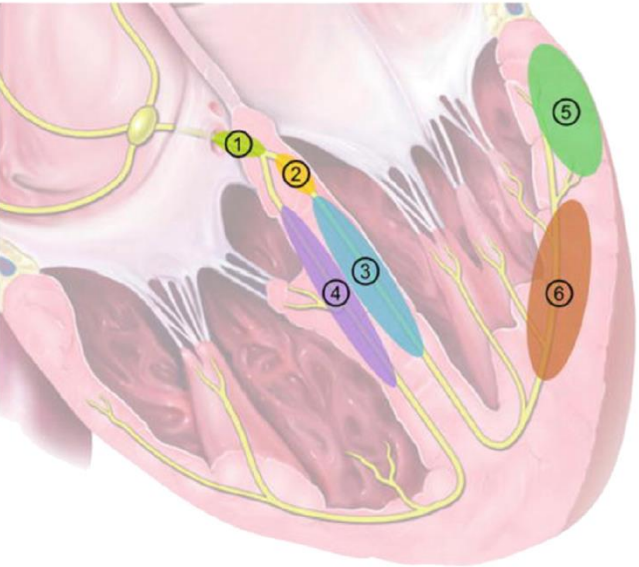
Encapsulation

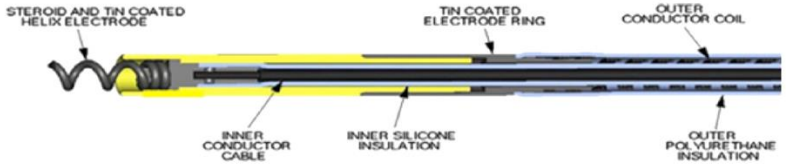
Protective covering

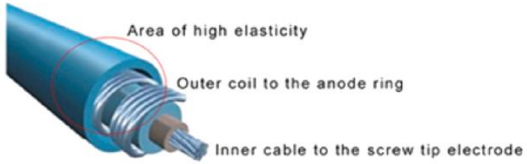


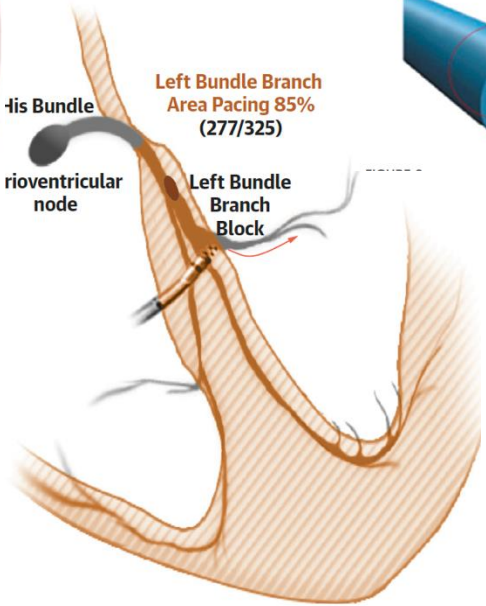
Turbulent flow

TLE in conduction system pacing









Medtronic 3830

EP CASE EXPRESS

doi:10.1093/europace/euab087

Extraction of left bundle branch pacing lead: a safe procedure?

Federico Migliore [1]*, Patrizia Aruta[1], Antonella Cecchetto[1], Sabino Iliceto[1], Gino Gerosa [1], and Domenico Catanzariti[2]

Europace 2021

CASE REPORT

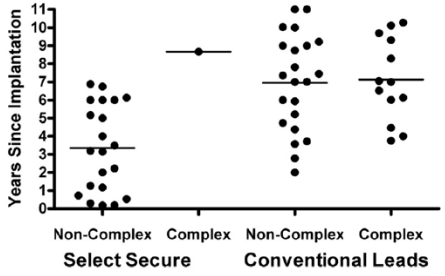
What goes in may need to come out: Considerations in the extraction of a lumenless, fixed-screw permanent pacemaker lead

Felix Krainski, MD,* Jennifer P. Miller, BSc, BFA, MBA,† Victor Pretorius, MBChB,‡
Ulrika Birgersdotter-Green, MD, FHRS*

Heart Rhythm 2020

Extraction of SelectSecure leads compared to conventional pacing leads in patients with congenital heart disease and congenital atrioventricular block

Emma Shepherd,* Graham Stuart, FRCP,*† Rob Martin, FRCP,*† Mark A. Walsh, MRCPCH*†



Heart Rhythm 2015

Lumenless Pacing Leads: Performance and Extraction in Pediatrics and Congenital Heart Disease

JASON GARNREITER, M.D.,* PATRICIA WHITAKER,† THOMAS PILCHER, M.D.,‡
SUSAN ETHERIDGE, M.D.,‡ and ELIZABETH SAAREL, M.D.‡
From the *Department of Pediatrics, Saint Louis University School of Medicine, St. Louis, Missouri; †Primary Children's Medical Center, Salt Lake City, Utah; and ‡Department of Pediatrics, University of Utah School of Medicine, Salt Lake City, Utah

PACE 2015

CASE REPORT

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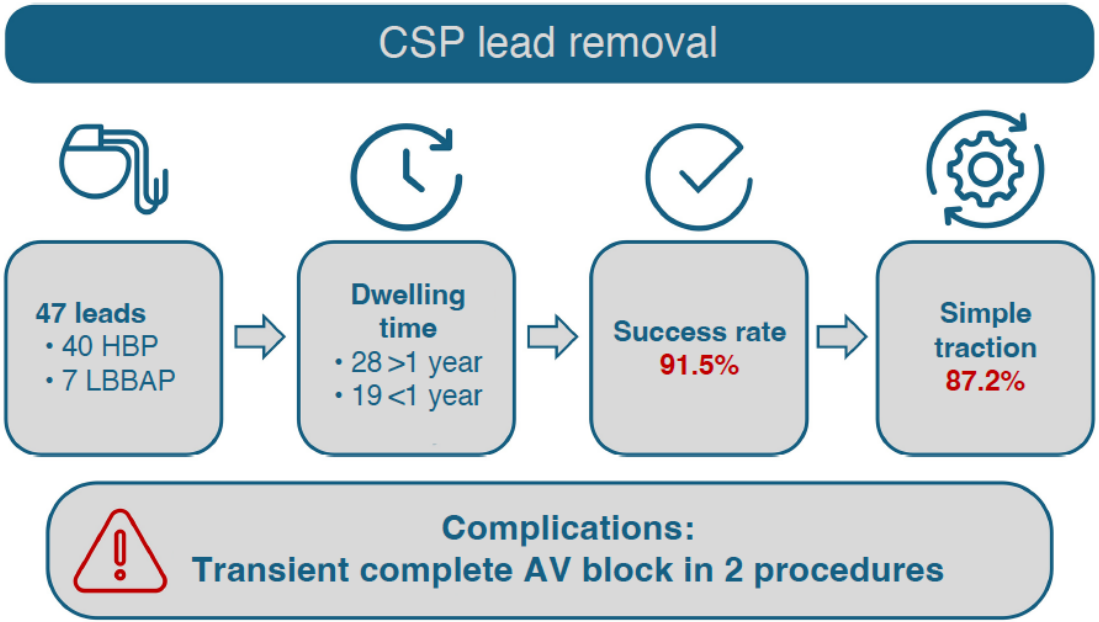
Felix Krainski, MD,* Jennifer P. Miller, BSc, BFA, MBA,† Victor Pretorius, MBChB,‡
Ulrika Birgersdotter-Green, MD, FHRS*

Heart Rhythm 2020

Extraction of lumenless pacing leads from the His bundle and left bundle branch area: outcomes of the high-volume centre

Rafal Gardas [1,2]*, Danuta Loboda [1,2], Jolanta Biernat [1], Tomasz Soral [1], Piotr Kulesza [1], Sylwia Gladysz-Wanha [1], Michal Joniec [1], Mateusz Sajdok [1], Kamil Zub [1], and Krzysztof S. Golba [1,2]



Europace 2024

Conclusion : past/present/future of lead extraction

- *Increase of infections at faster rate than implants*
- *Distribution 2/3-1/3 between infective and non-infective indications*

- *Infective indications Class I extraction indications*
  - *« The sooner the better » for infective indications : significant ≠ <or > 7 days »/ <3D*

- *Non functionnal leads :*
  - *Class IIa if ≥ 4 leads on 1 side or 5 leads in the SVC / Others cases IIb*
  - *despite very low mortality in reference centers/ rotational TLE lower risk??*

- *Others indications : no so rare : SVC syndrome/ Lead induced tricuspid regurgitation*

- *Cardiac surgery mandatory « on site »*

- *Rotational sheaths safer than Laser sheaths??? Tailored appoach*

- *Future and questions pending :*
  - *Necessity of retrievability of leadless PM*
  - *Faisability of extraction of lumenless leads (LBB area pacing)*


3
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content with other meeting
load the MirrorOp Apps