DOMENICA 10 OTTOBRE

Si ripropone il pacemaker senza fili (wireless); dall'elettrostimolazione alla sincronizzazione

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La prima parte della relazione

- L’Elettrostimolazione

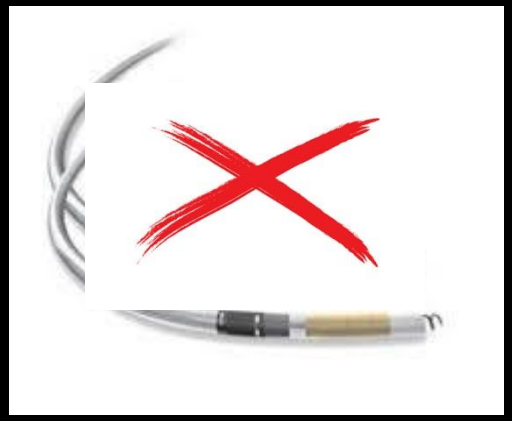
- La resincronizzazione

Procedure di routine ma…

- Complicanze a breve termine 9,5-12,6%
- Complicanze a lungo termine ulteriore 9%

Non uno ma due talloni d'Achille…

Due talloni d'Achille…



Gli elettrocateteri:
pneumotorace, tamponamento, ostruzione venosa, insufficienza tricuspidale, dislocazione, malfunzione

La tasca:
Ematoma, erosione, infezione

La soluzione?

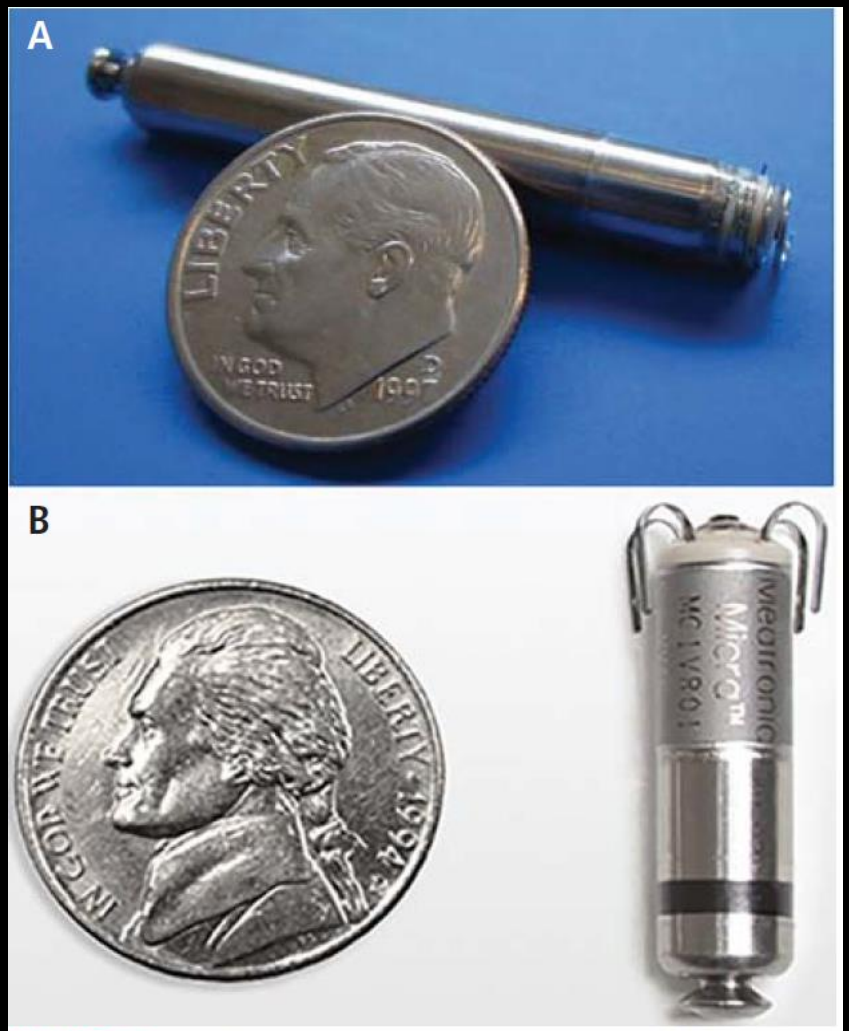


FIGURE 2. Leadless pacemakers (A) Nanostim and (B) Micra.

TABLE 1
Overview of leadless pacemakers Nanostim and Micra based on completed human trials

	Nanostim	Micra
Manufacturer	St. Jude Medical	Medtronic
Size (height × width)	42.0 × 6.0 mm	25.9 × 6.7 mm
Volume	1.0 mL	0.8 mL
Mass	2 g	2 g
Delivery sheath size	18 F	23 F
Primary fixation mechanism	Helix	Tines
Projected battery life[a]	15.0 years	12.5 years
Remote monitoring	No	Yes
Rate-responsive pacing	Yes, temperature-based	Yes, accelerometer-based
Retrieval system	Yes	No

[a]Based on reported projections at 3 months.
Data from references 21–27.

La soluzione?

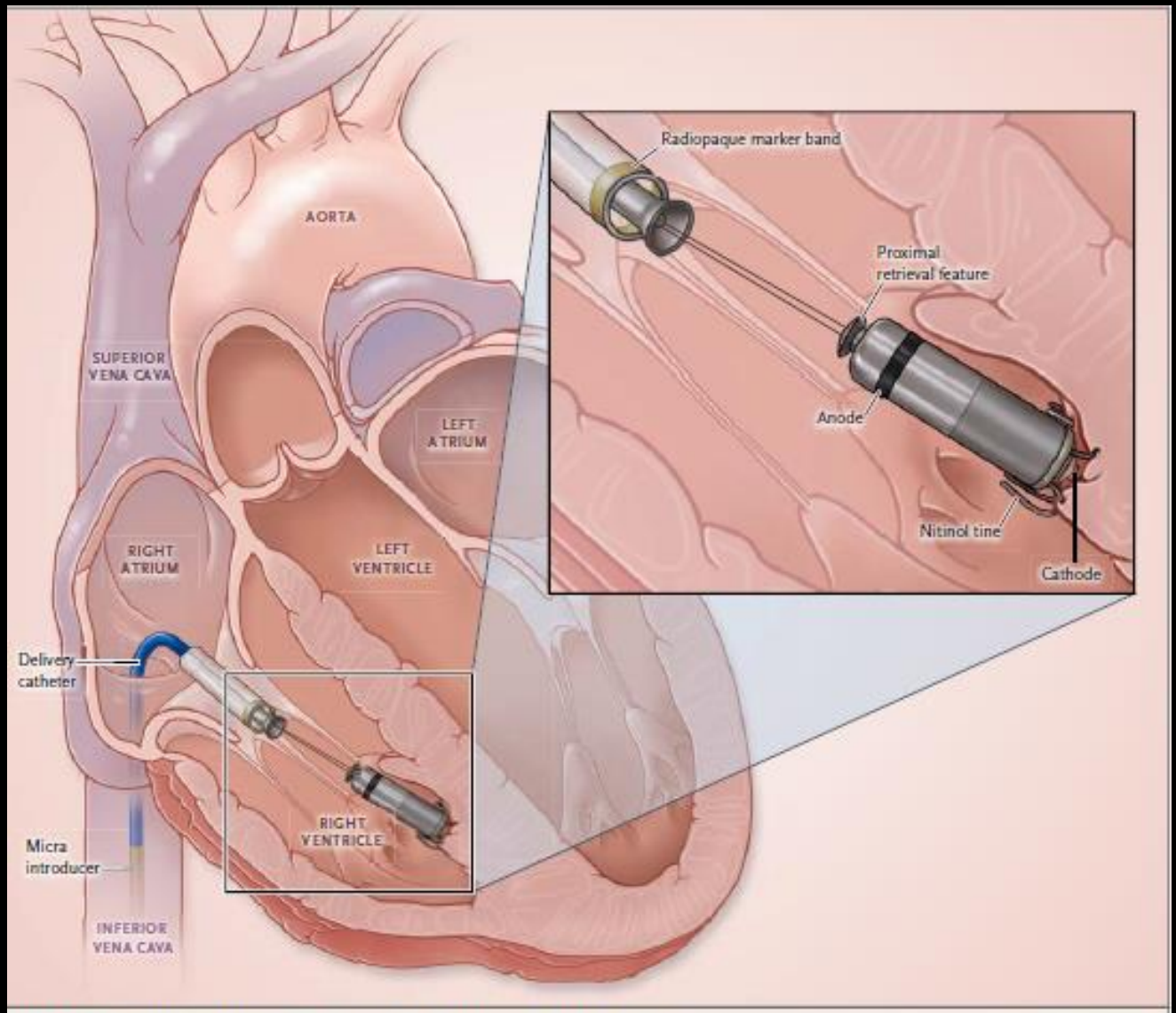


Figure 1. Micra Transcatheter Pacing System Positioned in the Right Ventricle.

I dati disponibili

Table 2 Summary of the registered studies on leadless pacemakers.

	LEADLESS II[18] Nanostim-LCP	Micra Transcatheter Pacing Study[19] Micra-TPS
	Prospective, nonrandomized, multicenter trial	Prospective, nonrandomized, single study group, multisite, international clinical study
Indication	Subjects who are indicated for a VVI(R) pacemaker	Class I or II indication for implantation of a single chamber ventricular pacemaker
Total number of patients	526	725
Number of patients with 6-month follow-up	300	297
Primary safety end point	Free of device-related serious adverse events through 6 months	Free of system-related or procedure-related major complications
Primary efficacy end point	Acceptable pacing threshold (2.0 V at 0.4 ms) and acceptable sensing amplitude (R wave 5.0 mV, or a value equal to or greater than the value at implantation) through 6 months	Percentage of patients with low and stable pacing capture thresholds at the 6th month (2.0 V at a pulse width of 0.24 ms and an increase of 1.5 V from the time of implantation)
Number of successful implantations	95.8% (504/526)	99.2% (719/725)
Primary safety end point	93.3% (280/300)	96% (700/725)
Primary efficacy end point	90.0% (270/300)	98.3% (292/297)
Device-related adverse events	**Primary cohort (completing 6 months of follow-up): 6.7%** • Device dislodgement with percutaneous retrieval: 1.7% • Cardiac perforation: 1.3% • Pacing-threshold elevation requiring percutaneous retrieval and device replacement: 1.3% • Vascular complications: 1.3% **Total cohort: 6.5%** • Device dislodgement with percutaneous retrieval: 1.1% • Cardiac perforation: 1.5% • Pacing-threshold elevation requiring percutaneous retrieval and device replacement: 0.8% • Vascular complications: 1.2%	**Total cohort: 4%** • Device dislodgement: 0% • Cardiac perforation: 1.6% • Pacing-threshold elevation: 0.2% • Vascular complications: 0.7% • Embolism/thrombosis: 0.3% • Other events: 1.7%
Device-related death	0	0
Procedural time (min)	28.6 ± 17.8	N/A
Fluoroscopy time (min)	13.9 ± 9.1	N/A
Patients not requiring device repositioning after initial deployment	70.2%	N/A
Retrieval	13 patients (dislodgments: 6, elevated pacing thresholds: 4, others: 3)	1 patient (loss of capture)
Pacemaker parameters (at follow-up)	Mean R-wave amplitude: 9.2 ± 2.9 mV Mean pacing capture threshold (at 0.4 ms): 0.58 ± 0.31 V	Mean R-wave amplitude: 15.3 mV Mean pacing capture threshold (at 0.24 ms): 0.54 V Mean pacing impedance: 627 Ohms

LCP: Leadless Pacemaker System, TPS: Transcatheter.

Sideris et al. Hellenic Society of Cardiology 2017; 58: 403

I parametri elettrici

- Buoni
- Stabili nel tempo
- Sovrapponibili ai PM tradizionali
- Importante la soglia all'impianto (< 2 V/0,24 msec)

Il confronto a 30 giorni

Table 2. Unadjusted and Adjusted 30-Day Complication Rates in Patients With Leadless VVI Pacemakers vs Patients With Transvenous VVI Pacemakers

	Unadjusted event, No. (%)			Adjusted rates %			
Measure	Leadless VVI (n = 5746)	Transvenous VVI (n = 9662)	*P* value	Leadless VVI (n = 5746)	Transvenous VVI (n = 9662)	Risk difference, % (95% CI)	*P* value
Overall complications	484 (8.4)	707 (7.3)	.02	7.7	7.4	0.3 (−0.6 to 1.3)	.49
Embolism and thrombosis	202 (3.5)	286 (3.0)	.07	3.2	3.1	0.1 (−0.5 to 0.7)	.81
Deep vein thrombosis	145 (2.5)	176 (1.8)	.003	2.2	2.0	0.3 (−0.2 to 0.7)	.27
Pulmonary embolism	72 (1.3)	128 (1.3)	.74	1.2	1.3	−0.1 (−0.5 to 0.3)	.52
Thrombosis due to cardiac device	≤10[a]	≤10[a]	.64	≤10[a]	≤10[a]	0 (0 to 0)	.52
Embolism due to cardiac device	≤10[a]	0	NA	≤10[a]	NA	NA	NA
Events at puncture site	78 (1.4)	31 (0.3)	<.001	1.2	0.3	0.8 (0.5 to 1.2)	<.001
Arteriovenous fistula	40 (0.7)	≤10[a]	<.001	0.5	NA	NA	.003
Vascular aneurysm	49 (0.9)	24 (0.3)	<.001	0.9	0.2	0.7 (0.4 to 0.9)	<.001
Cardiac effusion and/or perforation	47 (0.8)	38 (0.4)	<.001	0.8	0.4	0.4 (0.1 to 0.7)	.004
Device-related complication[b]	81 (1.4)	247 (2.6)	<.001	1.4	2.5	−1.1 (−1.5 to −0.6)	<.001
Other complications	136 (2.4)	169 (1.8)	.01	2.1	1.7	0.4 (−0.1 to 0.9)	.10
Device-related AMI	≤10[a]	≤10[a]	.71	≤10[a]	≤10[a]	.0 (0 to 0.1)	.40
Postprocedural hematoma	30 (0.5)	40 (0.4)	.33	0.5	0.4	0.1 (−0.1 to 0.3)	.45
Postprocedural hemorrhage	32 (0.6)	11 (0.1)	<.001	0.5	0.1	0.4 (0.2 to 0.6)	<.001
Intraoperative cardiac arrest	20 (0.4)	24 (0.3)	.30	0.3	0.3	0.1 (−0.2 to 0.3)	.51
Pericarditis	51 (0.9)	23 (0.2)	<.001	0.8	0.3	0.6 (0.3 to 0.9)	<.001
Vascular complication	38 (0.7)	16 (0.2)	<.001	0.6	0.2	0.4 (0.2 to 0.6)	<.001
Hemothorax	0	0	NA	NA	NA	NA	NA
Pneumothorax	0	77 (0.8)	NA	NA	0.8	NA	NA

Abbreviations: AMI, acute myocardial infarction; NA, not applicable.

[a] Cells with 10 or less patients were suppressed to protect beneficiary privacy as required by the US Centers of Medicare & Medicaid Services.

[b] Includes complications related to the mechanical integrity of the device or codes explicitly stating device relatedness (eg, device dislodgement, device infection, device pocket complication). See eTable 1 in the Supplement for details.

Piccini et al. jamacardio.2021.2621

Il confronto a 6 mesi

Table 3. Adjusted Rates of Device-Related Complication at 6-Month Follow-up in Patients with Leadless VVI Pacemakers vs Patients with Transvenous VVI Pacemakers

Complication type	6-mo Weighted CIF estimates, % (95% CI)		Relative risk reduction, % (95% CI)
	Leadless VVI (n = 3726)	Transvenous VVI (n = 7256)	
Overall complications	3.2 (2.9 to 3.6)	4.1 (3.8 to 4.6)	23 (4 to 38)
Embolism and thrombosis	≤10[a]	≤10[a]	53 (−163 to 92)
Thrombosis due to cardiac device	≤10[a]	≤10[a]	82 (−54 to 98)
Embolism due to cardiac device	≤10[a]	≤10[a]	−1 (−1430 to 93)
Device-related complication[b]	1.7 (1.5 to 1.9)	3.3 (3.0 to 3.7)	49 (33 to 61)
Other complications	1.6 (1.3 to 1.8)	0.8 (0.7 to 1.0)	−88 (−179 to 27)
Pericarditis	1.2 (1.0 to 1.5)	0.5 (0.4 to 0.6)	−161 (−316 to 63)
Hemothorax	0.4 (0.3 to 0.5)	0.4 (0.3 to 0.5)	1 (−102 to 51)

Abbreviation: CIF, cumulative incidence function.

[a] Cells with 10 or less patients were suppressed to protect beneficiary privacy as required by the US Centers of Medicare & Medicaid Services.

[b] Includes complications related to the mechanical integrity of the device or codes explicitly stating device relatedness (eg, device dislodgement, device infection, device pocket complication). See eTable 1 in the Supplement for details.

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Il confronto

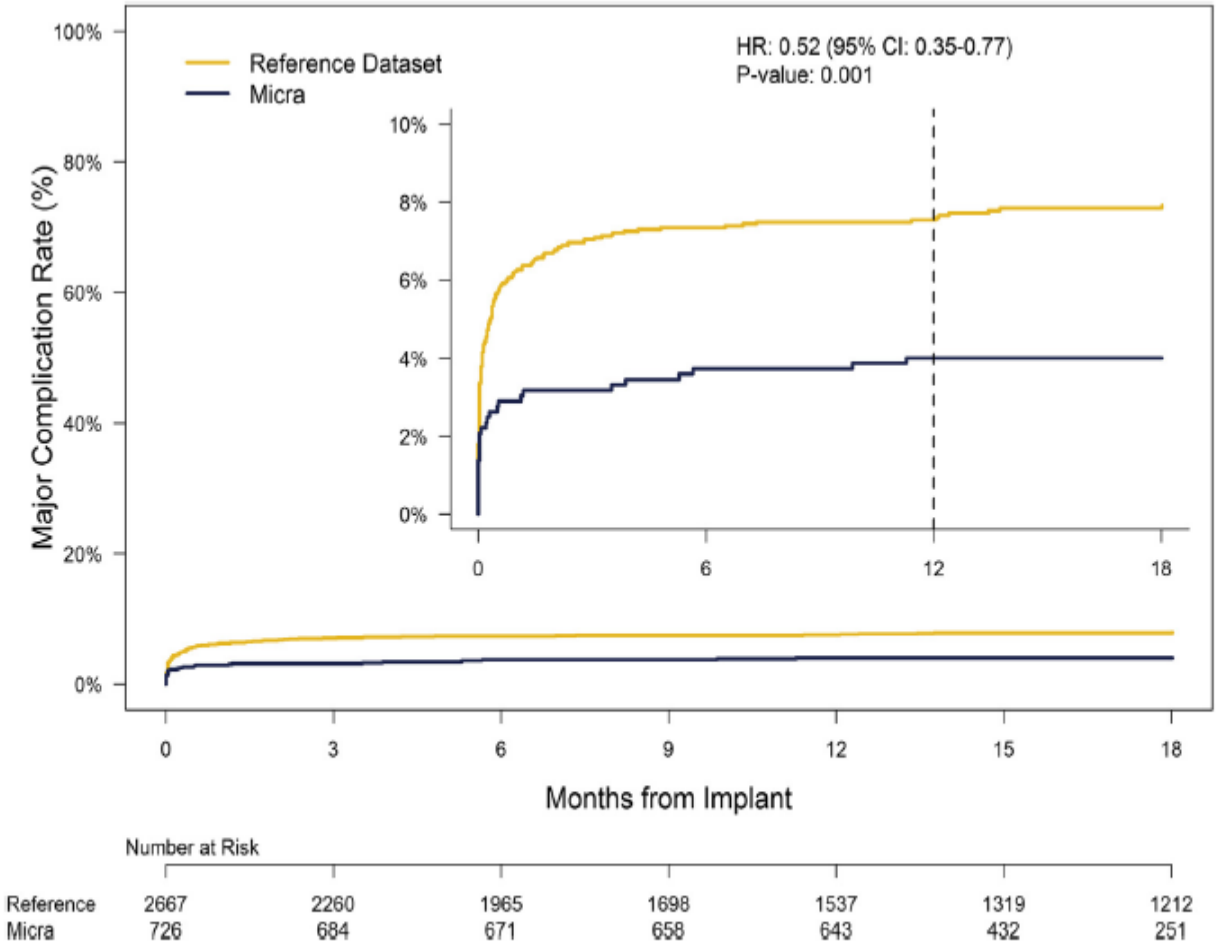


Figure 1 Major complication rate through 18 months postimplant for Micra and transvenous control cohorts. Subdistributional hazard ratio derived from data through 365 days postimplant for each cohort by comparing the cumulative incidence functions to the left of the dashed line. CI = confidence interval; HR = hazard ratio.

Duray et al. Heart Rhythm 2017; 14: 1375

A maggior rischio di complicanze

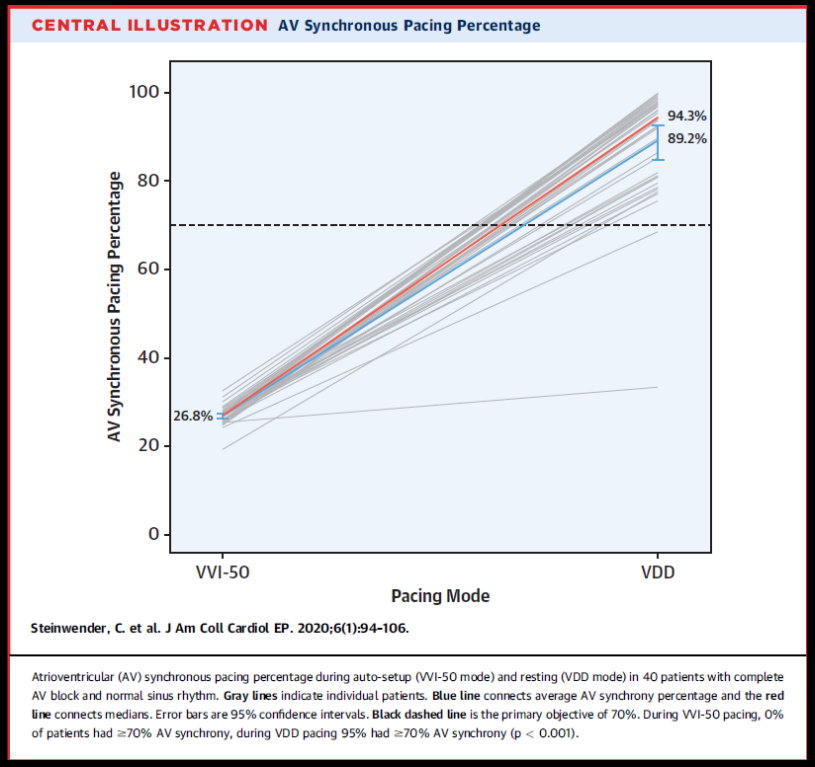
- Anziani
- Donne fragili
- Soggetti con basso BMI
- BPCO
- Pz in terapia steroidea cronica
- Plurimi riposizionamenti
- Impianti apicali

Le indicazioni

- FA a bassa fvm
- BAV parossistici, MNS, sincope con attesa bassa percentuale di pacing

VDD

- Accelerometro tridimensionale
- Sincronismo in ortostatismo 70%
- Valido fino a Fc 105 bpm



Le indicazioni

- Alto rischio di infezioni/pregressa infezione di device
- Alterato sistema venoso
  - precedente impianto di PM
  - Infezione cateteri a permanenza
  - chirurgia toracica
  - radioterapia
- Dialisi
  - salvaguardare la fistola
  - prevenire le infezioni

Estrarre o abbandonare?

Estrarre o abbandonare?

- Estrarre
  - Pochi dati
  - Semba sicura e fattibile, non documentate perforazioni cardiache
  - Successo forse maggiore con Micra
  - Tempo dipendenza
- Abbandonare
  - Riprogrammare in 000
  - < 2% del volume del VD
  - Se ne possono lasciare 3
  - Durata totale 30-45 anni

Vantaggi e svantaggi

- Riduzione (25-50%) delle complicazioni tardive (> 3 mesi)
- Minor rischio di infezioni (gestibili senza rimozione del device)
- Durata minore della procedura
- Ripresa funzionale più rapida (guida autoveicoli)
- Vantaggi estetici
- Consente attività (caccia, golf) altrimenti difficoltose

- Maggior rischio di perforazione cardiaca
- Maggiori costi
- Indicazioni limitate
- Problematica dell'estrazione
- Addestramento operatori
- Minori funzioni del dispositivo
- Follow up di minore durata rispetto ai PM tradizionali

La seconda parte della relazione

- L’Elettrostimolazione

- La resincronizzazione

L'appetito viene mangiando…

La stimolazione leadless anche del ventricolo sinistro consentirebbe una CRT completamente libera da elettrocateteri.

Il sistema potrebbe essere indicato in numerosi contesti clinici:

pz con FA in cui impiantare una CRT de novo

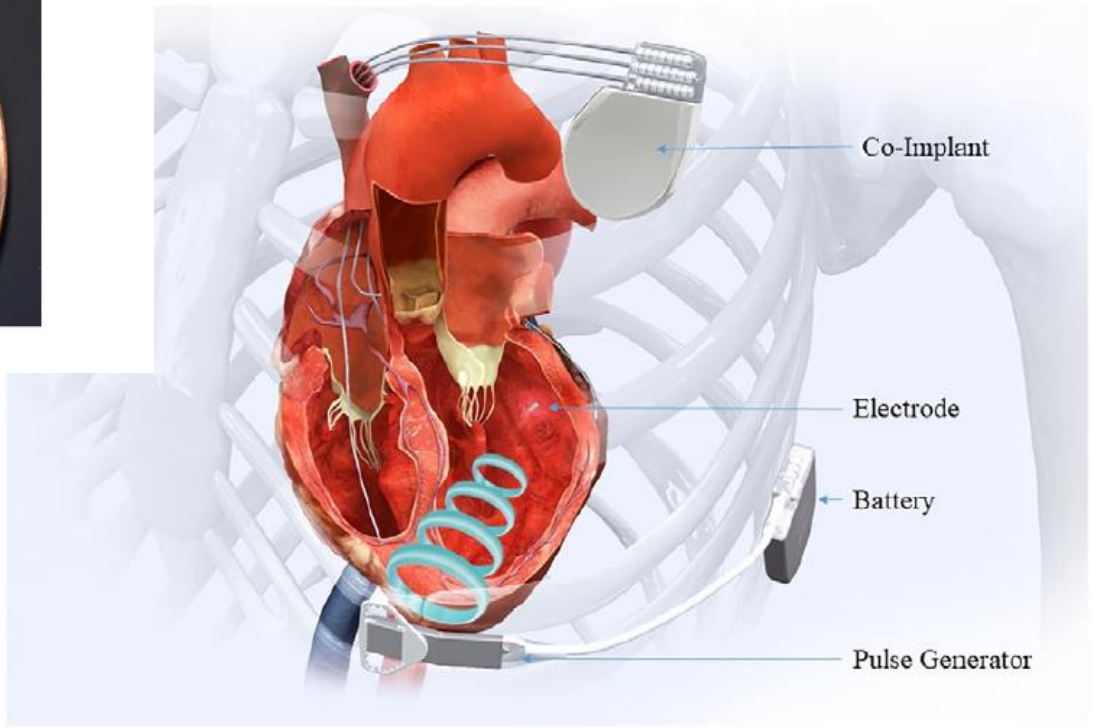
pz che, sottoposti ad un'elevata percentuale di stimolazione ventricolare destra col Micra, sviluppano una disfunzione ventricolare sinistra e che necessitano quindi di un upgrade del sistema

pz in cui l'impianto di una CRT tradizionale è fallito per problemi anatomici o procedurali

pz in cui, per la comparsa di un'infezione, è necessaria la rimozione di un sistema CRT precedentemente impiantato e in cui si stima il rischio di recidiva infettiva troppo elevato per consentire un reimpianto tradizionale.

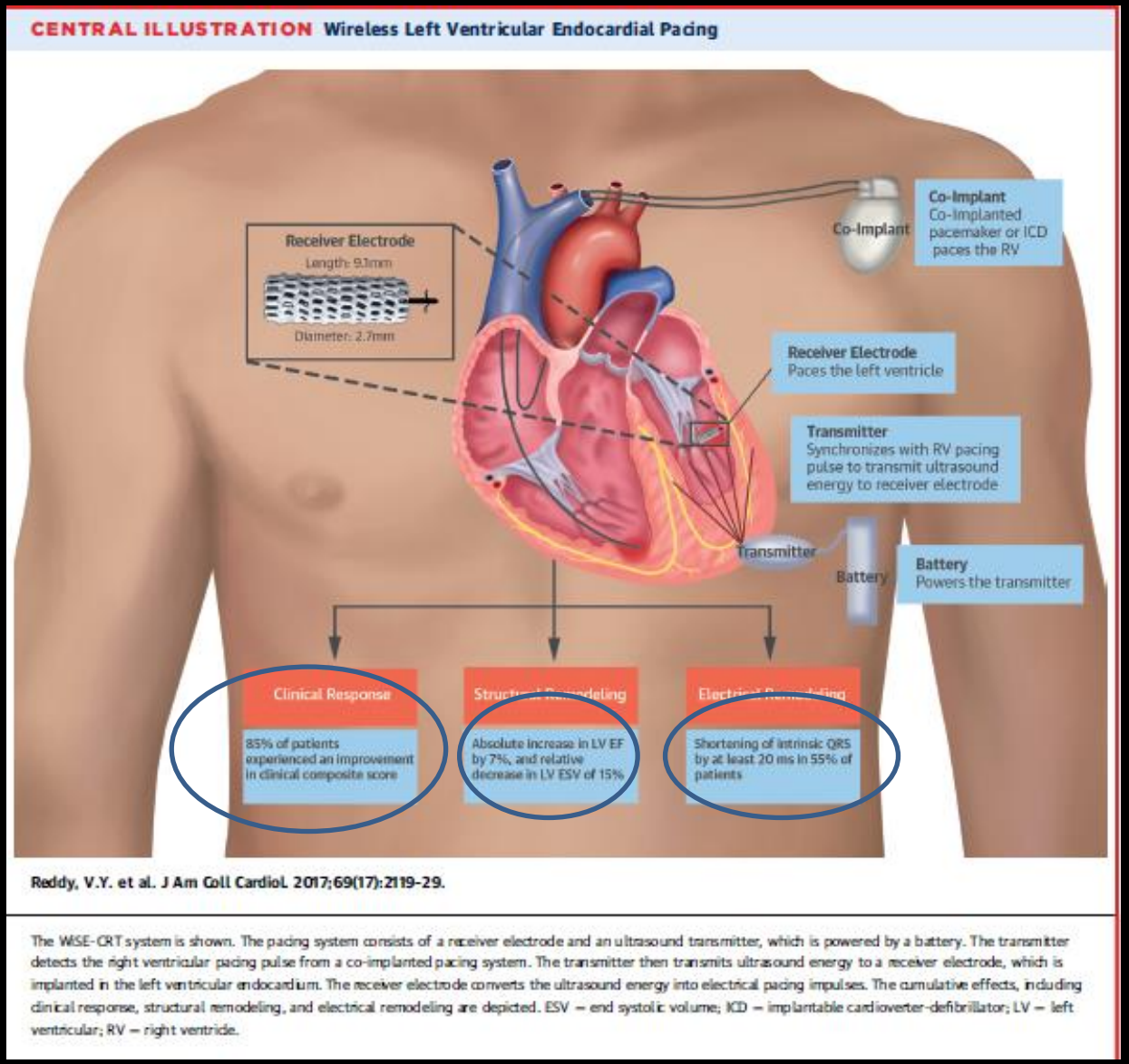
WISE-CRT

WiSE CRT System Electrode.



The wireless CRT system (WiSE-CRT, EBR Systems, Sunnyvale, California) consists of (1) a co-implanted cardiac rhythm management device, (2) a left ventricular endocardial electrode which receives ultrasound, converts it to electricity and immediately (≤5 ms) paces to administer CRT (3) a pulse generator module which emits directed ultrasound energy when right ventricular pacing is detected from the co-implant and (4) a battery.

SELECT-LV Study



Reddy et al. JACC 2017; 69: 2119

SELECT-LV Study

TABLE 3 Device- or Procedure-Related Adverse Events (n = 35)

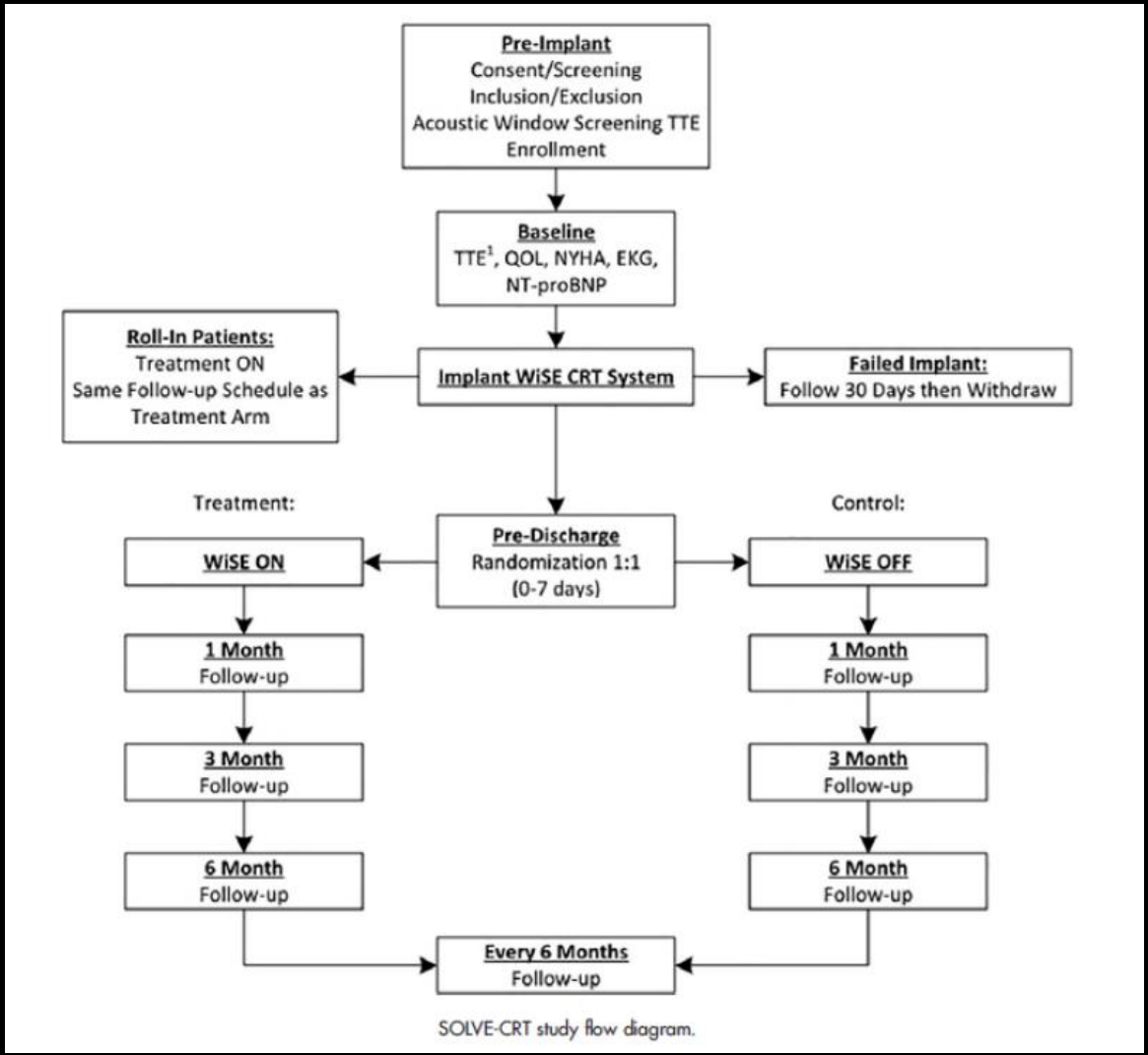
<24 h	3 (8.6%)
VF during catheter contact with LV endocardium	1
Electrode embolization to lower extremity	1
Femoral artery fistula (required surgical repair)	1
24 h to 1 month	8 (22.3)
Acute CVA (AF noncompliant with anticoagulation)	1
Femoral pseudoaneurysm	2
Pocket hematoma (generator)	1
Suspected infection (generator site)	3
Death (following VF during initial implant procedure)	1
1 to 6 months	3 (8.6)
Defective transmitter circuitry	3

Values are n (%) or n.

AF = atrial fibrillation; CVA = cerebrovascular accident; LV = left ventricular; VF = ventricular fibrillation.

Reddy et al. JACC 2017; 69: 2119

SOLVE-CRT Study



SOLVE-CRT study flow diagram.

Singh et al. Am Heart J 2019; 217: 13

WISE-CRT, limiti

- Connessione tramettitore-elettrodo
  - Severa (>45°) angolazione
  - Distanza > 10 cm
  - Assenza di buona finestra acustica (10%)
- Unica curva delivery sheath
  - Posizionamento in cuori marcatamente dilatati
- Rischio di eventi tromboembolici
- Elevato tasse di complicanze anche gravi
- Centri con maggiore expertise e con stand-by cardiochirurgico
- Mancata determinazione della percentuale di stimolazione BIV
- Esaurimenti in tempi diversi delle batterie con multiple sostituzioni (infezioni?)
- Miglioramento della CRT tradizionale (?)

Take Home Message

- La stimolazione leadless del VD è una realtà, specie in pz con indicazioni e caratteristiche cliniche precise, anche in assenza di studi randomizzati, comunque auspicabili
- La riduzione dei costi dei dispositivi e il miglioramento degli algoritmi di sincronizzazione AV ne sanciranno la futura maggiore diffusione

Take Home Message

La tecnologia leadless per la CRT, invece, è al momento opzione promettente ma ancora di nicchia, da limitare, specie in assenza di studi randomizzati, ai centri ad elevata specializzazione e nei pz in cui la CRT tradizionale è stata impossibile o inefficace


Grazie per
l'attenzione