Perioperative Management of Leadless Pacemakers

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Cardiac Anesthesia
MGH

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What I Will Review in this Lecture

- Anatomy and implantation
- Magnet use
- CXR assessment
- Rate response mode, MRI, and battery considerations
- Perioperative management of a patient with a LP

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Leadless Pacemakers

- **FDA Approved Devices:**
  - Medtronic Micra VR (2016)
    Micra AV (2020)
  - Abbott Aveir VR (2022)
    Aveir AR (2023)
- **Under Clinical Investigation:**
  - Boston Scien. Empower (2025?)

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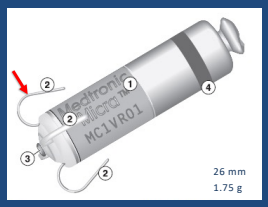
Micra VR (2016)

- Senses and paces the ventricle



A Leadless Intracardiac Transcatheter Pacing System
Reynolds, D. NEJM 2016; 37:533-41

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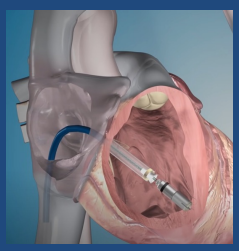
Catheter Based Insertion

1. Delivery catheter with pacemaker advanced into the RV through 27 Fr femoral sheath
2. Once the pacemaker is in good position, the device cup is retracted over the LP and the tines engage the myocardium



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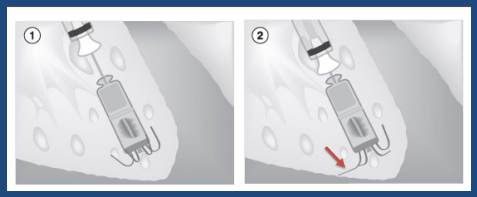
Pull and Hold Test



1. Device tines curved toward the device when LP deployed at the implant site.
2. Under traction, the engaged tines flare out

Micra User Manual

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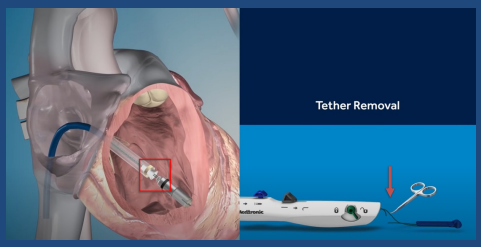
Releasing the Micra



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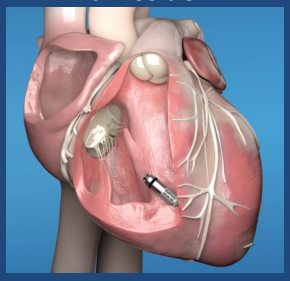
Final Position



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Micra VR Pacing Modes

- **VVI**
- **VVIR**
- VOO
- OVO
- Device Off

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Micra AV (2020)

- Paces and senses the ventricle
- Adds capability to track intrinsic atrial contractions

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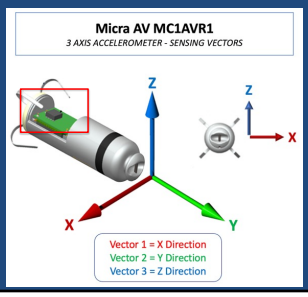
Micra Accelerometer Detects Atrial Contraction



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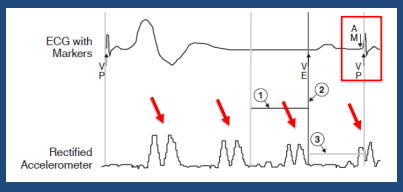
Four Intracardiac MECHANICAL Events Detected by the Accelerometer



Medtronic Micra User Manual

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Atrial Sensing Setup

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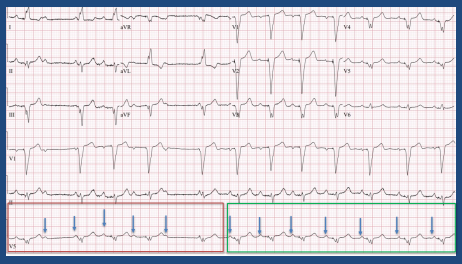
A-Sense V-Pace Variability



Arrows denote P-waves.
Poor tracking seen on left. Good tracking seen on right.

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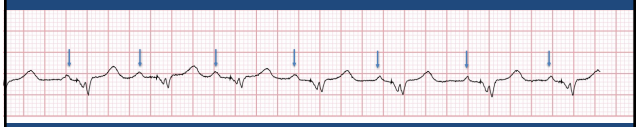
Good Tracking



Arrows denote P-waves.

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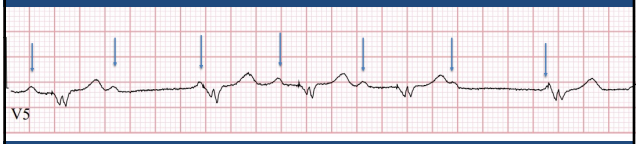
Poor Tracking



Arrows denote P-waves.

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Micra AV Pacing Modes

- **VDD**
- VDI
- VVI
- **VVIR**
- VVI+
- VOO
- ODO
- OVO
- Device off

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Aveir VR (2022)

- Senses and paces the ventricle
- Has a Reed Switch

Tang, et al JCTVA 36 (2022):4501-04

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Aveir VR Ventricular Leadless Pacemaker

- Placed through 27 Fr femoral venous sheath using steerable catheter-based system
- Active fixation mechanism used to secure the lead into the mid to lower interventricular septum
- Dome tip electrode facilitates parameter testing prior to fixation

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AVEIR VR Pacemaker Modes

- **VVI**
- **VVIR**
- VOO
- OVO
- Pacing Off

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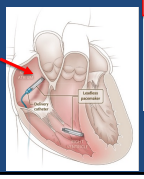
Aveir AR Leadless Pacemaker (2023)

- Implanted into the RAA
- Provides atrial sensing and pacing



Heart Rhythm May 2022 and NEJM June 22, 2023

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AVEIR AR Pacemaker Modes

- **AAI**
- AOO
- OAO
- Pacing Off

No rate response sensor in the Aveir AR, thus no AAIR

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Aveir DR Leadless Pacemaker System

- The Aveir AR communicates with the Aveir VR to facilitate DDD, dual-chamber pacing
- Many patients will have both Aveir leadless pacemakers
- "DR" indicates the patient has both: Aveir AR LP + Aveir VR LP

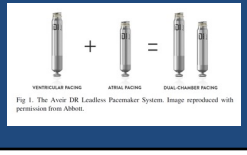
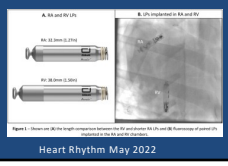


Fig 1. The Aveir DR Leadless Pacemaker System. Image reproduced with permission from Abbott.



Heart Rhythm May 2022

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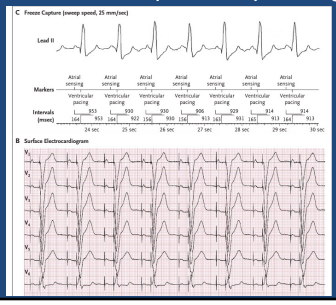
Aveir DR (AR + VR) Pacing Options



Atrial Tracking

AV Pacing

NEJM June 22, 2023

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Aveir DR LP System Pacing Modes

- **DDD(R)**
- **VVI(R)**
- AAI(R)
- **DDI(R)**
- VDD
- VDI
- VOO
- AOO
- ODO
- Pacer Off

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How Do Leadless Pacemakers Respond to a Magnet?

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Micra Magnet Response

- Micra/Micra AV pacemakers DO NOT respond to a magnet.
  - There is no Reed Switch/Hall Sensor
  - To convert the pacing mode to VOO, must use a Medtronic programmer

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Aveir Magnet Response

- The Aveir AR and VR pacemakers DO RESPOND to a standard magnet
  - They do have a Reed Switch

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Aveir Magnet Response: Where to Place the Magnet?

- Aveir AR Atrial LP: Place magnet on right side of sternum 3rd-4th ICS
- Aveir VR Ventricular LP : Place magnet on left side of sternum 5th ICS

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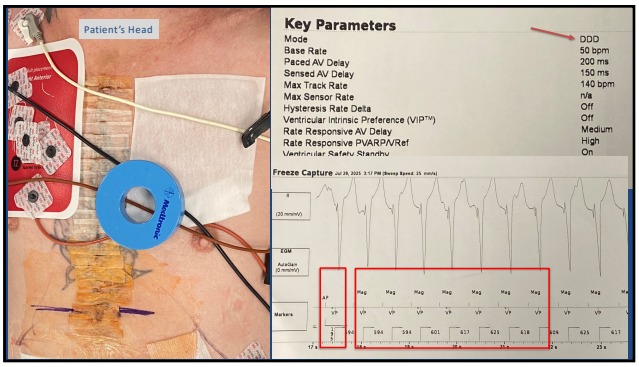

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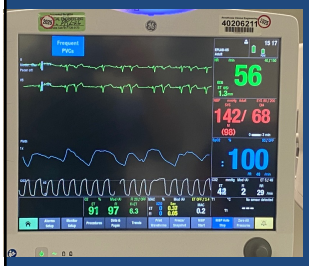

DDD without Magnet

VOO with magnet

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Aveir Magnet Response: What Rate?

- Magnet rate based on remaining battery life
  - 5 beats at 100 bpm, then battery indicated rate (100 to 85 bpm)

Table 13. Pacing rates following magnet detection (prior to RRT)

Battery Voltage	Magnet Rate
3.0 > V_{batt} ≥2.9 V	97 bpm
2.9 > V_{batt} ≥2.8 V	94 bpm
2.8 > V_{batt} ≥2.7 V	91 bpm
2.7 > V_{batt} ≥2.6 V	88 bpm
2.6 > V_{batt}	85 bpm

Abbott Aveir Technical Manual p. 65

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What if the Magnet does not Work?

- Abbott recognizes that magnet use may be more challenging than with standard pacemakers:

The effectiveness of magnets varies. If one magnet does not cause magnet response, place a second magnet on top of the first or try a different magnet. Pressing firmly on the magnet to decrease the distance between the magnet and the pulse generator can also help.

Abbott Aveir Technical Manual p. 65

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Aveir Magnet Response: Which Pacing Mode Occurs with Magnet Application?

1. Aveir AR Atrial LP only: Magnet induces AOO pacing
2. Aveir VR Ventricular LP only: Magnet induces VOO pacing
3. Aveir DR Atrial and Ventricular LP: magnet mode depends on the programmed mode:
   - If AAI(R) mode: Magnet over Atrial LP induces AOO pacing
   - If VVI(R) mode: Magnet over Ventricular LP induces **VOO** pacing
   - If DDD(R) mode: Magnet over Ventricular LP induces **VOO** pacing

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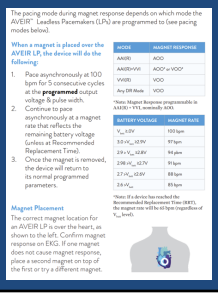
AVEIR Magnet Summary Sheet



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Abbott Aveir Magnet Response: Programmability

- As is the case with standard Abbott pacemakers, the magnet response can be turned OFF
  - This programming is rare
- To know for sure how the Aveir LP will respond to a magnet:
  - Check for a response to a magnet
  - Use a programmer to determine the MAGNET RESPONSE setting

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Abbott Aveir Magnet Summary

- Assuming the Magnet Response is programmed ON:
  - Aveir AR: AOO pacing at rate determined by the remaining battery life (100→85) until RRT
  - Aveir VR: VOO pacing at rate determined by the remaining battery life (100→85) until RRT
  - The Aveir DR system:
    - Atrial pacing mode→place magnet over Atrial device→AOO pacing
    - Ventricular pacing mode→place magnet over Vent. Device→VOO pacing
    - Dual chamber mode→place magnet over the Vent. Device→VOO pacing

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What Can You Determine with a CXR?

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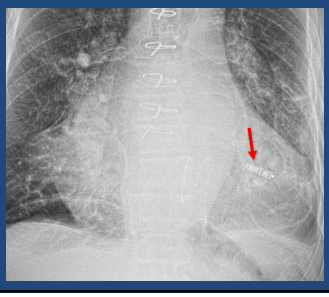
Micra CXR



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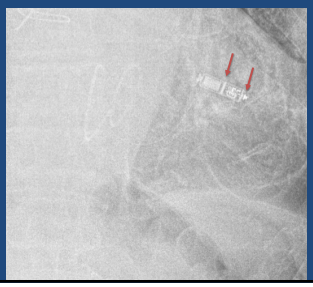
Micra CXR



Pertinent features:
1. Line in the middle
2. Bare cathode
3. Four Nitinol tines

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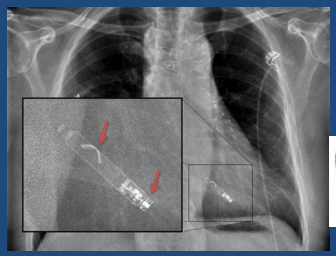
Aveir VR CXR



Pertinent Features
1. "V"
2. Active helix + cathode

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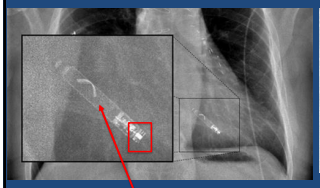
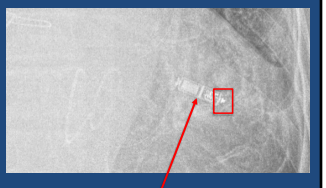
Simultaneous View





AVEIR MICRA

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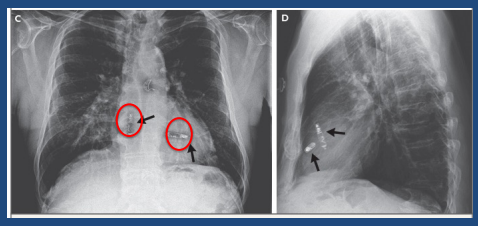
Aveir Dual Chamber Pacing System



NEJM June 22, 2023

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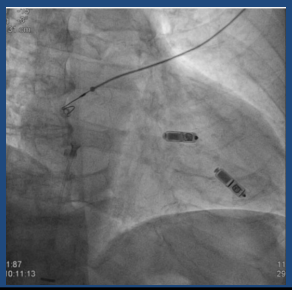
Micra: Two Pacemakers



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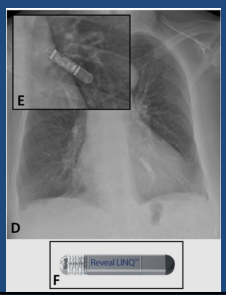
Implantable Cardiac Rhythm Monitor



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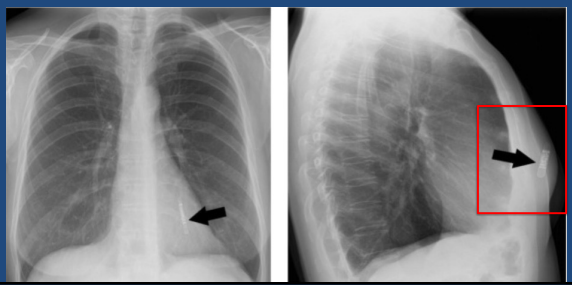
Internal Cardiac Monitoring Device



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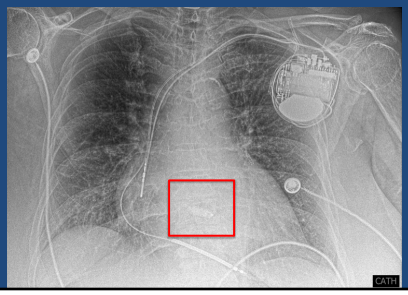
CXR of Patient with an ICD and LP



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Five CXR Interpretation Take Home Points

- You can differentiate a Micra from an Aveir with a good quality CXR
- If you see one leadless pacemaker in the atrium and one in the ventricle, they represent the Aveir DR system
- Some patients will have two leadless ventricular pacemakers—but only one will be active
- Some patients will have a conventional pacemaker or ICD in addition to the leadless pacemaker
- The leadless pacemaker may be difficult to see in poor quality CXR's

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Special Functions/Considerations for the Micra and Aveir Leadless Pacemakers

- Rate response mode
- MRI Exposure
- Noise Reversion Mode
- Hysteresis
- Battery Life Indicators
- Electrical Reset

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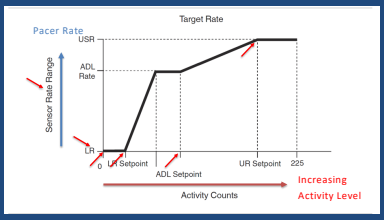
Micra Rate Response Mode: Accelerometer



Medtronic Micra User Manaul

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Rate Responsive Pacing

- Micra and Micra AV
  - Motion sensor (Accelerometer)
  - Patient movement will increase the pacing rate (LRL)
- Aveir VR
  - Temperature sensor
  - Body temperature changes increase the pacing rate (LRL)

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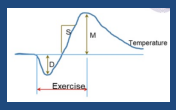
Aveir Temperature Sensor



- At onset of exercise central venous Temp DROPS (0.1-0.5 degree C)
- After approx. 5 minutes the Temp begins to rise
- At end of exercise, Temp gradually drops to baseline

- Sensor indicated rate increases with initial Temp drop and rises further based on timing and degree of Temp increase
- This could lead to pacing rate increases during the cooling associated with surgery and with rewarming during heart surgery

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Aveir Temperature Sensor

- Too early to know the implications of this sensor
- If wide temp fluctuations expected, best to suspend the RRM with a programmer.

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MRI Exposure

- Both devices are "MRI Conditional"
- Patients may have MRI's if the appropriate precautions are taken

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MRI Exposure

- How long does a patient have to wait for an MRI after implant?
  - Aveir devices—no wait
  - Micra VR and Micra AV—wait 6 weeks
  - Micra VR2 and Micra AV 2—no wait

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Noise Reversion Mode

- Both devices have optional Noise Reversion Modes (NRM)
  - Designed to prevent asystolic arrest caused by prolonged EMI
  - Continuous noise detected during the refractory period triggers the NRM
  - Pacemaker converts to temporary DOO or VOO pacing until the noise dissipates
- This may manifest in the OR as unexpected pacing after a burst of electrocautery use

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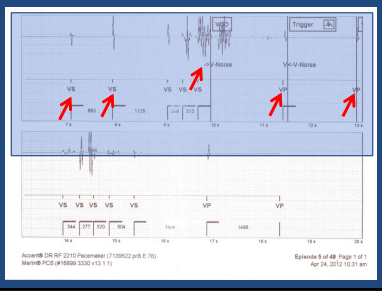
How Might You Notice the NRM in the OR?



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Rate Hysteresis

- Micra and Aveir pacemakers both have the option to have hysteresis programmed on
- When programmed on, the pacemaker will not start pacing at the Lower Rate Limit (LRL) until the patient's intrinsic heart rate falls below the LRL by 5-10 bpm

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Rate Hysteresis

Micra or Micra AV

- Hysteresis rate set at some rate below the LRL (60)

Aveir's hysteresis rate is set at some increment below the base rate

- Hysteresis: -5, -10 etc.

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Why Does Hysteresis Matter to You?

- Imagine you have a patient whose pacemaker has a Lower Rate Limit of 60.
- You might see a non-paced rhythm at 55 and wonder if the pacer is malfunctioning

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Medtronic Micra AV Mode Switching

- AV conduction mode switch
  - Programmable option
  - Attempts to reduce V-pacing by converting to VVI+ at 40 to periodically assess the need to continue V-pacing
  - If AV conduction is intact (a ventricular rate exceeds 40), the pacer stays in the VVI+ mode—and will not track the intrinsic atrial rhythm and will not pace the ventricle
  - This means that the pacemaker will not pace if the patient's intrinsic ventricular rate is 41 or higher

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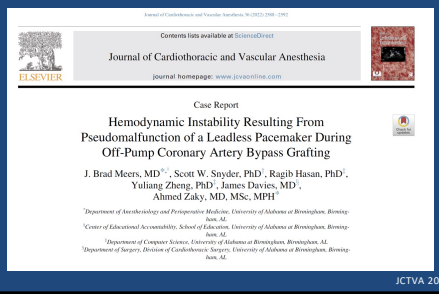
Why Am I Telling You About The AV Mode Switch?



Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Case Report

Hemodynamic Instability Resulting From Pseudomalfunction of a Leadless Pacemaker During Off-Pump Coronary Artery Bypass Grafting

J. Brad Meers, MD[a,*], Scott W. Snyder, PhD[b], Ragib Hasan, PhD[c], Yuliang Zheng, PhD[c], James Davies, MD[d], Ahmed Zaky, MD, MSc, MPH[a]

JCTVA 2022; 36:2588-2592

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Trouble with AV Mode Switch

- The patient's pacemaker was in the VDD mode with a LRL of 60
- The patient was NOT pacemaker dependent preoperatively
- AV Mode Switch was programmed ON so pacemaker periodically went to VVI+ to check for intrinsic ventricular conduction
- Because the patient had a ventricular rate in the 40's, the device stayed VVI+ at 40
- During the off-pump CABG, the HR fell into the low 40's and the BP fell significantly
- The team was expecting the device to V-pace at the LRL of 60, but it did not
- The team placed atrial pacing wires, also expecting the pacemaker to track the higher paced atrial rate (assuming the pacer was still in the VDD mode)
- The bradycardia did not respond to atrial pacing because the device stayed in the VVI+ mode and confusion ensued
- One treatment option would have been to suspend the AV Mode Switch

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Micra Battery Life Indicators

- RRT 180 days prior to End of Service (EOS)
  Normal device function
- ERI 90 days prior to EOS
  Pacer reverts to VVI at 65
- EOS 90 days after ERI or
  Battery < 2.5 V for 3 consecutive days
  Device permanently deactivated

RRT-recommended replacement time
ERI-elective replacement indicator
EOS-end of service

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Aveir Battery Life Indicators

- RRT Battery < 2.71 V for 3 consec. days
  Device has approx 9.5 mos prior to EOS
  Magnet induced pacing rate = 65
  RRM sensor turns off
- EOS Battery < 2.2 V
  Device permanently deactivated

RRT-recommended replacement time
EOS-end of service

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Take Home Message re: Battery Life

- Always determine the battery life preop
  - If a Micra LP is pacing at **65**, it is likely at ERI
  - If an Aveir magnet rate is 65, it is at RRT
  - If at **ERI or RRT** consider consulting the EP team to ensure the battery will make it through the case
  - If you cannot do this, ensure backup pacing option

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Electrical Reset

- Exposure to strong magnetic field or high intensity EMI causes the pacer to power off and reset
  - Medtronic Micras
    - Paces VVI at 65 upon reset
    - Must use Medtronic programmer to re-establish intended mode and rate
  - Abbott Aveir Pacer
    - Paces VVI at 70 and ventricular output at 6 V
    - Must use Abbott programmer to re-establish baseline settings

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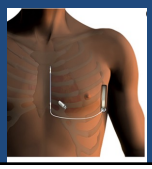
Boston Scientific Empower RV Leadless Pacemaker

- Still in clinical trials
- Will communicate with Boston Scientific S-ICD's
  - The S-ICD can detect VT and use the Empower LP to deliver anti-tachy pacing prior to delivering shocks
  - Will provide VVI pacing that the S-ICD cannot



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Anesthesia for Leadless Pacemaker Implantation

- Femoral sheath for device delivery is large (27 Fr)
- Takes 1-3 hours
- Typically done with MAC; occasionally with nursing sedation; rarely with general anesthesia
- Ensure adequate IV access, a blood bank sample, and cardiac surgical backup.
- Complications infrequent but can be significant

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Leadless Pacemaker Insertion Complications

- Cardiac Perforation
  - May be higher incidence and severity than standard pacemaker
  - Typically presents during insertion, but may occur weeks to months later
  - Tx is catheter drainage or cardiac surgery

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FDA Letter Nov 17, 2021

Leadless Pacing Systems: Risk of Major Complications Related to Cardiac Perforation During Implantation - Letter to Health Care Providers

"Since 2016, 300 medical device reports describe a perforation, and over 90 of these described a perforation resulting in death"

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Take Home Message

- Have good IV access, an active blood bank sample, and immediate access to cardiac surgery.

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Perioperative Management of a Patient with a Leadless Pacemaker

1. Obtain Device Information
2. Obtain Surgical Plan
3. Determine Intraoperative Management Plan
4. Interrogate device Post-op if indicated

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Perioperative Management of a Patient with a Leadless Pacemaker

1. **Obtain Device Information:**
   - Device manufacturer and model
   - Last Interrogation
   - Battery status
   - % pacing (pacer dependence)
   - Underlying rhythm
   - Device settings
     - Mode
     - Rate
     - RRM

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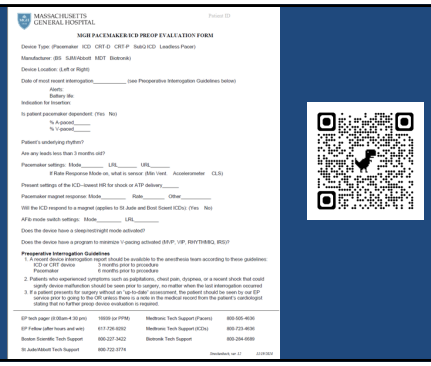
MASSACHUSETTS GENERAL HOSPITAL

MGH PACEMAKER/ICD PREOP EVALUATION FORM

Device Type: (Pacemaker ICD CRT-D CRT-P SubQ ICD Leadless Pacer)

Manufacturer: (BS SJM/Abbott MDT Biotronik)

Device Location: (Left or Right)

Date of most recent interrogation_____ (see Preoperative Interrogation Guidelines below)

Alerts:

Battery life:

Indication for Insertion:

Is patient pacemaker dependent: (Yes No)

% A-paced_____

% V-paced_____

Patient's underlying rhythm?

Are any leads less than 3 months old?

Pacemaker settings: Mode_____ LRL_____ URL_____

If Rate Response Mode on, what is sensor: (Min Vent. Accelerometer CLS)

Present settings of the ICD--lowest HR for shock or ATP delivery_____

Pacemaker magnet response: Mode_____ Rate_____ Other_____

Will the ICD respond to a magnet (applies to St Jude and Bost Scient ICDs): (Yes No)

AFib mode switch settings: Mode_____ LRL_____

Does the device have a Sleep/Rest/Night mode activated?

Does the device have a program to minimize V-pacing activated (MVP, VIP, RHYTHMIQ, IRS)?

Preoperative Interrogation Guidelines

1. A recent device interrogation report should be available to the anesthesia team according to these guidelines:
   ICD or CRT device: 3 months prior to procedure
   Pacemaker: 6 months prior to procedure
2. Patients who experienced symptoms such as palpitations, chest pain, dyspnea, or a recent shock that could signify device malfunction should be seen prior to surgery, no matter when the last interrogation occurred
3. If a patient presents for surgery without an "up-to-date" assessment, the patient should be seen by our EP service prior to going to the OR unless there is a note in the medical record from the patient's cardiologist stating that no further preop device evaluation is required.

EP tech pager (0:00am-4:30 pm)	19939 (or PPM)	Medtronic Tech Support (Pacers)	800-505-4636
EP Fellow (after hours and wkt)	617-726-9292	Medtronic Tech Support (ICDs)	800-723-4636
Boston Scientific Tech Support	800-227-3422	Biotronik Tech Support	800-284-6589
St Jude/Abbott Tech Support	800-722-3774		

Deidentified, ver. 3.7 12/19/2024

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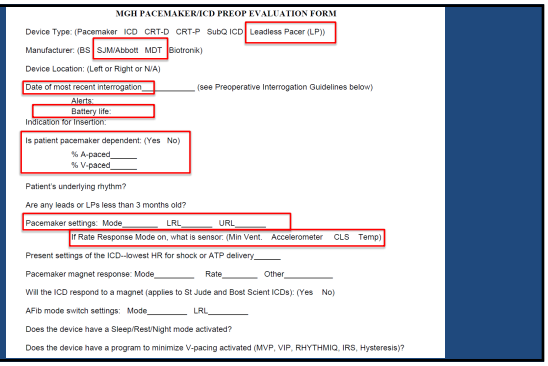
MGH PACEMAKER/ICD PREOP EVALUATION FORM

Device Type: (Pacemaker ICD CRT-D CRT-P SubQ ICD Leadless Pacer (LP))

Manufacturer: (BS SJM/Abbott MDT Biotronik)

Device Location: (Left or Right or N/A)

Date of most recent interrogation_____ (see Preoperative Interrogation Guidelines below)

Alerts:

Battery life:

Indication for Insertion:

Is patient pacemaker dependent: (Yes No)

% A-paced_____

% V-paced_____

Patient's underlying rhythm?

Are any leads or LPs less than 3 months old?

Pacemaker settings: Mode_____ LRL_____ URL_____

If Rate Response Mode on, what is sensor: (Min Vent. Accelerometer CLS Temp)

Present settings of the ICD--lowest HR for shock or ATP delivery_____

Pacemaker magnet response: Mode_____ Rate_____ Other_____

Will the ICD respond to a magnet (applies to St Jude and Bost Scient ICDs): (Yes No)

AFib mode switch settings: Mode_____ LRL_____

Does the device have a Sleep/Rest/Night mode activated?

Does the device have a program to minimize V-pacing activated (MVP, VIP, RHYTHMIQ, IRS, Hysteresis)?

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Perioperative Management of a Patient with a Leadless Pacemaker

2. **Obtain Surgical Plan**:
   - Need for cautery
     - None
     - Bipolar (always ask surgeon if this is an option)
     - Monopolar
   - Location of incision
   - Patient position

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Perioperative Management of a Patient with a Leadless Pacemaker

3. **Determine Intraoperative Management Plan**:
   - Leave device alone
   - Suspend the RRM—use programmer
   - Increase the pacing rate—use programmer
   - Convert the pacer to asynchronous pacing
     - Micra—use programmer
     - Aveir—may use magnet or programmer

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Converting Leadless Pacemakers to Asynchronous Pacing: Four Important Things to Remember

1. Converting the Micra or AVEIR to VOO or DOO ever-so-slightly increases the risk of R-on-T if patient has an underlying rhythm
2. Converting the Micra AV to VOO results in loss of A-V synchrony, which might significantly compromise BP.
3. Using a magnet to convert the Aveir DR to Asynchronous pacing results in VOO pacing, which might significantly compromise BP
4. If you want to convert an Aveir DR to DOO pacing, must use a programmer

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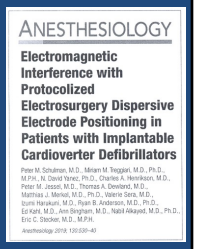
General Considerations for Patients with Leadless Pacemakers

1. Place electrocautery return pad optimally*
2. Use lowest effective cautery output
3. Be vigilant, especially if pacer VOO or DOO
4. Have back up pacing/defibrillator available
5. Consider fluoroscopy if placing a PA line within 1-3 months of LP implant (or TEE)


ANESTHESIOLOGY

Electromagnetic Interference with Protocolized Electrosurgery Dispersive Electrode Positioning in Patients with Implantable Cardioverter Defibrillators

Peter M. Schulman, M.D., Miriam M. Treggiari, M.D., Ph.D., M.P.H., N. David Yanez, Ph.D., Charles A. Henrikson, M.D., Peter M. Jessel, M.D., Thomas A. Dewland, M.D., Matthias J. Merkel, M.D., Ph.D., Valerie Sens, M.D., Izumi Harakumi, M.D., Ryan B. Anderson, M.D., Ph.D., Ed Kahl, M.D., Ann Bingham, M.D., Nabil Alkayed, M.D., Ph.D., Eric C. Stecker, M.D., M.P.H.

Anesthesiology 2019; 130:530–40

*Anesthesiology 2019 130:530-40

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What if the Patient with a LP needs to have an intracardiac device inserted?

- Pulmonary artery catheter
- Right atrial cannulation for CPB
- Right ventricular assist device

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What if the Patient with a LP needs to have an intracardiac device inserted?

- It is unclear when the LP is secure enough to prevent dislodgement and embolization
- If device implantation less than 3 months, check with implanting physician prior to RA or RV cannulation:
  - PA line placement with fluoroscopy may be prudent
  - If patient pacemaker dependent, it may be prudent to establish a back up pacing option (transcutaneous or transvenous)

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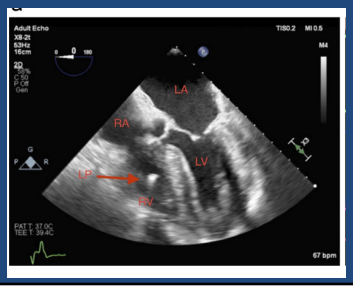
You Can Monitor the Leadless Pacemaker with TEE



J. Brad Meers et al; JCTVA 36 (2022) 2588-2592

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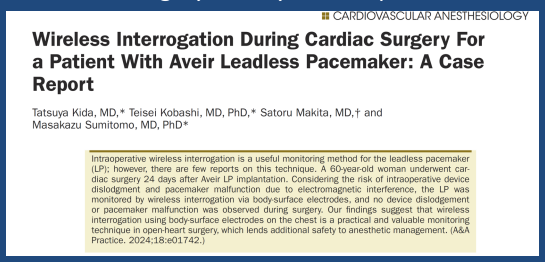
Intraoperative Monitoring of an Aveir VR during Heart Surgery Shortly after Implantation


CARDIOVASCULAR ANESTHESIOLOGY

Wireless Interrogation During Cardiac Surgery For a Patient With Aveir Leadless Pacemaker: A Case Report

Tatsuya Kida, MD,* Teisei Kobashi, MD, PhD,* Satoru Makita, MD,† and Masakazu Sumitomo, MD, PhD*

Intraoperative wireless interrogation is a useful monitoring method for the leadless pacemaker (LP); however, there are few reports on this technique. A 60-year-old woman underwent cardiac surgery 24 days after Aveir LP implantation. Considering the risk of intraoperative device dislodgment and pacemaker malfunction due to electromagnetic interference, the LP was monitored by wireless interrogation via body-surface electrodes, and no device dislodgement or pacemaker malfunction was observed during surgery. Our findings suggest that wireless interrogation using body-surface electrodes on the chest is a practical and valuable monitoring technique in open-heart surgery, which lends additional safety to anesthetic management. (A&A Practice. 2024;18:e01742.)

Kida et al. A and A Practice 2024;18e01742

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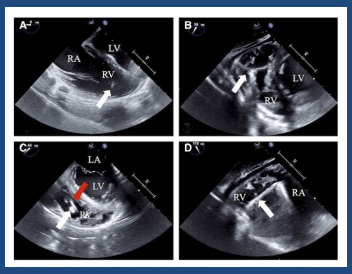
Using TEE to Monitor an Aveir Leadless Pacemaker



Kida et al. A and A Practice 2024;18e01742

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Take Home Messages

If device implantation less than 3 months would check with implanting physician prior to RA or RV cannulation

If patient pacemaker dependent, it may be prudent to establish a back up pacing option (transcutaneous or transvenous)

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Perioperative Management of a Patient with a Leadless Pacemaker

4. Postoperative Management
   - Abbott recommends full postop assessment if cautery is used:
     1. Programmer—check impedance, sensing amplitude, and capture threshold
     2. CXR—to assess device position
   - For the Micra, I suggest using the HRS/ASA Guidelines with a low threshold to request an interrogation

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Important Publications to Guide Periop Management

HRS/ASA Consensus Statement 2011

The Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement on the Perioperative Management of Patients with Implantable Defibrillators, Pacemakers and Arrhythmia Monitors: Facilities and Patient Management

This document was developed as a joint project with the American Society of Anesthesiologists (ASA), and in collaboration with the American Heart Association (AHA), and the Society of Thoracic Surgeons (STS)

George H. Crossley, MD, FHRS,[1] Jeanne E. Poole, MD, FHRS,[2] Marc A. Rozner, PhD, MD,[3A] Samuel J. Asirvatham, MD, FHRS,[4] Alan Cheng, MD, FHRS,[5] Mina K. Chung, MD, FHRS,[6] T. Bruce Ferguson, Jr., MD,[7A,B] John D. Gallagher, MD,[8] Michael R. Gold, MD, PhD, FHRS,[9A] Robert H. Hoyt, MD,[10] Samuel Ikefin, MD,[11A] Fred M. Kusumoto, MD, FHRS,[12] Liza Prudente Moorman, MSN, ACNP, FHRS,[13] Annemarie Thompson, MD[14C]

Heart Rhythm July 2011; 1114-1154

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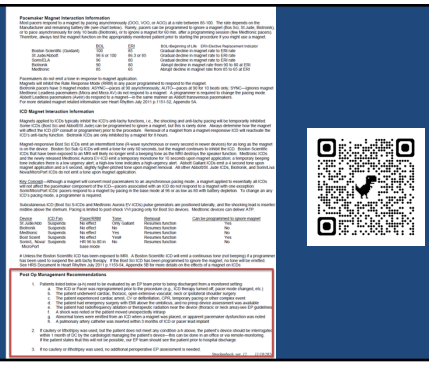

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Postoperative Management according to HRS

Post Op Management Recommendations

1. Patients listed below (a-h) need to be evaluated by an EP team prior to being discharged from a monitored setting:
   a. The ICD or Pacer was reprogrammed prior to the procedure (e.g., ICD therapy turned off, pacer mode changed, etc.)
   b. The patient underwent cardiac, thoracic, open extensive vascular, neck or ipsilateral shoulder surgery
   c. The patient experienced cardiac arrest, CV or defibrillation, CPR, temporary pacing or other complex event
   d. The patient had emergency surgery with EMI above the umbilicus, and no preop device assessment was available
   e. The patient had radiofrequency ablation or therapeutic radiation near the device (thoracic or neck area)-see EP guidelines
   f. A shock was noted or the patient moved unexpectedly intraop
   g. Abnormal tones were emitted from an ICD when a magnet was placed, or apparent pacemaker dysfunction was noted
   h. A pulmonary artery catheter was inserted within 3 months of ICD or pacer lead implant
2. If cautery or lithotripsy was used, but the patient does not meet any condition a-h above, the patient's device should be interrogated within 1 month of DC by the cardiologist managing the patient's device—this can be done in an office or via remote-monitoring. If the patient states that this will not be possible, our EP team should see the patient prior to hospital discharge.
3. If no cautery or lithotripsy was used, no additional perioperative EP assessment is needed.

Strackenbach, ver. 12 11/19/2024

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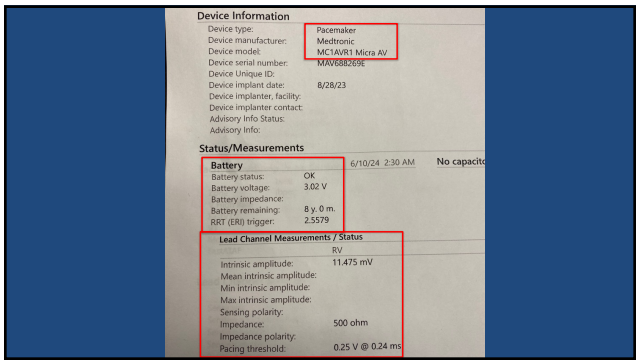

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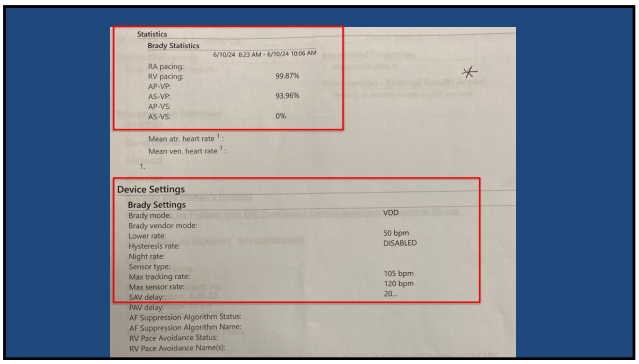

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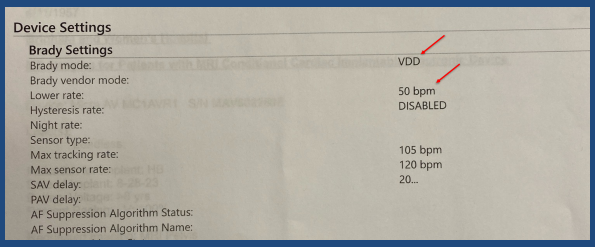
Programmed Settings



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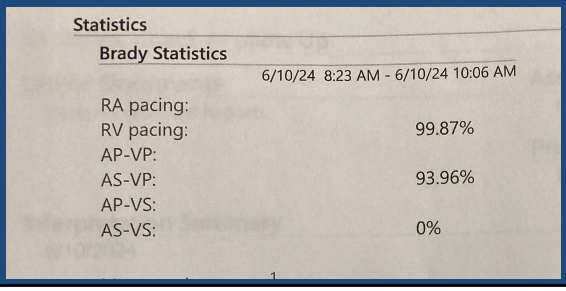
Pacing Statistics



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Clinical Example #1

- Converted the pacer to VOO and increased the base rate to 80 using a programmer
- A-V synchrony was sacrificed (DOO is not an option with a Micra AV)
- V-pacing was guaranteed even during cautery use

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Clinical Example #1

- Post op Interrogation done in OR
  - To confirm leadless pacemaker OK
  - To convert the device back to VDD with LRL 50.

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Summary

1. There are 2 leadless pacemaker brands being implanted: Micra and Aveir.
2. The Micra VR can deliver VVI, VVIR, and VOO pacing.
3. The Micra AV can track atrial contractions and deliver VDD pacing.
4. The Aveir VR paces the ventricle; the Aveir AR paces the atrium
5. The Aveir DR system provides DDD pacing
6. Micra LPs DO NOT respond to a magnet. To convert to VOO pacing, a Medtronic programmer is needed.
7. Aveir LPs DO respond to a magnet with AOO or VOO, but not DOO pacing.
8. LPs can include a rate response mode (Micras: Accelerometer; Aveir VR: Temp sensor).
9. All LPs can safely be exposed to MRI if required precautions are followed.
10. At ERI, the Micra LPs will pace at 65; the Aveir RRT magnet rate is 65.
11. Micra and Aveir LPs can be differentiated on a CXR or by their magnet response.
12. Periop Management: Obtain device settings, determine surgical needs, define intraop plan, interrogate post op when indicated.

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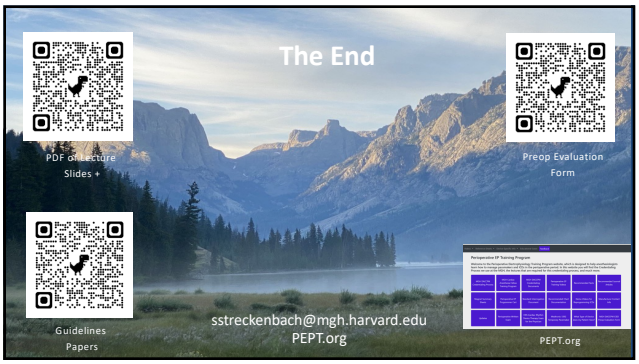

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