Endoscopic Electrosurgery in Patients with Cardiac Implantable Electronic Devices

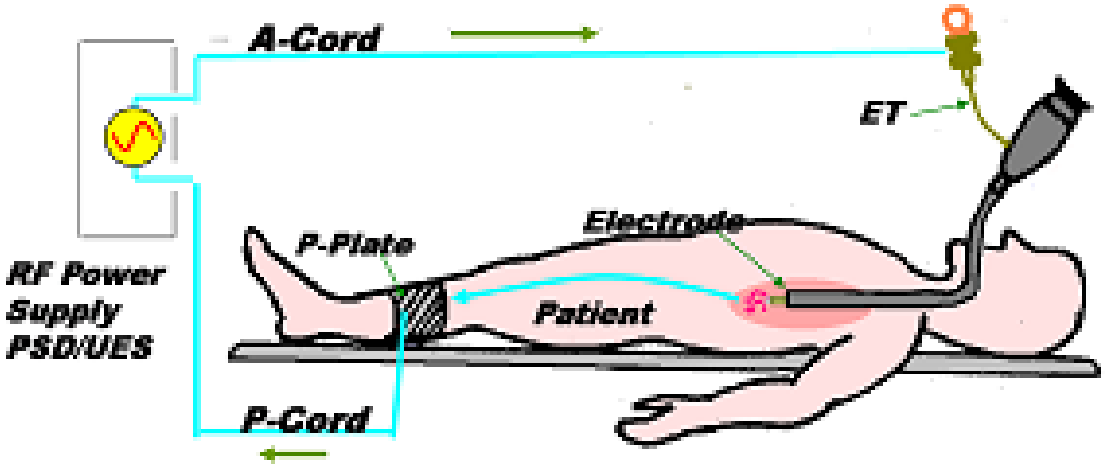
삼성서울병원 소화기내과 임상강사 이세옥

Endoscopic Electrosurgery in Patients with Cardiac Implantable Electronic Devices

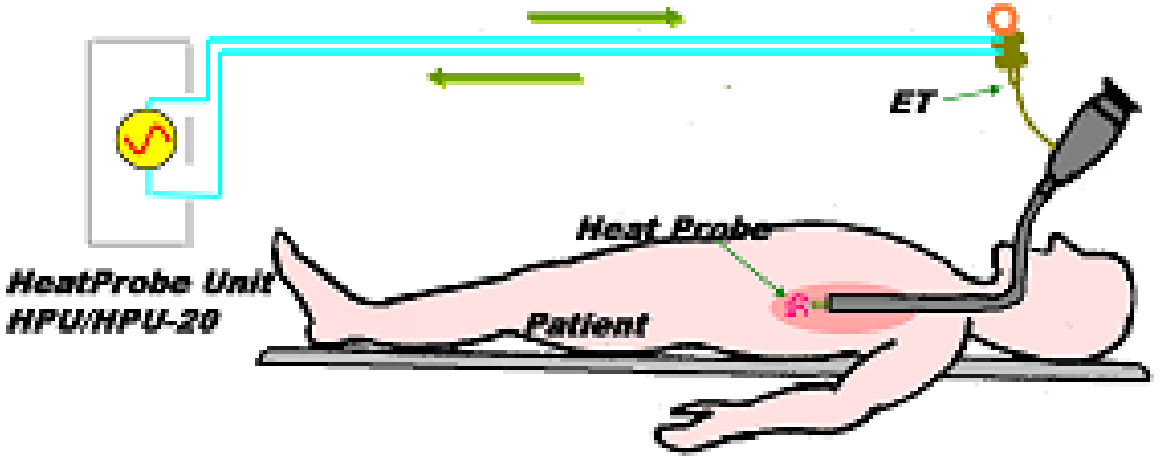
- Electromagnetic Interference (EMI)
- Cardiac Implantable Electronic Device (CIED)
  - Pacemaker (PPM)
  - Implantable Cardiac Defibrillator (ICD)
  - Cardiac Resynchronized Therapy (CRT)
- Effect of monopolar radiofrequency energy on pacemaker
- Perioperative Management of Patients with CIED
- Application Magnets on CIED

Electromagnetic Interference (EMI)

- Endoscopic electrosurgery
  - Polypectomy, fulguration of tissue, sphincterotomy, coagulation of bleeding vessels….
  - Unipolar, bipolar, multipolar devices



Unipolar(monopolar) system의 circuit.



Bipolar system의 circuit.

Electromagnetic Interference (EMI)

- ICDs, PPMs sense cardiac electrical activity using electrodes placed in the heart.
- It is possible for these system to detect electrical currents produced by an electrosurgical device as being intrinsic cardiac activity.

= Oversensing !

→ inappropriate reprogramming of the device
→ **PPM → pacing ↓**
→ **ICD → inappropriate Shock ↑**

Pacemaker (PPM)

Symptomatic bradycardia
AV block
Syncope
Heart failure

Sensing

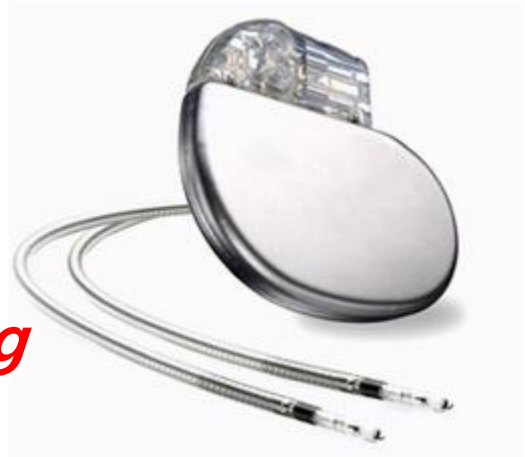
Pacing

dyssynchrony
→ wall motion abnormalites
→ stroke volume ↓

Pacemaker (PPM)

Symptomatic bradycardia
AV block
Syncope
Heart failure

Oversensing



~~**Pacing**~~

Electromagnetic Interference

How to manage pacemakers in the setting of potential EMI ?

- Whether a patient is **pacemaker dependent** or not

  - Adequate hemodynamic stability or cardiac rhythm cannot be maintained without assistance from the pacemaker
  - Complete AV block, no spontaneous ventricular activity, bradyarrhythmia resulting in syncope or hypotension

→ Interrogation, reprogramming of the pacemaker **should** occur immediately before and after the procedure.

How to manage pacemakers in the setting of potential EMI ?

Asynchronous pacing

- regular, uninhibited pacing in which the pacemaker has **no sensing** capability
- any interference detected as a result of electrosurgery will **not result in a pacemaker response**.
- by programming the pacemaker in the **VOO mode**, in which **a single ventricle** generates or in **DOO mode**, in which **both the atrium and ventricle** generate **a fixed interval rate with no relationship to a spontaneous rhythm**

Perioperative management of pacemaker-dependent patients

- **ACCF/AHA**
  (American College of Cardiology Foundation and the American Heart Association)
  - Specifically recommend that PPM be **reprogrammed to an asynchronous mode (VOO or DOO)** **throughout the entire procedure**.
  - **External pacing** can also be effective as long as it too is set the asynchronous mode that will be unaffected by cautery.

- **ASGE** (American Society for Gastrointestinal Endoscopy)
  - **Reprogramming** is only needed in pacemaker-dependent patients and in those in whom **prolonged electrocautery** is anticipated such as in the treatment of gastric antral vascular ectasia or radiation proctitis.

Perioperative management of PPM Pts

- If a patient is **not pacemaker dependent** or in procedures in which there will **not be prolonged use of electrocautery**,

  no further intervention is required.
- Apply **bipolar or multipolar** currents rather than unipolar currents whenever possible.
- Whenever **unipolar** cautery is required, place the **grounding pad** on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device.
- **Minimize the strength** of the electrosurgical current applied.
- Apply the electrosurgical current **intermittently** and for the **shortest** amount of time possible.

Effect of monopolar radiofrequency energy on pacemaker function

Surg Endosc (2012) 26:2784–2788
DOI 10.1007/s00464-012-2279-3

- **Cardiac implantable electronic devices (CIED)**
  - **350,000 annually in US, increasing by 4.7 % annually**
- **Monopolar Bovie**
  - **Monopolar instruments are used in virtually every operation.**
- **Guideline for Perioperative management of Patients with CIED**
  - "there are **no randomized trials** and **very few case series** to rely upon … many of the recommendations are based upon **the extensive experience** of the writing group" **rather than scientific evidence**

Aim

- To quantify the clinical parameters of mono- and bipolar instruments that inhibit pacemaker function.
- The specific aims of our study were to quantify pacemaker inhibition resulting from **monopolar** instruments by altering
  1. the generator power setting
  2. the generator mode (cut vs coagulation)
  3. the distance between the active electrode and the pacemaker
  4. the location of the dispersive electrode
  5. the activation technique (intermittent bursts vs continuous activation)
  6. the energy modality (monopolar vs bipolar instruments)
  7. the different monopolar generator manufacturers

Method (1)

- Pig overdrive paced

  (85 beats/min→the pacemaker 110 beats/min)
- Measurements were recorded by monitoring the electrocardiogram strip for dropped beats during activation of the mono- and bipolar instruments.
- Each experimental setup was tested with ten activations of the energy-based device.
- The active electrode
  coagulation mode vs cut mode

Method (2)

1. the generator power setting : 30W vs 60W
2. the generator mode : Cut vs coagulation
3. the distance between the active electrode and the pacemaker
   : 3.75cm vs 7.5cm vs 15cm vs 30 cm
4. the location of the dispersive electrode
   : right gluteus vs left gluteus
   vs right shoulder vs left shoulder
5. the activation technique
   : intermittent bursts (→1 s on and then 1 s off for 10 s)
   vs continuous activation (→ 5-s activations)
6. the energy modality (monopolar vs bipolar instruments)
7. the different monopolar generator manufacturers

Result

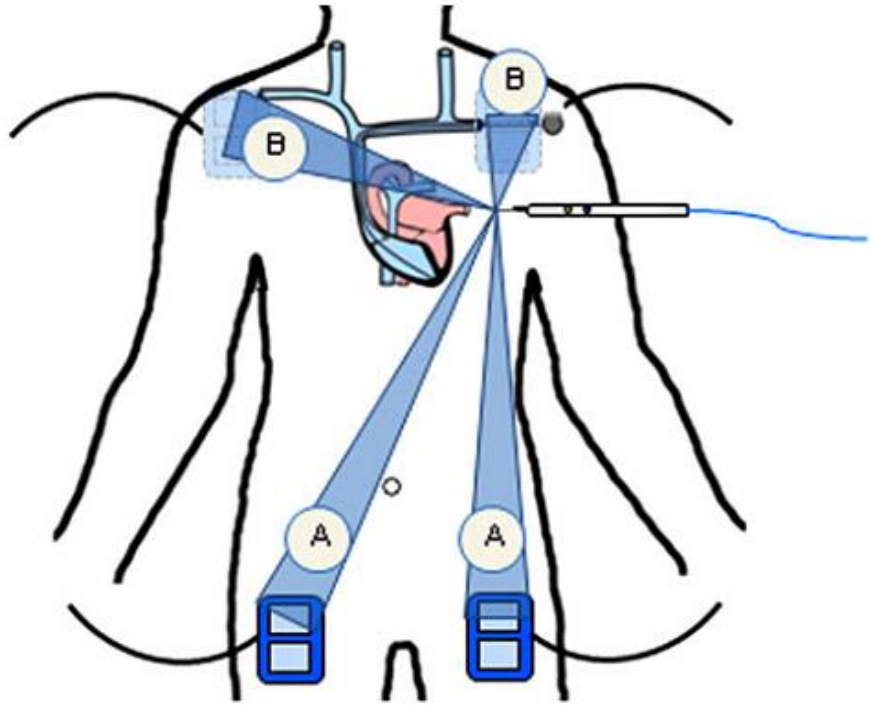
1. the generator power setting
   : **30W** vs 60W (**1.6** ± 0.8 vs 2.3 ± 1.2; p = 0.045)
2. the generator mode
   : **Cut** vs coagulation (**0.6** ± 0.5 vs 1.6 ± 0.8; p = 0.015)
3. the distance between the active electrode and the pacemaker
   : 3.75cm vs 7.5cm vs 15cm vs 30 cm

Table 1 Pacemaker inhibition and distance between the active electrode and the pacemaker generator

Dispersive electrode location	Distance from pacemaker generator (cm)				
	3.75	7.5	15	30	ANOVA *p* Value
Right gluteus	0 ± 0	0 ± 0	0.2 ± 0.5	0.1 ± 0.3	0.397
Left gluteus	0.2 ± 0.5	0.2 ± 0.5	0.2 ± 0.5	0 ± 0	0.801
Right posterior shoulder	1.0 ± 0.7	1.0 ± 0.7	1.4 ± 1.1	0.4 ± 0.5	0.306
Left posterior shoulder	1.8 ± 1.3	1.6 ± 1.1	2.2 ± 1.3	0.8 ± 0.8	0.314

Result

1. the generator power setting
   : **30W** vs 60W
2. the generator mode
   : **Cut** vs coagulation
3. ~~the distance between the active electrode and the pacemaker~~
   ~~: 3.75cm vs 7.5cm vs 15cm vs 30 cm~~
4. the location of the dispersive electrode
   : **right gluteus** vs **left gluteus**
   vs right shoulder vs left shoulder
   (**0.2** ± 0.4 vs 1.5 ± 1.0; p<0.001)



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4. the location of the dispersive electrode
   : **right gluteus** vs **left gluteus**
   vs right shoulder vs left shoulder
5. the activation technique
   : **intermittent** bursts vs continuous activation
   (**0.9** ± 0.6 vs 1.6 ± 0.8; p = 0.001)
6. the energy modality (monopolar vs bipolar instruments)
7. the different monopolar generator manufacturers

Result

1. the generator power setting
   : **30W** vs 60W
2. the generator mode
   : **Cut** vs coagulation
3. ~~the distance between the active electrode and the pacemaker~~
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4. the location of the dispersive electrode
   : **right gluteus** vs **left gluteus**
   vs right shoulder vs left shoulder
5. the activation technique
   : **intermittent** bursts vs continuous activation
6. the energy modality
   : When 30 and 60 W of power were used, **bipolar** instruments at both 0 and 7.5 cm from the pacemaker generator **dropped no paced beats** ($p<0.001$ vs monopolar instruments at both power settings and both distances)

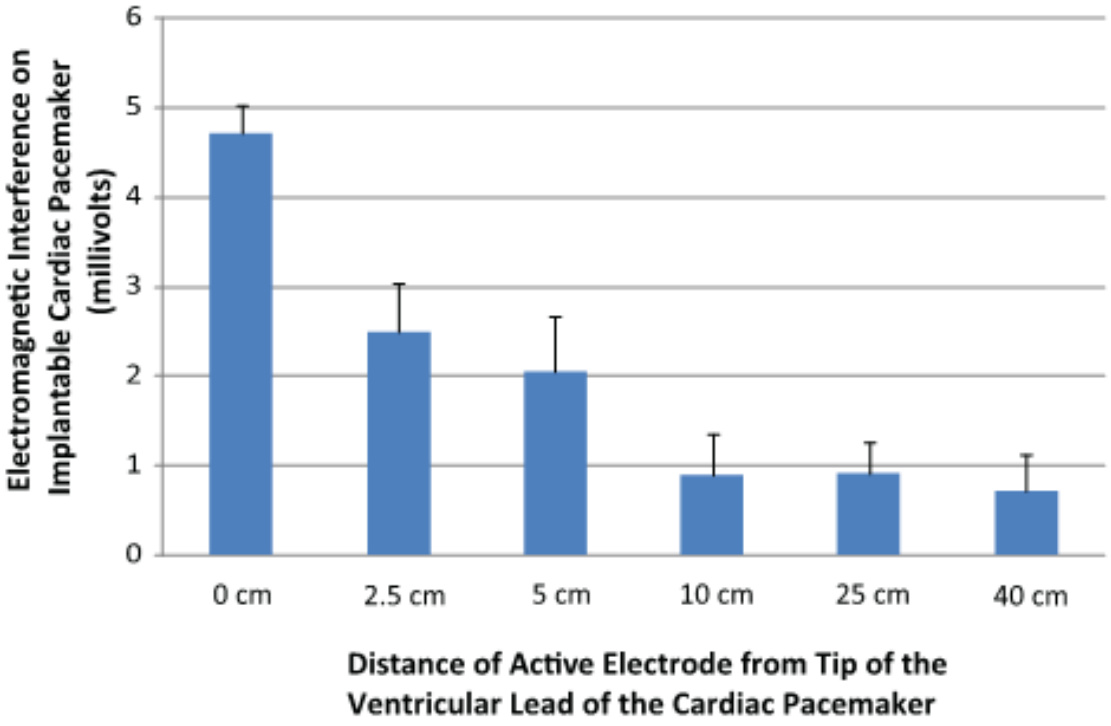
Result

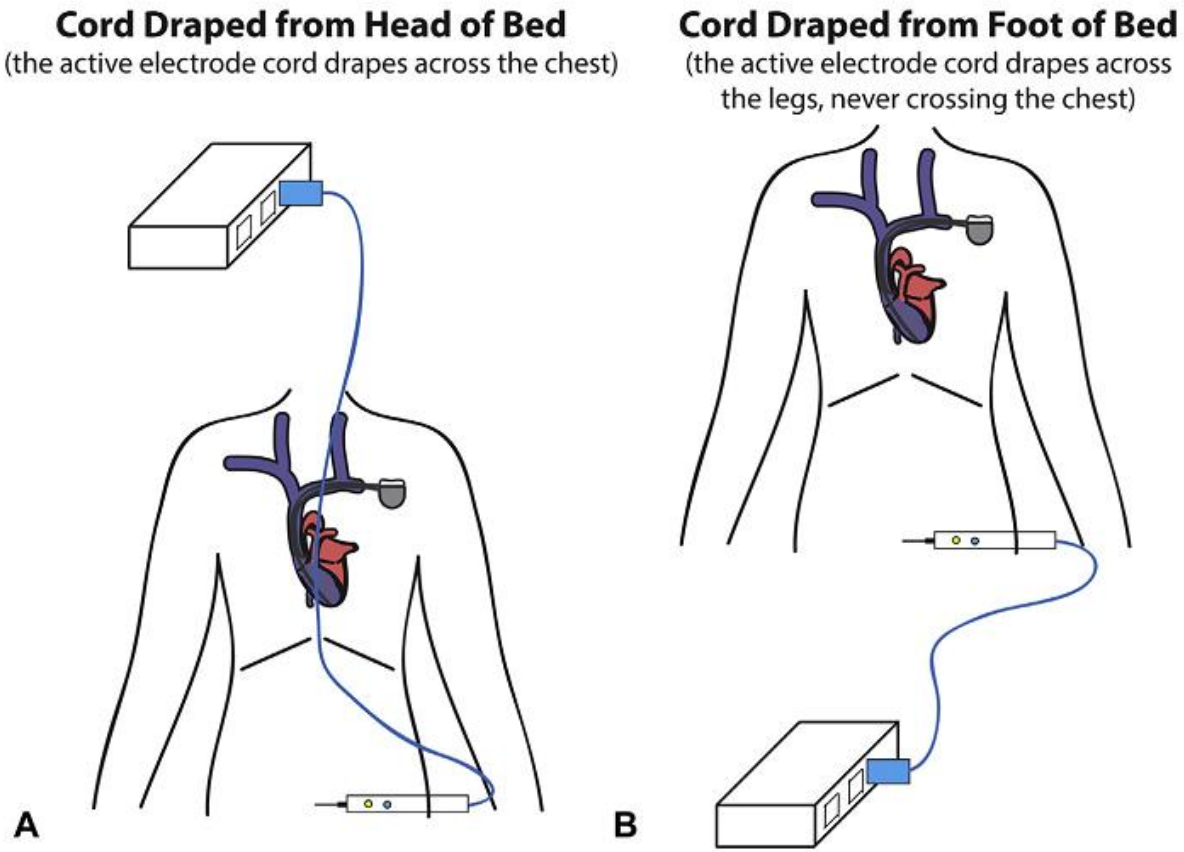
1. the generator power setting
   : **30W** vs 60W
2. the generator mode
   : **Cut** vs coagulation
3. ~~the distance between the active electrode and the pacemaker~~
   ~~: 3.75cm vs 7.5cm vs 15cm vs 30 cm~~
4. the location of the dispersive electrode
   : **right gluteus** vs **left gluteus**
   vs right shoulder vs left shoulder
5. the activation technique
   : **intermittent** bursts vs continuous activation
6. the energy modality (monopolar vs **bipolar** instruments)
7. ~~the different monopolar generator manufacturers~~
   ~~(1.2 ± 0.9 vs 1.6 ± 0.8; p = 0.307)~~

Effect of Radiofrequency Energy Emitted from Monopolar "Bovie" Instruments on Cardiac Implantable Electronic Devices

- The monopolar "Bovie" instrument emits radiofrequency energy that can disrupt the function of other implanted electronic devices through a phenomenon termed

"*Electromagnetic interference*"





Effect of Radiofrequency Energy Emitted from Monopolar "Bovie" Instruments on Cardiac Implantable Electronic Devices

Table 2. Measured Electromagnetic Interference on the Implantable Cardiac Device and Monopolar Generator Voltage Output in Clinically Modifiable Operative Scenarios

	Voltage magnitude of electrosurgery generator output, V_{RMS}		Maximum voltage* occurring on cardiac implanted device, mV	
	Mean ± SD	p Value	Mean ± SD	p Value
Aim 1: generator power setting, animal 3		0.260		<0.001
30 W	334 ± 53		1.7 ± 0.4	
60 W	309 ± 32		3.6 ± 0.2	
Aim 2: generator mode, animal 3		0.012		<0.001
Cut mode (30 W)	281 ± 18		0.4 ± 0.2	
Coag mode (30 W)	334 ± 53		1.7 ± 0.4	
Aim 3: surgical technique, animal 3		<0.001		<0.001
Desiccation (30 W)	67 ± 8		0.1 ± 0.02	
Fulguration (30 W)	334 ± 53		1.7 ± 0.4	
Aim 4: active electrode cord location, animal 3		0.112		<0.001
Cord extending from foot of bed across the legs	334 ± 53		1.7 ± 0.4	
Cord extending from head of bed across the chest	371 ± 46		2.4 ± 0.5	
Aim 5: tool-to-dispersive electrode current vector pathway, animal 3		0.300		<0.001
Vector not through cardiac device/leads	334 ± 53		1.7 ± 0.4	
Vector through cardiac device/leads	312 ± 40		3.1 ± 0.3	

Table 4. Comparing Current Practice Advisory Statements to Findings from this Study: Optimizing Use of the Monopolar Instrument in the Setting of a Cardiac Implantable Device

Current practice advisory statement	Evidence statement from this study
Generator power setting choice	
"Use… the lowest feasible energy levels"[2]	Statement confirmed: Lower generator power settings decrease the electromagnetic interference on the CIED
Generator mode choice	
Not addressed by guidelines	Cut mode should be used in preference to coag mode because of decreased electromagnetic interference (due to decreased voltage) occurring on the CIED
Surgical technique choice	
Not addressed by guidelines	Desiccation technique should be used in preference fulguration technique because of decreased electromagnetic interference occurring on the CIED
"Use short, intermittent and irregular bursts"[2] of the monopolar instrument	Not addressed by this study
Active electrode cord location choice	
Not addressed by guidelines	The active electrode cord should be oriented from the foot of the bed (avoiding proximity of the cord and the CIED) in preference to draping the cord from the head of the bed across the chest (in close proximity to the CIED)
Current vector pathway choice	
"Assure that the electrosurgical receiving plate is positioned so the current pathway does not pass through or near the CIED"[2]	Statement confirmed: The dispersive electrode should be positioned to avoid the current vector (the line between the active electrode tip and the dispersive electrode) traveling through the generator/leads
Proximity of active electrode to CIED choice	
"Avoid proximity of the cautery's* electrical field to the pulse generator or leads"[2]	Statement confirmed: There is decreased electromagnetic interference on the CIED with increasing distance between the active electrode tip and the generator/leads
"Electrosurgery applied below the umbilicus is much less likely to cause… interference"[3]	Statement confirmed: The study confirms this statement noting 3 points: the dispersive electrode should be placed ensuring the current vector travels away from the generator/leads; the distance between the ventricular tip lead and the umbilicus needs to be a minimum of 10 cm; and electromagnetic interference occurs even at 40 cm from the CIED system

TABLE 1. Pacemakers: recommendations for managing pacemakers in the setting of electrosurgical procedures

	Pre-procedure	During procedure	Post-procedure
Universal recommendations	1. Assess the type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. Determine whether the patient is pacemaker dependent and attempt to predict whether prolonged electromagnetic current will be needed. a. If patient is not pacemaker dependent, then no reprogramming is necessary. b. If pacemaker dependent and prolonged electrocautery may be required, see specific recommendations below.	1. Closely monitor vital signs and heart rhythms with electrocardiography during the procedure. The patient should be monitored continuously via hard-wired monitoring. 2. Cardioverter-defibrillation equipment should readily available. 3. Use alternative methods to electrocautery whenever possible. 4. Apply bipolar or multipolar currents rather than unipolar currents whenever possible. 5. Whenever unipolar cautery is required, place the grounding pad on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device. 6. Minimize the strength of the electrosurgical current applied. 7. Apply the electrosurgical current intermittently and for the shortest amount of time possible. 8. External pacing can be effective. It can be set to the asynchronous mode and will be unaffected by cautery.	1. If the pacemaker or ICD was reprogrammed, restore baseline function of the device. 2. There is no need for further follow-up if the device is interrogated after the procedure.
AACF/AHA	1. Procedure team should be responsible for determining type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. If pacemaker dependent and prolonged electrocautery may be required, the pacemaker should be reprogrammed to the asynchronous mode for the duration of the procedure.		1. Restore baseline settings and closely monitor the patient in the immediate postprocedural period, but no need for specific consultation or follow-up.
ASGE[1]	1. Procedure team should be responsible for determining type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. If pacemaker dependent and prolonged electrocautery may be required, the pacemaker should be reprogrammed to the asynchronous mode for the duration of the procedure.		1. Restore baseline settings and closely monitor the patient in the immediate postprocedural period, but no need for specific consultation or follow-up.
HRS/ASA[5]	1. A team specifically trained in cardiovascular implantable devices should be consulted to determine type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. If pacemaker dependent and prolonged electrocautery may be required, reprogram the pacemaker to the asynchronous mode only when electrosurgical procedures are used above the level of the umbilicus.		1. Consult cardiology or pacemaker/ICD service for restoring baseline device settings. 2. An additional evaluation of the device should be performed within 1 month after the procedure.

ACCF/AHA, American College of Cardiology Foundation/American Heart Association; *ASGE*, American Society for Gastrointestinal Endoscopy; *HRS/ASA*, Heart Rhythm Society and the American Society of Anesthesiologists; *ICD*, implantable cardioverter-defibrillator.

TABLE 1. Pacemakers: recommendations for managing pacemakers in the setting of electrosurgical procedures

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Universal recommendations	1. Assess the type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. Determine whether the patient is pacemaker dependent and attempt to predict whether prolonged electromagnetic current will be needed. a. If patient is not pacemaker dependent, then no reprogramming is necessary. b. If pacemaker dependent and prolonged electrocautery may be required, see specific recommendations below.	1. Closely monitor vital signs and heart rhythms with electrocardiography during the procedure. The patient should be monitored continuously via hard-wired monitoring. 2. Cardioverter-defibrillation equipment should readily available. 3. Use alternative methods to electrocautery whenever possible. 4. Apply bipolar or multipolar currents rather than unipolar currents whenever possible. 5. Whenever unipolar cautery is required, place the grounding pad on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device. 6. Minimize the strength of the electrosurgical current applied. 7. Apply the electrosurgical current intermittently and for the shortest amount of time possible. 8. External pacing can be effective. It can be set to the asynchronous mode and will be unaffected by cautery.	1. If the pacemaker or ICD was reprogrammed, restore baseline function of the device. 2. There is no need for further follow-up if the device is interrogated after the procedure.

Implantable Cardioverter Defibril

- Reduce mortality
  - in patients who have **survived a cardiac arrest** secor ventricular arrhythmia (secondary prevention)
  - in selected patients with **left ventricular systolic dys** despite optimal medical management (primary preve
- Consists of
  - Pulse generator (a titanium case, battery, electronics, converters)
  - 1 to 3 leads
    - single-chamber system : a single lead in the **RV**
    - dual-chamber system : leads in the **RA and RV**

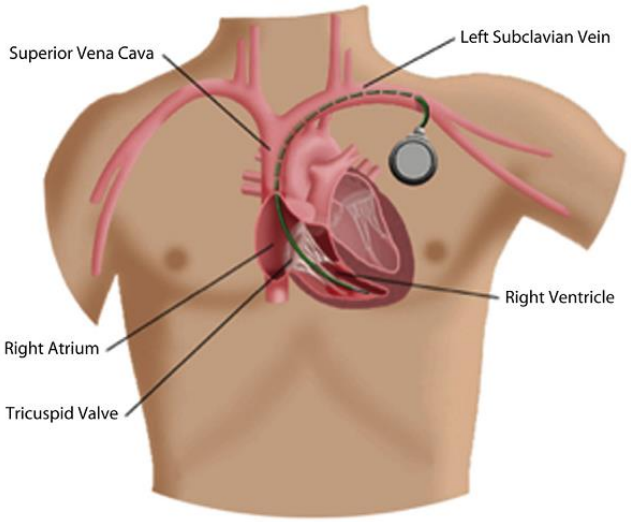

Figure 1. Lead placement in single-chamber implantable cardioverter-defibrillator/pacemaker.[19]

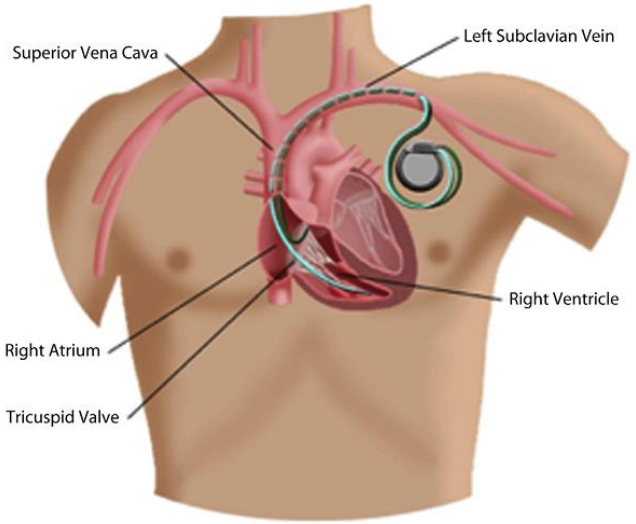

Figure 2. Lead placement in a dual-chamber implantable cardioverter-defibrillator/pacemaker.[19]

Implantable Cardioverter Defibrillator (ICD)

Ventricular fibrillation

Sensing

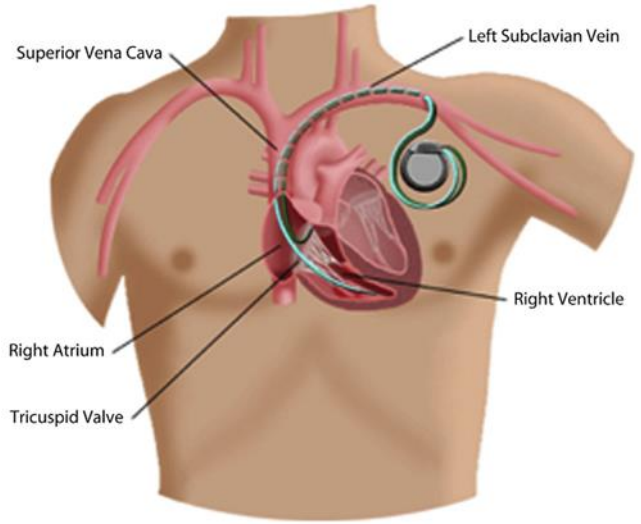

Figure 2. Lead placement in a dual-chamber implantable cardioverter-defibrillator/pacemaker.[19]

Shock

Implantable Cardioverter Defibrillator (ICD)

Electromagnetic Interference

Oversensing

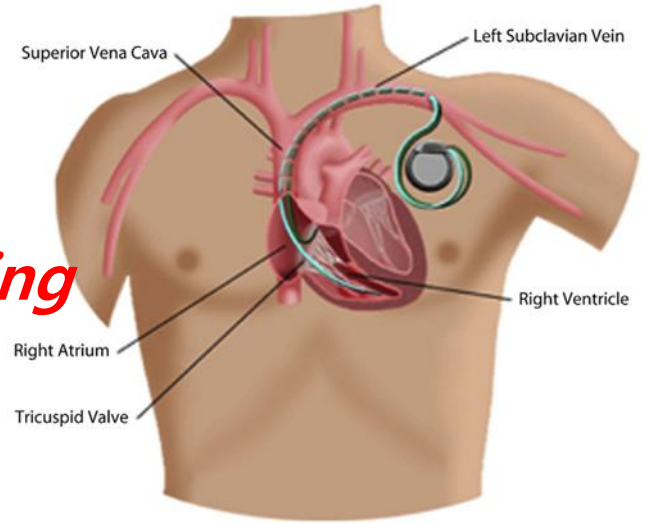

Figure 2. Lead placement in a dual-chamber implantable cardioverter-defibrillator/pacemaker.[19]

Inappropriate Shock ↑

Cardiac Resynchronized Therapy (CRT)

- Ix : **Heart failure**, LBBB,..
  - Improve Symptom, survival
  - Mechanical, electrical dyssynchrony
    → wall motion abnormalites
    → Decline in stroke volume
- Like dual-chamber devices
  - Sense only the RA and RV
- Stimulating the RV, **LV**
  → Correction of dyssynchrony
- No specific recommendation

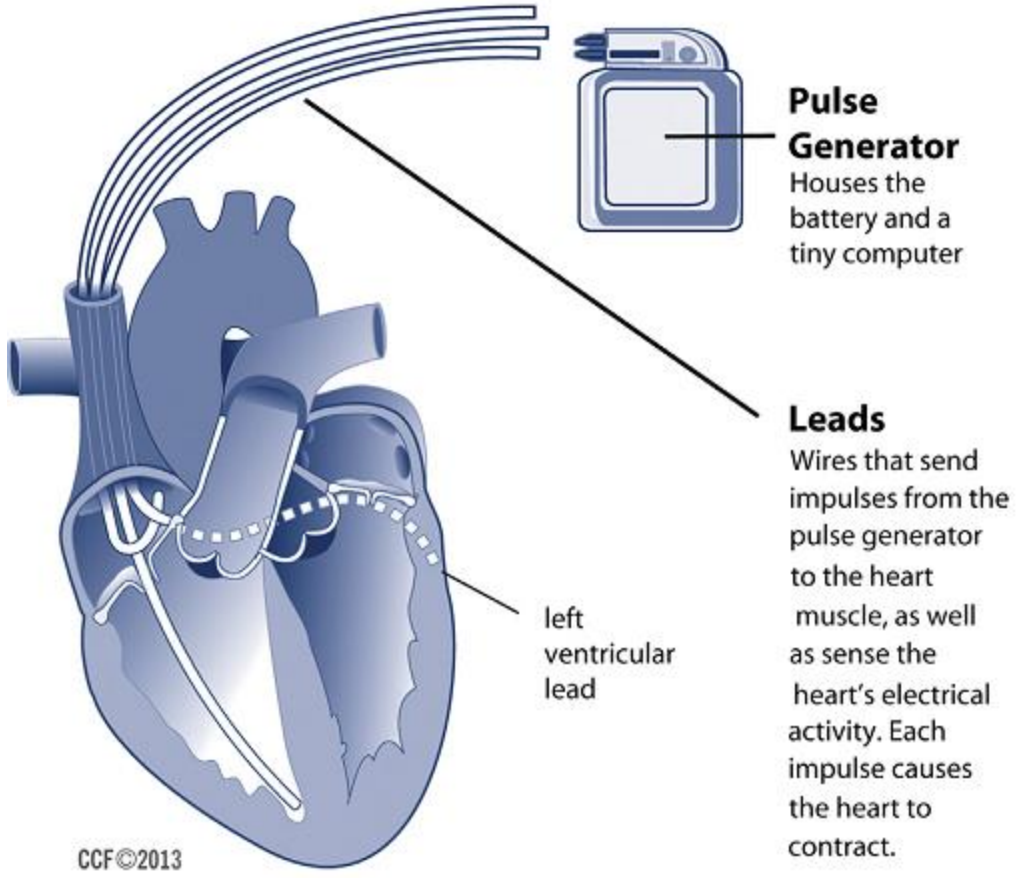

TABLE 2. Recommendations for managing ICDs in the setting of electrosurgical procedures

	Pre-procedure	During procedure	Post-procedure
Universal recommendations	1. Assess the type of implanted cardiac device, its location, the reason for the patient's need for the device, and dependence on the device. 2. Reprogram an ICD to inactivate tachyarrhythmia detection before procedures in which electrocautery is to be used. If unable to do so, a magnet could be used if the magnet can be secured over the pulse generator. Consult cardiology or a team specifically trained in cardiovascular implantable device management.	1. Closely monitor vital signs and heart rhythms with electrocardiography during the procedure. 2. Cardioverter-defibrillation equipment should be readily available. 3. Use alternative methods to electrocautery whenever possible. 4. Apply bipolar or multipolar currents rather than unipolar currents whenever possible. 5. Whenever unipolar cautery is required, place the grounding pad on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device. 6. Minimize the strength the electrosurgical current applied. 7. Apply electrosurgical current intermittently and for the shortest amount of time possible.	1. The ICD should be reprogrammed to its original function as soon as possible by trained personnel, including either a cardiologist or a team specifically trained in cardiovascular implantable device management.

ICD, Implantable cardioverter-defibrillator.

The American College of Cardiology Foundation/American Heart Association, American Society for Gastrointestinal Endoscopy, and Heart Rhythm Society and the American Society of Anesthesiologists all agree on these recommendations.[1,4,5]

전신질환이 있거나 초고령인 환자

이 강 문
가톨릭대학교 의과대학 성빈센트병원 소화기내과학교실

Endoscopy in Patients with Systemic Disorders or Extremely Old Age

Kang-Moon Lee
Department of Internal Medicine, St. Vincent Hospital, The Catholic University College of Medicine, Suwon, Korea

제 47회 대한소화내시경학회 세미나

(2) 삽입형 심장보조기구를 가진 환자에서의 내시경 검사

내시경검사로 인한 자극이나 용종절제술을 할 때 사용하는 전기응고술 등은 전자기 방해를 유발하여 인공심장박동기를 정지시키거나 심실부정맥으로 인지하여 오작동을 일으킬 수 있지만 실제 위험성은 매우 낮은 것으로 보고되었다. 아직까지 인공심장박동기나 삽입형 제세동기를 장착한 환자에 대한 명확한 가이드라인은 없지만, 삽입형 제세동기를 장착한 환자에서 전기소작술이 필요한 경우 시술 전 삽입형 제세동기 작동을 중지시키고 시술하여야 한다. 그렇지 못한 상황이라면 전기를 사용하지 않고 올가미를 사용하여 조직을 제거하거나, 생검겸자, 밴드결찰술, 헤모클립 등을 사용하여 조직을 절제하거나 제거하여야 한다.[11-15] 캡슐내시경 검사 시 이런 심장박동기나 삽입형 제세동기를 장착한 환자는 캡슐내시경과 결과 저장장치 사이의 디지털 무선주파수 통신에 영향을 줄 수 있어 미국 FDA에서는 이 경우를 캡슐내시경의 상대적 금기증에 포함시켰다. 그러나 여러 연구에서 캡슐내시경과 삽입형 심장보조기구들이 서로 기능에 영향을 주지 않는 것으로 보고되고 있다.[16,17]

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REVIEW

Magnet

Clinical applications of magnets on cardiac rhythm management devices

Sony Jacob[1]*, Sidakpal S. Panaich[1], Rahul Maheshwari[2], John W. Haddad[3], Benzy J. Padanilam[4], and Sinoj K. John[5]

- In general, magnet application switches
  - pacemakers to an asynchronous pacing mode
  - suspends all anti-tachycardia therapies of most ICDs without affecting the pacing mode.

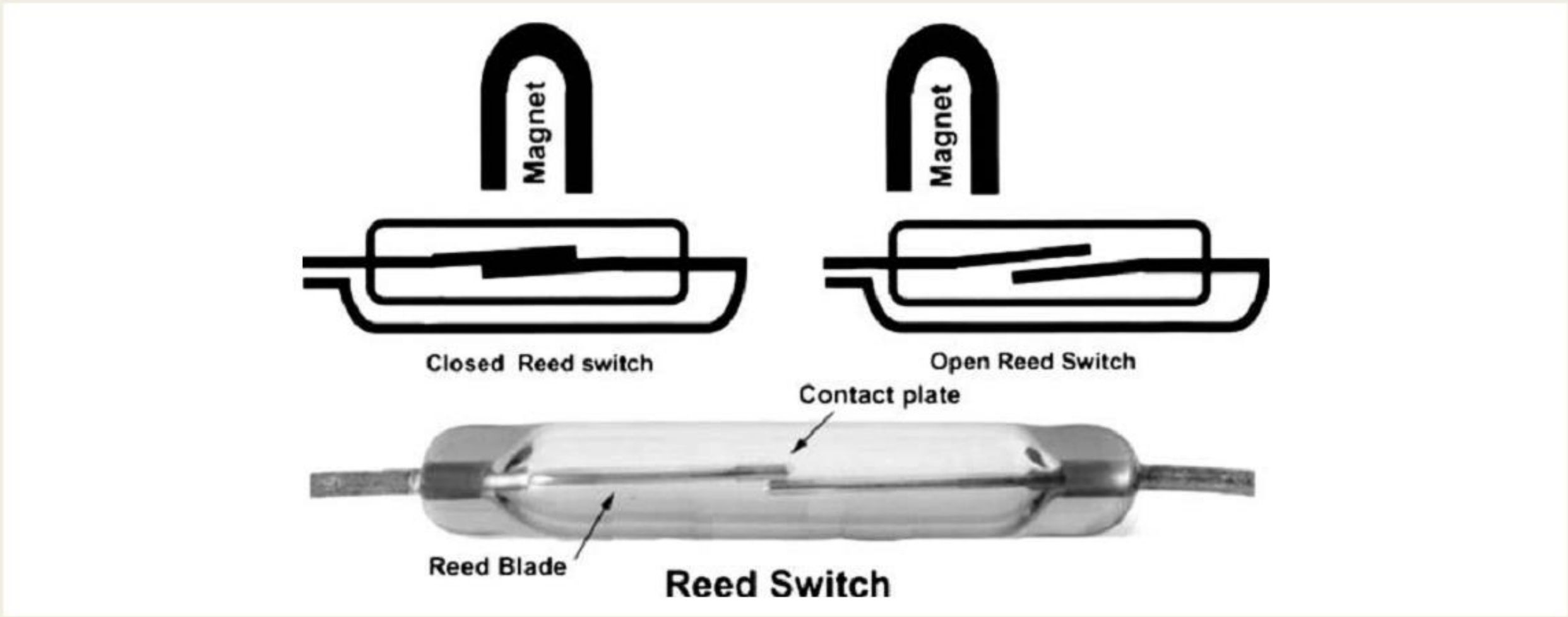


Figure 1 Magnetic reed switch. Above: Closed and open reed switch in response to magnet placement. Below: Magnetic reed switch showing the reed blade incorporated into a small glass capsule.

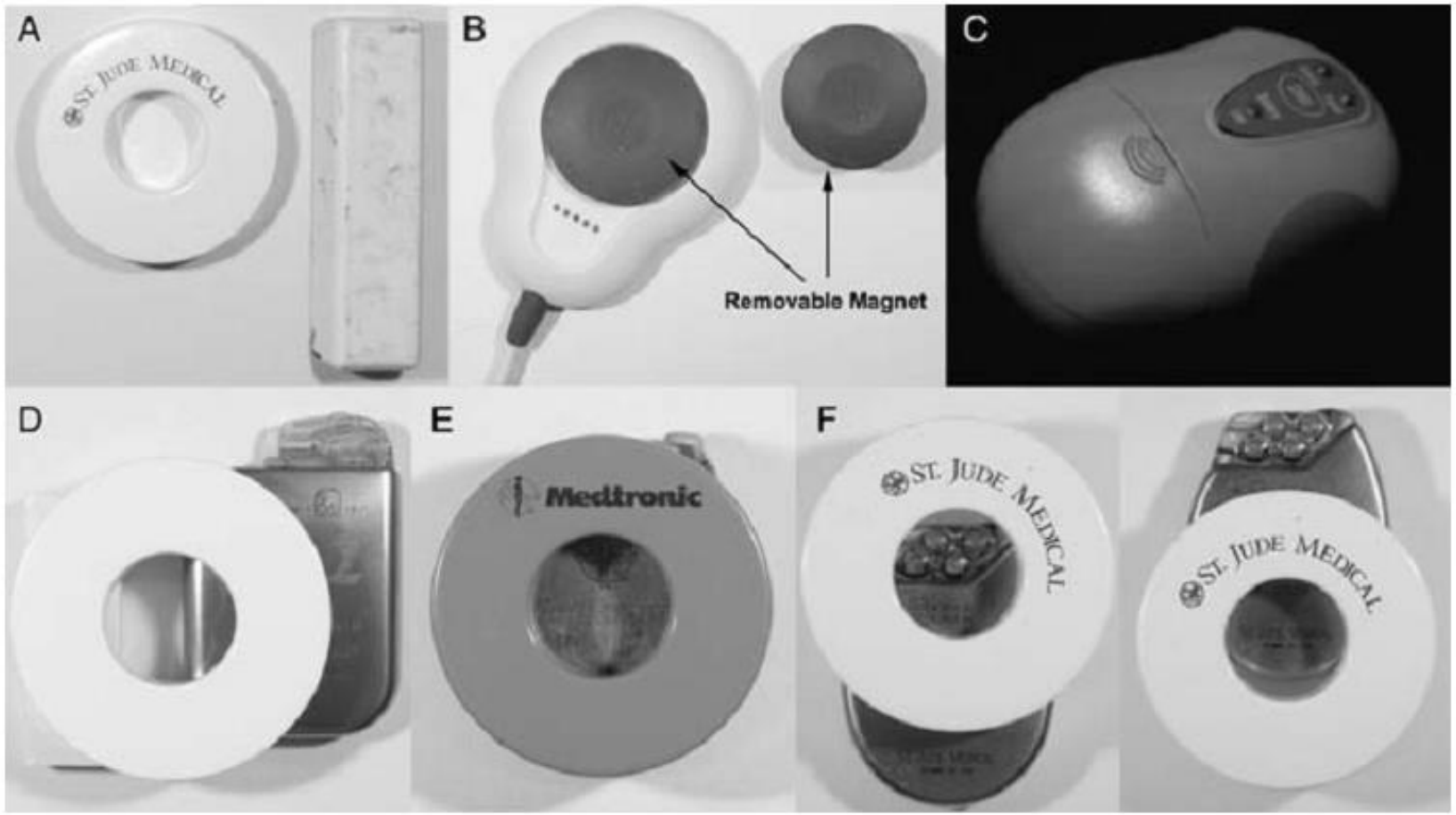
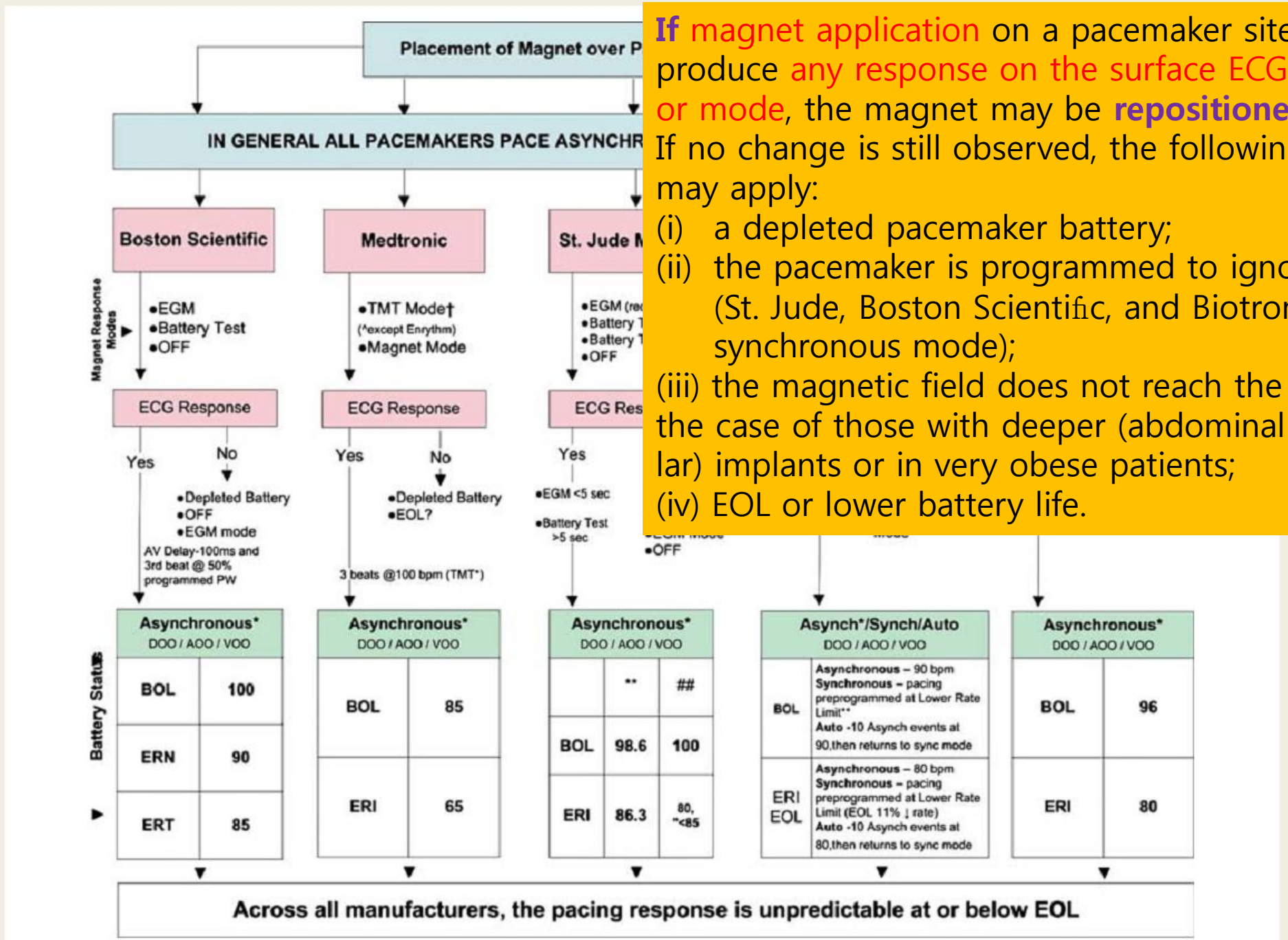


Figure 2 Clinical magnets and their proper placement as per manufacturer (white papers) recommendations. (*A*) Ring/doughnut and bar magnets. (*B*) St. Jude Telemetry Wand magnet in position and removed from the wand. (*C*) Medtronic Smart Magnet™. (*D*) Sorin implantable cardioverter defibrillator: ring magnet placed off-centre avoiding the header on the top end of the device. (*E*) Medtronic, Boston Scientific, and Biotronik implantable cardioverter defibrillators: ring magnet placed directly on top of the device. (*F*) St. Jude implantable cardioverter defibrillator: the curve of the ring/doughnut magnet on the top or bottom end of the device.



If magnet application on a pacemaker site does not produce any response on the surface ECG pacing rate or mode, the magnet may be **repositioned**.

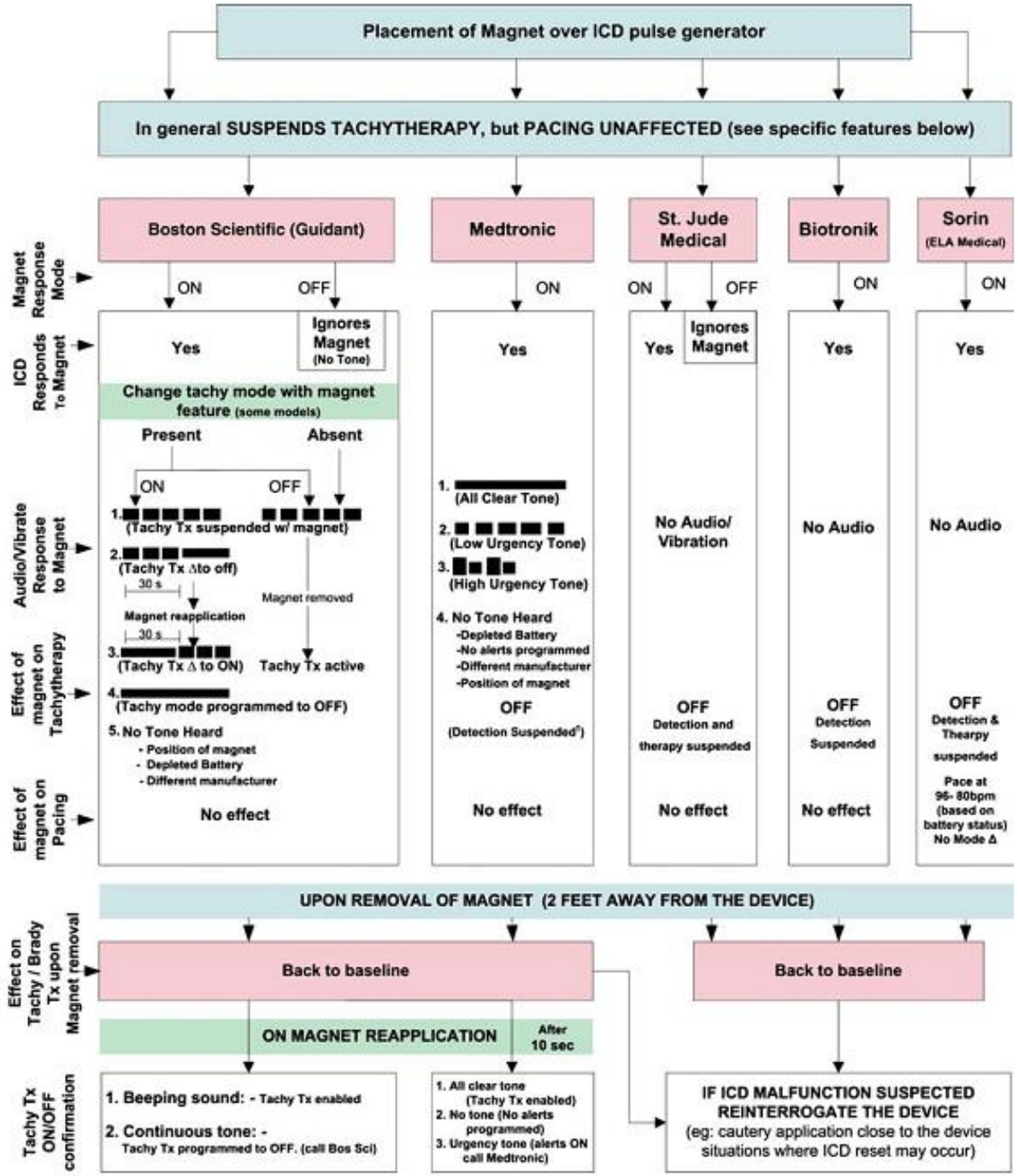
If no change is still observed, the following reasons may apply:

(i) a depleted pacemaker battery;

(ii) the pacemaker is programmed to ignore themagnet (St. Jude, Boston Scientific, and Biotronik synchronous mode);

(iii) the magnetic field does not reach the device, as in the case of those with deeper (abdominal or submuscular) implants or in very obese patients;

(iv) EOL or lower battery life.


Placement of Magnet over ICD pulse generator
In general SUSPENDS TACHYTHERAPY, but PACING UNAFFECTED (see specific features below)
Boston Scientific (Guidant)
Medtronic
St. Jude Medical
Biotronik
Sorin
(ELA Medical)
Magnet Response Mode
ON
OFF
ON
ON
ON
OFF
ON
ON
ICD Responds To Magnet
Yes
Ignores Magnet (No Tone)
Yes
Yes
Ignores Magnet
Yes
Yes
Change tachy mode with magnet feature (some models)
Present
Absent
ON
OFF
Audio/Vibrate Response to Magnet
1. (Tachy Tx suspended w/ magnet)
2. (Tachy Tx Δto off)
30 s
Magnet reapplication
30 s
Magnet removed
3. (Tachy Tx Δ to ON)
Tachy Tx active
4. (Tachy mode programmed to OFF)
5. No Tone Heard
- Position of magnet
- Depleted Battery
- Different manufacturer
1. (All Clear Tone)
2. (Low Urgency Tone)
3. (High Urgency Tone)
4. No Tone Heard
-Depleted Battery
-No alerts programmed
-Different manufacturer
-Position of magnet
No Audio/ Vibration
No Audio
No Audio
Effect of magnet on Tachytherapy
OFF
(Detection Suspended*)
OFF
Detection and therapy suspended
OFF
Detection Suspended
OFF
Detection & Thearpy suspended
Effect of magnet on Pacing
No effect
No effect
No effect
No effect
Pace at 96- 80bpm (based on battery status) No Mode Δ
UPON REMOVAL OF MAGNET (2 FEET AWAY FROM THE DEVICE)
Effect on Tachy / Brady Tx upon Magnet removal
Back to baseline
Back to baseline
ON MAGNET REAPPLICATION
After 10 sec
Tachy Tx ON/OFF confirmation
1. Beeping sound: - Tachy Tx enabled
2. Continuous tone: -
Tachy Tx programmed to OFF. (call Bos Sci)
1. All clear tone (Tachy Tx enabled)
2. No tone (No alerts programmed)
3. Urgency tone (alerts ON call Medtronic)
IF ICD MALFUNCTION SUSPECTED REINTERROGATE THE DEVICE
(eg: cautery application close to the device situations where ICD reset may occur)

Precautions against clinical magnet use

- Surgeries to be performed in a **non-supine position** making magnet position over the CRMD unstable.
- When the magnet response mode has been **deactivated by the manufacturer or clinician** for any reason.

Precautions against clinical magnet use

- Some of ICD models with specific programmable modes may **not revert to original programming** after removal of the magnet.
- **Unusual responses to magnet** application

  ex) switching of the ICD to an EOL battery status.

ORIGINAL ARTICLE

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CLINICAL ENDOSCOPY

Open Access

Endoscopic Electrosurgery in Patients with Cardiac Implantable Electronic Devices

Background/Aims: Patients with cardiac implantable electronic devices (CIEDs) undergoing endoscopic electrosurgery (EE) are at a risk of electromagnetic interference (EMI). We aimed to analyze the effects of EE in CIED patients.

Methods: Patients with CIED who underwent EE procedures such as snare polypectomy, endoscopic submucosal dissection (ESD), and endoscopic retrograde cholangiopancreatography (ERCP) with endoscopic sphincterotomy (EST) were retrospectively analyzed. Postprocedural symptoms as well as demographic and outpatient follow-up data were reviewed through medical records. Electrical data, including preprocedural and postprocedural arrhythmia records, were reviewed through pacemaker interrogation, 24-hour Holter monitoring, or electrocardiogram.

Table 1. Demographic Characteristics of Patients with Cardiac Implanted Electronic Devices Undergoing Endoscopic Electrosurgery

Characteristic	Total	Pacemaker	ICD
No. of patients	49	43	6
No. of procedures	59	50	9
Age, yr	69.1±9.1	71.1±8.2	57.7±4.4
Male sex	39	30	6
Reason for device implantation			
Sick sinus syndrome	32	32	0
Complete atrioventricular block	8	8	0
Second degree atrioventricular block	5	5	0
Atrial fibrillation with slow ventricular response	2	2	0
Junctional bradycardia	2	2	0
Idiopathic ventricular tachycardia	8	0	8
Brugada syndrome	1	0	1
Unknown	1	1	0
Time from device implantation to endoscopic surgery, day	1,844±1,640	2,006±1,722	982±653
Type of endoscopic electrosurgery			
Colon snare polypectomy	44	35	9
Colon ESD	1	1	0
Gastric snare polypectomy	1	1	0
Gastric ESD	5	5	0
ERCP with EST	8	8	0
Admission status			
Admission	26	26	0
Outpatient	33	24	9

Table 3. Follow-Up Data of Patients with Cardiac Implanted Electronic Devices Undergoing Endoscopic Electrosurgery

Variable	Total	Pacemaker	ICD
Time to cardiology outpatient clinic visit, day	46±47 (53/59[a])	44±46 (44)	59±54 (9)
Time to initial electrical follow-up, day	111±119 (55/59[b])	103±122 (46)	154±92 (9)
Type of initial electrical follow-up[c]			
Not done	5	5	0
Time to next pacemaker interrogation after endoscopic electrosurgery	226±222 (55)	242±240 (46)	173±113 (9)
Postprocedure changes noted on electrical follow-up	2	2	0

Our study included five types of EE in **59 procedures**, including gastric and colon ESDs, which require repeated and prolonged electrical current application. Our patients did **not** report **any symptoms related to EMI** during or after the procedures, and **two asymptomatic tachycardia events** were reported. **The device programs showed two changes after the procedures**, **one of which may have been related to EE.**

Table 4. Pacemaker Interrogation Results of Devices with Recordings during Endoscopic Electrosurgery

Variable	Total	Pacemaker	ICD
No. of devices with recordings	31	22	9
No events recorded	29	20	9
Events recorded	2	2	0

ICD, implantable cardioverter-defibrillator.

Limitation

1. **Retrospectively**
   - **not assessed for CIED dependency** before EE
   - recall bias may have occurred
2. **The decisions** about the type of procedure, admission, and need for CIED reprogramming were taken **by endoscopists**, which may have placed patients at an unnecessary risk.
3. Asymptomatic and no adverse events in all patient?
   - **Associated symptoms with device-function changes**
   - **Symptoms induced by the endoscopic procedure**
   - **the sedative medicine masked the cardiac symptoms**

Limitation

4. Although routine postprocedural device interrogation provided data on 31 procedures, **real-time electrocardiographic monitoring was not performed**, which limited the arrhythmic data available.

5. **Two tachycardia events** occurred. in PPMs. **If they had occurred in ICD patients,** unnecessary and **possibly harmful defibrillation** may have been triggered.

6. **Follow-up** was done **according to the cardiologist's schedule** without accounting for the EE. This led to some patients having CIED evaluation **up to 3 months after** the procedure.

TABLE 1. Pacemakers: recommendations for managing pacemakers in the setting of electrosurgical procedures

	Pre-procedure	During procedure	Post-procedure
Universal recommendations	1. Assess the type of implanted cardiac device, its location, the reason for the patient's need for the device and dependence on the device. 2. Determine whether the patient is pacemaker dependent and attempt to predict whether prolonged electromagnetic current will be needed. a. If patient is not pacemaker dependent, then no reprogramming is necessary. b. If pacemaker dependent and prolonged electrocautery may be required, see specific recommendations below.	1. Closely monitor vital signs and heart rhythms with electrocardiography during the procedure. The patient should be monitored continuously via hard-wired monitoring. 2. Cardioverter-defibrillation equipment should readily available. 3. Use alternative methods to electrocautery whenever possible. 4. Apply bipolar or multipolar currents rather than unipolar currents whenever possible. 5. Whenever unipolar cautery is required, place the grounding pad on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device. 6. Minimize the strength of the electrosurgical current applied. 7. Apply the electrosurgical current intermittently and for the shortest amount of time possible. 8. External pacing can be effective. It can be set to the asynchronous mode and will be unaffected by cautery.	1. If the pacemaker or ICD was reprogrammed, restore baseline function of the device. 2. There is no need for further follow-up if the device is interrogated after the procedure.

TABLE 2. Recommendations for managing ICDs in the setting of electrosurgical procedures

	Pre-procedure	During procedure	Post-procedure
Universal recommendations	1. Assess the type of implanted cardiac device, its location, the reason for the patient's need for the device, and dependence on the device. 2. Reprogram an ICD to inactivate tachyarrhythmia detection before procedures in which electrocautery is to be used. If unable to do so, a magnet could be used if the magnet can be secured over the pulse generator. Consult cardiology or a team specifically trained in cardiovascular implantable device management.	1. Closely monitor vital signs and heart rhythms with electrocardiography during the procedure. 2. Cardioverter-defibrillation equipment should be readily available. 3. Use alternative methods to electrocautery whenever possible. 4. Apply bipolar or multipolar currents rather than unipolar currents whenever possible. 5. Whenever unipolar cautery is required, place the grounding pad on the patient in a location such that the applied current does not pass close to or through the leads of the cardiac device. 6. Minimize the strength the electrosurgical current applied. 7. Apply electrosurgical current intermittently and for the shortest amount of time possible.	1. The ICD should be reprogrammed to its original function as soon as possible by trained personnel, including either a cardiologist or a team specifically trained in cardiovascular implantable device management.

ICD, Implantable cardioverter-defibrillator.

The American College of Cardiology Foundation/American Heart Association, American Society for Gastrointestinal Endoscopy, and Heart Rhythm Society and the American Society of Anesthesiologists all agree on these recommendations.[1,4,5]