

Monopolar Radiofrequency Ablation of the Trigeminal Ganglion in a Patient with a Dual-Chamber MRI-Conditional Pacemaker : A Case Report

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ABSTRACT

Background:

Radiofrequency (RF) thermocoagulation of the trigeminal ganglion is an established minimally invasive treatment for medically refractory trigeminal neuralgia. However, the use of monopolar RF energy in patients with permanent cardiac implantable electronic devices (CIEDs) raises concerns regarding electromagnetic interference (EMI), particularly in pacemaker-dependent patients. We report the successful performance of trigeminal ganglion radiofrequency ablation in a patient with a dual-chamber MRI-conditional pacemaker using a multidisciplinary peri-procedural device management strategy.

Case Presentation:

A 61-year-old male with a 2-year history of left-sided trigeminal neuralgia involving the V2 and V3 divisions presented with severe, electric shock-like facial pain triggered by touch, chewing, speaking, and brushing his teeth. Despite treatment with carbamazepine and pregabalin, he continued to experience significant pain with a baseline intensity of 9/10. Percutaneous trigeminal ganglion RF thermocoagulation was planned. The patient had an Abbott Assurity MRI 2272 dual-chamber pacemaker implanted for sinus pause and was pacemaker-dependent. After pre-procedure interrogation and multidisciplinary discussion with the cardiology/electrophysiology team, the pacemaker was temporarily reprogrammed from DDDR-MRI to DOO mode immediately before RF application. Fluoroscopy-guided percutaneous trigeminal ganglion RFA was performed through the foramen ovale using a 22-gauge, 5-mm active-tip RF cannula. Monopolar RF lesions were delivered at 75°C for 90 seconds, with two lesions targeting the V2 and V3 divisions. Continuous electrocardio-

graphic and hemodynamic monitoring was maintained, with external pacing and defibrillation equipment immediately available. Careful positioning of the dispersive electrode was undertaken to minimize the RF current pathway through the pacemaker system.

Outcome:

The procedure was completed without neurological, cardiovascular, or pacemaker-related complications. The pacemaker was interrogated immediately after the procedure and restored to its baseline DDDR-MRI mode, with no significant changes in sensing, pacing thresholds, lead impedance, or battery parameters. The patient experienced complete immediate relief of facial pain. At 2-week follow-up, the pain score had decreased from 9/10 to 0/10, corresponding to 100% pain relief, with improved function and reduced medication requirements.

Conclusion:

This case demonstrates that monopolar trigeminal ganglion RFA can be successfully performed in a carefully selected pacemaker-dependent patient when appropriate CIED precautions are implemented. Pre-procedure device interrogation, assessment of pacemaker dependence, temporary conversion to an appropriate asynchronous pacing mode, optimization of the RF current pathway, continuous cardiovascular monitoring, availability of emergency pacing and defibrillation, and post-procedure device interrogation are important components of a safe peri-procedural strategy. MRI-conditional status does not eliminate the risk of EMI from therapeutic RF systems. Larger studies and standardized protocols are required to better define the safety of RF interventions in patients with CIEDs.

Keywords: Trigeminal neuralgia; trigeminal ganglion; radiofrequency thermocoagulation; monopolar radiofrequency; pacemaker; cardiac implantable electronic device; electromagnetic interference; DOO pacing; pain medicine

Introduction:

Trigeminal neuralgia is a debilitating neuropathic pain disorder characterized by recurrent episodes of severe, electric shock-like pain in the distribution of one or more divisions of the trigeminal nerve. Although pharmacological therapy remains the initial treatment for most patients, interventional procedures are frequently considered in patients with inadequate pain control, medication intolerance, or recurrent symptoms.

Percutaneous radiofrequency thermocoagulation of

the trigeminal ganglion is an established intervention for trigeminal neuralgia, particularly in patients with involvement of the maxillary (V2) or mandibular (V3) divisions. This procedure uses radiofrequency-generated thermal energy to produce a controlled lesion within the selected divisions of trigeminal ganglion.

The presence of a permanent pacemaker introduces additional consideration during procedures involving radiofrequency energy. Radiofrequency current may generate electromagnetic interference

(EMI), potentially resulting in inappropriate sensing, inhibition of pacing, asynchronous or inappropriate pacing, device reset or rarely, device malfunction. The risk is influenced by the type of radiofrequency system, electrode configuration, current pathway, distance between the RF circuit and the CIED, and the patient's dependence on the pacemaker.

We present a case of successful monopolar radiofrequency ablation of the trigeminal ganglion in a patient with a dual-chamber MRI-conditional permanent pacemaker after temporary conversion of the pacing mode from DDDR-MRI to DOO, followed by restoration of the original device mode after completion of the procedure.

Case Presentation

A 61-year-old male, presented with clinically diagnosed trigeminal neuralgia involving the left maxillary (V2) & mandibular (V3) division of the trigeminal nerve.

The patient reported 2 years duration of left sided facial pain characterized by electric shock-like pain episodes affecting the left V2 & V3 distribution. The pain was triggered by touch, chewing, speaking, brushing teeth, etc. His baseline pain severity was 9/10.

He had received pharmacological treatment with oral medications carbamazepine 400mg + pregabalin 75mg per day dosage. Patient had inadequate response to oral medications and recurrence of symptoms. In view of persistent and functionally limiting pain despite conservative treatment, percutaneous radiofrequency treatment of the trigeminal ganglion was planned.

Cardiac history

The patient had a permanent dual-chamber pacemaker with MRI-conditional capability. The device was programmed in DDDR-MRI mode before the

intervention.

Pre-procedure pacemaker evaluation demonstrated:

- Pacemaker manufacturer: Abbott
- Device model: Assurity MRI 2272
- Date of implantation: 08.10.2021
- Indication for pacemaker implantation: Sinus pause
- Battery status: 2.98 V
- Atrial lead parameters: Threshold- 0.5 V, Pulse Amplitude- 1.5V (A), Pulse width- 0.4ms, Lead impedance- 530 ohm
- Ventricular lead parameters: Threshold- 1.37 V, Pulse Amplitude- 1.625 V(A), Pulse width- 0.4ms, Lead impedance- 440ohm
- Pacing dependence: yes
- Baseline programmed mode: DDDR-MRI
- Lower rate limit: 60 bpm
- Upper rate limit: 130 bpm
- Magnet response: 100 ppm

The case was discussed with the cardiology & electrophysiology team, and a peri-procedural pacemaker management plan was established.

Procedural management

After getting informed consent, the patient was brought to the procedure room and standard monitors were instituted, including continuous electrocardiography, non-invasive blood pressure monitoring, and pulse oximetry. Oxygen supplementation was provided with nasal cannula. Emergency medications trolley, external pacing device, defibrillator and back up emergency airway management devices with ventilator support checked and kept ready.

Because radiofrequency energy was to be used

during the procedure, the pacemaker was reprogrammed from DDDR-MRI mode to DOO mode immediately before commencement of the procedure. The dispersive electrode was positioned over the right gluteal region, to direct the radio frequency current pathway away from the pacemaker pulse generator and leads.

The patient underwent fluoroscopy-guided percutaneous trigeminal ganglion radiofrequency ablation through foramen ovale approach, targeting the V2 & V3 division. A 22 gauge, 5mm tip RF cannula was introduced through foramen ovale under fluoroscopic guidance.

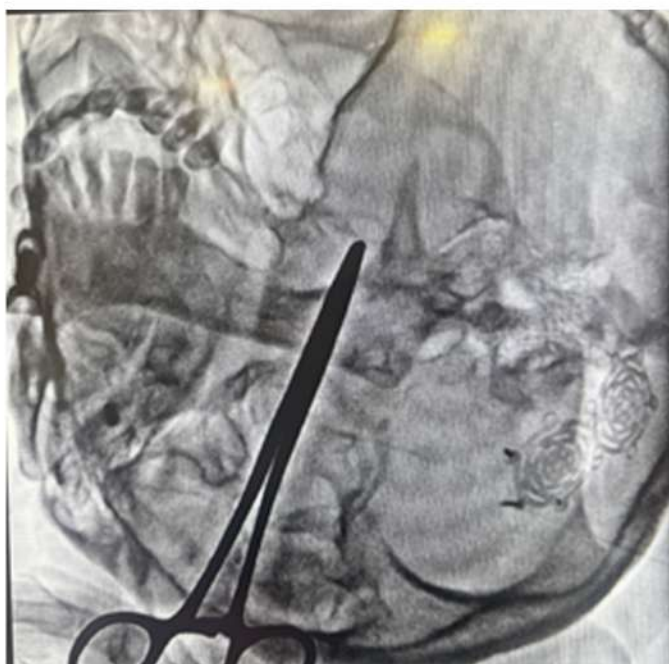


Figure 1: Fluoroscopic view showing the radiopaque marker positioned over the foramen ovale, as the target landmark for percutaneous trigeminal ganglion RFA.

Following appropriate sensory and motor stimulation, the RF electrode was positioned at the intended target. Monopolar radiofrequency thermo-coagulation was performed using the following parameters:

- RF temperature: 75 °C

- Duration: 90 seconds
- Number of lesions: 2 lesions
- RF Power: 10 V
- Impedance: 280 ohm
- RF generator model: BNS RFE2-A
- RF cannula: 22G 5mm tip

The dispersive electrode was positioned appropriately targeting the V2 division initially followed by V3 division done (2 lesions at 75 degree Celsius & 90 seconds each). Particular attention was paid to the anticipated RF current pathway to minimize the possibility of current passing through the pacemaker generator or leads.

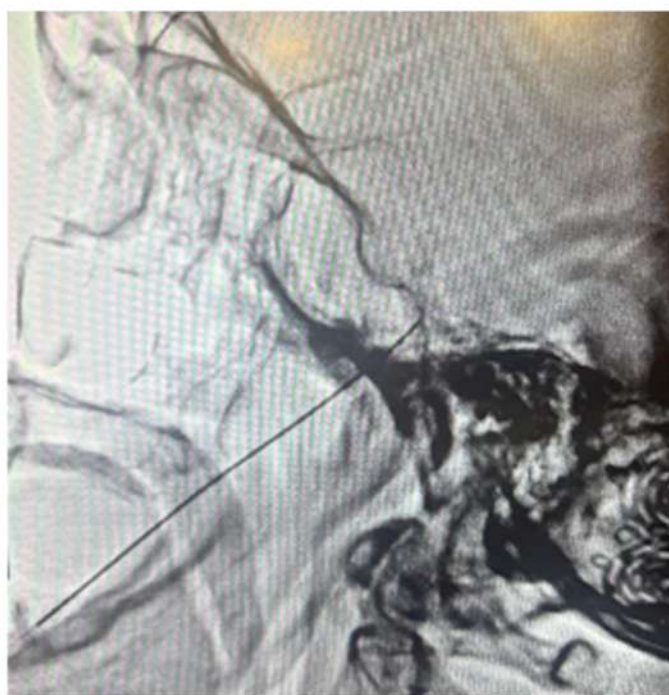


Figure 2: Lateral fluoroscopic view showing the final RF needle position for targeting the trigeminal ganglion V2 division.

Throughout the procedure, continuous ECG and hemodynamic monitoring was maintained.

The procedure was completed without any complications.

Immediately after completion of radiofrequency treatment, the pacemaker was reassessed and the device was reprogrammed from DOO mode back to its pre-procedure DDDR-MRI mode.



Figure 3: Final fluoroscopic RF needle position for V3 division trigeminal ganglion radiofrequency ablation.

Outcome

The patient tolerated the procedure well and was transferred to the recovery area in a hemodynamically stable condition.

There was complete relief of the patient's V2 & V3 division facial pain immediately following the procedure. The post-procedure neurological examination demonstrated with particular attention to facial sensation, corneal reflex, and motor function.

Post-procedure pacemaker interrogation demonstrated, normal device function with no significant change in sensing, pacing thresholds, lead

impedance or battery parameters. No clinically significant arrhythmia or device malfunction was identified.

At 2 weeks follow-up, the patient's pain score had decreased from 9/10 to 0/10, representing 100 % pain relief. The patient reported functional improvement, reduction in medication requirements, improved quality of life. There were no reported cardiac or pacemaker-related complications.

Discussion

Radiofrequency thermocoagulation of the trigeminal ganglion is an established percutaneous intervention for trigeminal neuralgia. However, the presence of a permanent pacemaker requires additional planning because RF energy can potentially interact with CIEDs.

The principal concern is electromagnetic interference between the RF system and the pacemaker. Monopolar RF systems generate an electrical circuit between the active electrode and a distant dispersive electrode. Depending on the position of the dispersive electrode and the patient's anatomy, the RF current pathway may theoretically interact with the pacemaker generator or its leads.

Potential consequences include inappropriate sensing of electrical signals, pacing inhibition, inappropriate pacing, device reset, changes in device programming, and, rarely, permanent device malfunction. The clinical significance of these effects is particularly important in patients who are pacemaker-dependent, because inhibition of pacing could potentially result in severe bradycardia or asystole.

In the present case, the pacemaker was temporarily

Ireprogrammed from DDDR-MRI to DOO mode before the use of monopolar RF energy. DOO is an asynchronous dual-chamber pacing mode in which atrial and ventricular pacing are delivered at a programmed rate without inhibition from sensed intrinsic cardiac activity. This strategy was selected to reduce the potential clinical consequences of inappropriate sensing or pacing inhibition during RF application.

Following completion of the RF procedure, the device was returned to its original DDDR-MRI mode. This step is important because asynchronous pacing is not generally intended to be maintained indefinitely in a patient who does not require it, particularly because competition between paced and intrinsic cardiac activity may create other risks. Another important consideration is the placement of the dispersive electrode. Whenever monopolar RF is used in a patient with a CIED, the RF current pathway should be planned so that it minimizes passage through the pacemaker generator and leads. The anatomical location of trigeminal ganglion RFA and the position of the pacemaker generator therefore need to be considered when planning the procedure.

Continuous ECG monitoring alone may not reliably demonstrate effective mechanical cardiac activity in every circumstance. Accordingly, simultaneous monitoring of pulse oximetry waveform and/or another reliable pulse monitoring modality provides useful confirmation of effective cardiac output during the procedure.

The present case also highlights the importance of multidisciplinary management. Pre-procedure device interrogation, determination of pacemaker dependence, communication with cardiology/electrophysiology, appropriate reprogramming, availability of external pacing and defibrillation equipment, and post-procedure device assessment are important components of a safe approach.

Although the pacemaker in this case was MRI-conditional, this designation should not be interpreted as indicating immunity from radiofrequency interference. MRI-conditional labelling refers to specific conditions under which the device can safely undergo MRI examination and does not eliminate the possibility of EMI from therapeutic RF systems.

The successful completion of the present procedure without clinically significant device-related complications suggests that, with appropriate precautions, monopolar trigeminal ganglion RFA can be considered in carefully selected patients with permanent pacemakers. However, this is a single case and cannot establish the safety of the technique universally. Individual device characteristics, pacemaker dependence, RF system configuration, electrode placement, and the patient's underlying cardiac condition must be considered for every case.

Conclusion

Monopolar radiofrequency ablation of the trigeminal ganglion was successfully performed in a patient with a dual-chamber MRI-conditional permanent pacemaker following temporary conversion of the pacemaker from DDDR-MRI to DOO mode.

This case emphasizes that the presence of a permanent pacemaker should not necessarily preclude trigeminal ganglion RFA. Careful pre-procedure CIED assessment, identification of pacemaker dependence, appropriate device reprogramming, optimization of the RF current pathway, continuous cardiovascular monitoring, immediate availability of resuscitation and pacing equipment, and restoration and verification of the original pacemaker settings are essential for minimizing potential complications.

Further studies and standardized protocols are needed to establish evidence-based recommendations for RF procedures involving patients with CIEDs.

Declarations

Consent for publication

Written informed consent for publication of the case report and associated clinical information was obtained from the patient.

Competing interests

None

Funding

No external funding was received for this case report.

Data availability

All relevant clinical information is contained within the case report. Additional information may be made available from the corresponding author upon reasonable request, subject to patient confidentiality and institutional policies.

Authors' contributions

Conceptualization: Dr. Nishad P K
Data collection: Dr. Kathija Begam A
Data analysis: Dr. Najwa Abdulla

First draft of the manuscript: Dr. Kathija Begam A
Approved this manuscript for submission: All authors

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