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The Intracavitary Compass: Intracavitary Electrogram Guided Temporary Pacing when Fluoroscopy is Unavailable

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ABSTRACT: Temporary transvenous pacemaker (TPM) placement without fluoroscopy is typically guided solely by surface electrocardiogram (ECG), a technique lacking anatomical precision and associated with procedural risks. We describe a safer alternative based on continuous intracavitary electrogram (I-EGM) monitoring, obtained directly from the pacing lead during implantation. In a patient with complete atrioventricular block and urgent indication for renal replacement therapy, we used an active-fixation lead to allow real-time correlation between lead progression under fluoroscopic visualization and intracavitary electrogram signals. We were able to accurately identify the lead's passage through the right atrium, right ventricle, and its endocardial contact point prior to final fixation. This technique, which we refer to as the "intracavitary compass," enhances both safety and accuracy in temporary pacemaker placement, particularly in settings where fluoroscopy is unavailable.

KEYWORDS: Cardiac pacing, intracavitary electrogram, electrogram-guided navigation, electrophysiological guidance, temporary transvenous pacing, active-fixation lead.

I. INTRODUCTION

The insertion of a temporary transvenous pacemaker (TPM) is a common intervention for patients with rhythm disorders that compromise hemodynamic stability or increase the risk of malignant ventricular arrhythmias, such as atrioventricular block (AVB) or symptomatic bradyarrhythmias. Ideally, TPM insertion should be guided by fluoroscopy, which allows direct visualization of the lead's trajectory from venous access — typically via the subclavian, jugular, or femoral vein — to its final position at the apex or septum of the right ventricle. Fluoroscopic guidance reduces the risk of malposition, myocardial perforation, pacing failure, and lead-induced arrhythmias.

However, in many clinical scenarios — particularly in emergency departments, intensive care units, or hospitals without continuous access to interventional imaging — fluoroscopy is not immediately available. In such cases, operators often rely solely on surface ECG to advance the lead "blindly" until a QRS morphology resembling left bundle branch block is observed, indicating presumed right ventricular capture. While practical, this approach has notable limitations: it does not confirm the exact anatomical location of the lead, lacks three-dimensional orientation, and is associated with an increased risk of complications such as diaphragmatic stimulation, lead dislodgement, or cardiac perforation.

To address these challenges, complementary techniques have been proposed to improve lead navigation in the absence of fluoroscopy. One such method involves the use of the intracavitary electrogram (I-EGM), recorded through the bipolar electrodes at the distal tip of the pacing lead as it is advanced intravenously. This signal provides continuous intracardiac electrophysiological information that, when interpreted in real time, can help infer the lead's anatomical position, distinguish its transition through right heart chambers, and identify endocardial contact, ultimately enabling more stable pacing.

We present the case of a patient with complete AV block secondary to metabolic disturbance, in whom a TPM was inserted using an active-fixation lead while simultaneously integrating I-EGM and fluoroscopic guidance. This visual and electrophysiological

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correlation allowed for precise characterization of each phase of lead advancement, reinforcing the value of I-EGM as a tool for intracardiac navigation.

II. CASE REPORT

A 76-year-old male with a history of systemic arterial hypertension and stage 5 chronic kidney disease (not on dialysis) presented to the emergency department with recurrent syncopal episodes. Upon arrival, he experienced a Stokes-Adams event. A 12-lead ECG revealed complete AV block of infra-Hisian origin with a wide idioventricular escape rhythm. Initial laboratory tests showed severe uremic syndrome with marked metabolic acidosis and significant electrolyte disturbances. Urgent initiation of renal replacement therapy was indicated.

A conventional temporary pacemaker was first placed, yielding a favorable clinical response. However, due to the anticipated need for sustained electrical support during metabolic stabilization and the inability to determine definitive pacing strategy at that moment, the initial system was replaced with an active-fixation lead. This choice provided enhanced lead stability, facilitated patient mobilization, and reduced the need for repositioning.

III. RESULTS

During the procedure, the active-fixation lead was connected to a polygraph system to obtain a continuous intracavitary electrogram, alongside a simultaneous surface ECG recording ***(Figure 1).*** Fluoroscopic imaging was also employed to visualize the anatomical progression of the lead from the superior vena cava to its final fixation site in the mid-septal region of the right ventricle.

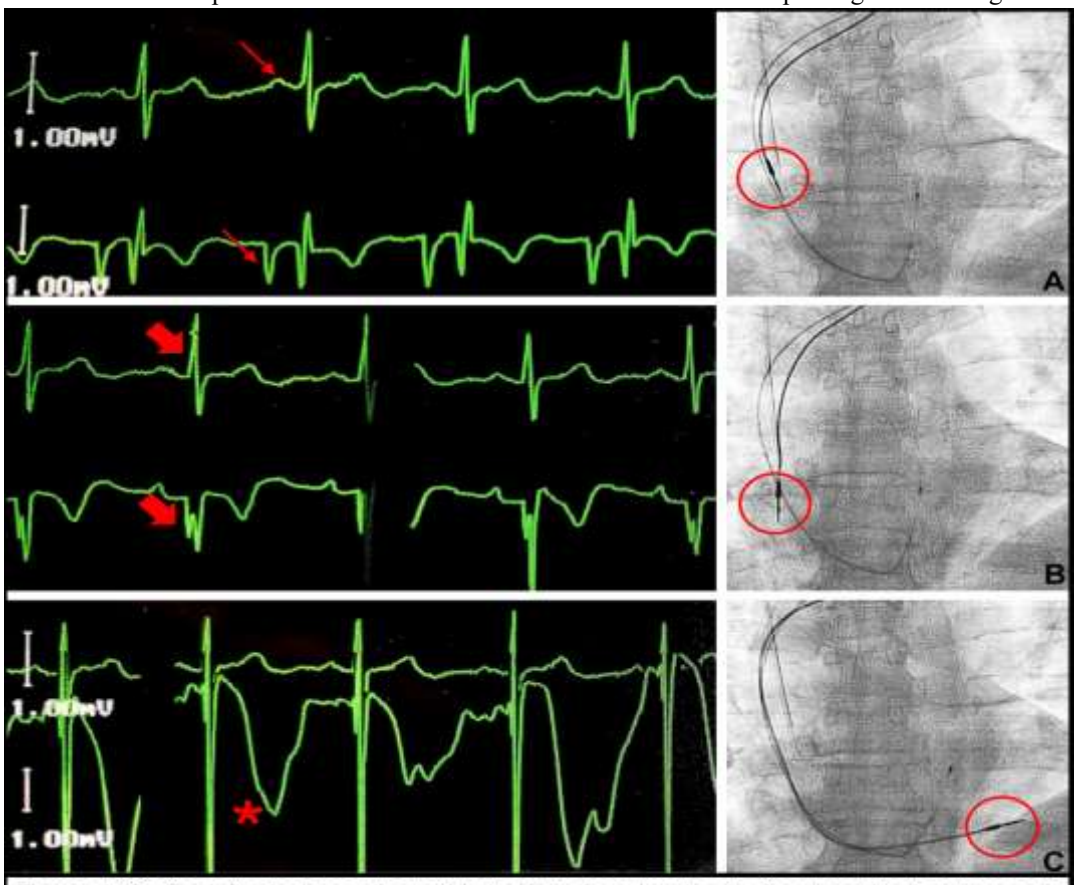

Figure 1. On the left, electrocardiographic tracings from two leads: the upper lead corresponds to Lead I (surface ECG), and the lower lead corresponds to the pacemaker lead intracavitary electrogram (I-EGM). On the right, fluoroscopic images showing the progression of the active-fixation lead (circle) through: A) the right atrium, with I-EGM showing increased atrial signal (thin arrow); B) the right ventricle, with increased ventricular signal on I-EGM (thick arrow); and C) endocardial contact, evidenced by an injury pattern on I-EGM (asterisk).

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The combined analysis of I-EGM, ECG, and fluoroscopy enabled clear correlation between anatomical lead progression and electrogram morphology. As the lead entered the right atrium ***(Figure 1A),*** a high-amplitude atrial signal was observed, synchronized with the P wave on surface ECG, along with a far-field low-amplitude ventricular component. Upon transition into the right ventricle ***(Figure 1B),*** the I-EGM shifted to a predominant high-amplitude ventricular signal, consistent with intracavitary ventricular activation. Finally, upon firm contact with the septal endocardium, an acute injury current was identified ***(Figure 1C),*** characterized by sustained deviation of the electrogram from the isoelectric baseline, indicating effective electrode-endocardial apposition.

Once optimal contact was confirmed, active fixation was performed by rotating the screw-in mechanism. Ventricular capture was verified with low thresholds, and lead stability was confirmed during respiratory movements and patient mobilization. The procedure was uneventful, and the patient underwent hemodialysis safely, maintaining stable ventricular pacing over the following days.

IV. DISCUSSION

This case illustrates the practical utility of the intracavitary electrogram as a real-time navigation tool during temporary pacemaker implantation. The combined correlation of I-EGM with fluoroscopy and surface ECG enabled precise identification of each phase of lead advancement and reliable localization of the pacing site. Compared with surface ECG guidance alone, I-EGM offers superior anatomical specificity, especially in settings where fluoroscopy is unavailable.

The use of active-fixation leads further enhances procedural safety by reducing the likelihood of dislodgement and minimizing the need for repositioning, particularly in critically ill patients or those requiring prolonged pacing support. Incorporating I-EGM guidance offers a reproducible, accessible, and safe strategy for improving procedural outcomes in temporary pacing.

V. CONCLUSION

We propose the “intracavitary compass” as a technique that integrates intracavitary electrogram monitoring with surface ECG interpretation to guide the safe and accurate placement of temporary pacing leads. This strategy improves procedural precision, lead stability, and overall safety, particularly in environments where fluoroscopic support is unavailable or limited.

We are currently developing a case series to standardize this technique and promote its clinical adoption in emergency, intensive care, and resource-limited settings.

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