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# Using Coronary Guidewires for Temporary Cardiac Pacing and Evaluating Heart Muscle Health: Present Insights and Future Possibilities

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## ABSTRACT

Coronary guidewires, which are routinely used in percutaneous coronary intervention (PCI), can also be modified to provide temporary pacing to the ventricles of the heart. With these wires, one can record electrical signals from within the coronary arteries, a method that referred to as transcoronary electrophysiology. This technique may assist physicians in evaluating if the heart muscle (myocardium) remains alive and functional (myocardial viability) and may aid in rapid decision-making within the procedure itself. Although some small studies have demonstrated this technique to be safe for acute pacing, further study is necessary to enhance the method and verify its usefulness in testing heart muscle viability. This is a discussion of how transcoronary electrophysiological information could be utilized to assess myocardial viability.

***Keywords:*** Myocardial viability, Transcoronary Pacing, Intracoronary ECG, Electrophysiology, Percutaneous Coronary Intervention.

## INTRODUCTION

Coronary artery disease remains a leading cause of morbidity and mortality worldwide, often requiring percutaneous coronary intervention (PCI) for effective treatment. During PCI, coronary guidewires play a crucial role in navigating the coronary vasculature and facilitating the delivery of balloons, stents, and imaging catheters to target lesions.

Beyond their established mechanical role, coronary guidewires possess the ability to conduct electrical impulses, introducing the possibility of their use in cardiac pacing. This concept, first explored in the 1980s, that firstly introduced the minimally invasive method for temporary cardiac stimulation during interventional procedures. The investigation of guidewire-based pacing has been restarted in the recent years due to growing its clinical interest and technological advancements. The use of this strategy in standard clinical practice is still restricted and unexplored, despite the encouraging experimental results. Additionally, its potential diagnostic utility in evaluating cardiac vitality directly in the catheterization laboratory has not been thoroughly evaluated.

Coronary artery disease frequently causes the conduction abnormalities or hemodynamic instability during PCI that requires the interim pacing support. Despite their efficacy, traditional transvenous pacing techniques can be difficult, technically demanding, and occasionally problematic due to vascular injury or lead displacement. Therefore, looking into a different pacing

method that makes use of existing coronary guidewires would offer a quicker, safer, and more effective choice for interventional procedures.

This study summarizes the current evidence regarding the use of coronary guidewires for temporary transcoronary pacing and to explore their emerging role in real-time myocardial viability assessment. For clarity, the term transcoronary refers to signals recorded via electrodes positioned within the coronary artery, while intracoronary denotes the physical placement of the guidewire itself.

## LITERATURE

A comprehensive and structured literature search was conducted to identify relevant studies addressing the use of coronary guidewires for temporary cardiac pacing and for evaluating myocardial viability through transcoronary electrophysiological methods. The search encompassed four major electronic databases: MEDLINE, Embase, PubMed, and CINAHL, covering all available literature up to June 2023. The search strategy incorporated a combination of controlled vocabulary terms (MeSH) and free-text keywords, including: coronary pacing, guidewire pacing, intracoronary pacing, transcoronary pacing, cardiac pacing, emergency pacing, myocardial viability, and cardiac imaging (both nuclear and MRI-based modalities).

The methodology thereby established a robust evidence base for the subsequent sections, which detail the structural characteristics of coronary guidewires, the mechanisms and feasibility of transcoronary pacing, and their potential clinical applications in the evaluation of myocardial health.

### Coronary Guidewires: Structure and Electrical Potential

**Structure:**

Coronary guidewires typically consisted of three components:

- A metallic core (stainless steel or nitinol) that provides torque and flexibility;
- A radiopaque tip for fluoroscopic visualization;
- A surface coating (hydrophilic or hydrophobic) that aids smooth navigation through vessels [1].

Because the metal core extends from the handle to the distal tip, it can transmit electrical current, allowing its potential use in temporary pacing [2]. Hydrophobic coatings like PTFE improve control but may reduce electrical conductivity, whereas hydrophilic coatings such as PVP improve navigability [3].

Laboratory and preclinical studies have demonstrated that certain guidewires, especially when used with insulating balloon catheters, can safely deliver pacing stimuli and record local electrical activity [4]. Coronary guide wire is prepared from specialized raw materials, which provide flexibility and strength along with safe passage through coronary arteries [5]. The core is typically composed of stainless steel for torque control and strength or nitinol for kink resistance. To make it slide easily through vessels, it is covered with hydrophilic substances such as PVP (for slip) or hydrophobic substances such as PTFE (for improved control). The outside jacket or coil, usually stainless steel or platinum alloy, is flexible and allows visualization under X-ray (radiopacity). The distal end is usually soft and of platinum or flexible polymers to avoid injury to vessels. All these works together to render the guide wire safe, steerable, and efficient in negotiating obstructed or stenosed coronary arteries.

### Transcoronary Pacing (TCP):

Transcoronary pacing (TCP) is a technique that enables temporary cardiac stimulation through the coronary circulation using a coronary guidewire [6]. Unlike the conventional transvenous approach, which requires venous access and placement of a pacing lead in the right ventricle, TCP

utilizes the metallic core of the coronary guidewire—already positioned during percutaneous coronary intervention (PCI)—to deliver pacing stimuli directly to the myocardium.

During PCI, arterial access is achieved by the radial or femoral route, and the guidewire is advanced across by a stenotic lesion under the fluoroscopic guidance. If bradycardia or transient heart block occurs, then the guidewire can be connected to an external pacemaker to provide the immediate pacing support. This eliminates the need for a separate venous catheter, thereby reducing procedural time and risks. The concept, first introduced by Chatelain et al. in 1984 and later refined with balloon catheter insulation, improved pacing success rates from 77% to nearly 100%.

TCP is important not only for managing intra-procedural rhythm disturbances but also for its emerging role in cardiac assessment [7]. The same setup that enables pacing can record intracoronary electrograms and evaluate myocardial viability based on electrical signals. This dual functionality makes TCP a practical, efficient, and promising tool for both temporary cardiac pacing and real-time evaluation of heart muscle health during interventional procedures.

## Clinical Applications of Transcoronary Pacing

### Pacing During PCI Procedures:

Transcoronary pacing (TCP) has emerged as a valuable adjunct technique during percutaneous coronary intervention (PCI) procedure, particularly in managing transient bradyarrhythmias or conduction disturbances that may occur during the process [8]. Complex interventions, like rotational atherectomy, balloon angioplasty, or the stent deployment in the right coronary artery, often causes the temporary slowing of the heart rate or atrio-ventricular block due to the transient ischemia or mechanical irritation.

These kinds of conditions cause the disturbances that required the use of a temporary transvenous pacing system introduced through the femoral or jugular vein. While effective, this method may start the procedural complexity, which eventually prolongs intervention time, and introduces risks such as vascular injury, bleeding, and infection. TCP eliminates these limitations by utilizing the coronary guidewire that already positioned within the target artery as a temporary pacing electrode [9]. This approach enables immediate and reliable pacing support without any additional venous access or the dedicated equipment.

Beyond rhythm stabilization, TCP also provides enhanced procedural control. By enabling rapid pacing during critical phases like stent positioning in ostial or bifurcation lesions it minimizes the cardiac motion and facilitates precise device deployment. The technique's simplicity, procedural efficiency, and safety profile make TCP a practical and time-saving alternative to conventional pacing methods in interventional cardiology.

### Myocardial Viability Assessment

Assessment of myocardial viability is critical for guiding revascularization strategies.

- Determining myocardial viability is critical in patients with ischemic cardiomyopathy or prior myocardial infarction. Current modalities like Cardiac MRI (CMR): It is used for the visualization of the scar tissue, blood flow, and myocardial function. However, it is expensive, time-consuming, and not widely accessible
- PET Scans: The scans are provides most accurate results that demonstrate blood flow and metabolism [10]. Tracers such as FDG identify areas that are alive but not contracting. Despite their precision, PET scans are costly and may expose the patients to radiation, and are not routinely used.
- Echocardiography: Readily available and common but can provide unreliable results and is operator-dependent.

- Nuclear Imaging: Tends to overestimate non-viable tissue because the images are not clear.

These technologies provide the valuable data but cannot be performed intra-procedurally that often resulted into delaying the treatment decisions. If electrical measurements via TCP that could give the reliably that indicate viability and clinicians could make on-table decisions about revascularization.

**Utilizing Trans Coronary Pacing for Myocardial Viability Assessment:**

In addition to providing temporary pacing, TCP offers a novel platform for real-time myocardial viability assessment within the catheterization laboratory [11]. Using the same coronary guidewire employed for pacing, physicians can record intracoronary electrograms that reflect local myocardial electrical activity. This allows the detection of subtle electrophysiological differences between viable and non-viable myocardial regions.

Viable myocardium continues to conduct and respond to electrical stimuli, but non-viable or damaged tissue exhibits decreased voltage amplitude, increased signal length, and irregular patterns. During PCI, doctors can directly assess myocardial health by evaluating electrical characteristics such as pacing threshold, impedance, and signal strength. This gives useful on-the-spot information, potentially reducing the requirement for delayed or external imaging tests such as cardiac MRI or PET scans.

Integrating TCP into viability evaluation offers an immediate, cost-effective, and minimally invasive method for guiding revascularization decisions. As device technology and signal interpretation techniques continue to evolve, TCP may become an essential intra-procedural tool—combining both temporary cardiac pacing and functional myocardial assessment within a single, streamlined intervention [12].

**Electrical Activity in Scarred Tissue**

Interestingly, even regions with trans-mural infarction have occasionally shown electrical capture, suggesting that islands of viable myocytes may persist within scar tissue. This observation parallels the mechanism of post-infarction arrhythmogenesis and raises the intriguing possibility that intracoronary electrical mapping could one day helps to identify arrhythmia-prone substrates during PCI.

While small-scale studies show promise, larger clinical trials are essential to:

- Validate impedance and pacing threshold as reliable viability markers,
- Optimize guidewire design and electrode contact, and
- Determine reproducibility across patient populations.

If successfully standardized, this approach could revolutionize the in-procedure evaluation of myocardial health, particularly in settings where advanced imaging modalities like MRI or PET are limited.

**Survey on Published Clinical Studies Supporting Transcoronary Pacing (TCP)**

1. A 72-year-old woman with worsening effort angina (CCS Class III) and severe calcified stenosis of the proximal right coronary artery (RCA) underwent percutaneous intervention involving rotational atherectomy (RA). During RA, the patient developed transient heart block and significant bradycardia. Immediate transcoronary pacing was initiated via the Rota wire placed distally in the RCA. The external pacemaker cathode was attached to the distal end of the guidewire using a crocodile clip, while the anode was inserted subcutaneously through a needle at the groin. Pacing was maintained at 60 beats per minute with an 8 V output. After the lesion was successfully debulked and stented the normal rhythm was observed to be resumed, and permanent pacing was not required. This case demonstrated the effectiveness of the TCP as an

immediate and reliable backup plan for the pacing modality during the complex atherectomy procedures, especially when the transient atrioventricular conduction disturbances occur [13].

2. A 65-year-old female was going through the LCX angioplasty developed complete heart block unresponsive to atropine. In TCP procedure the coronary guidewire immediately stabilized the rhythm, which is allowing the procedure to be completed safely. Pacing was delivered at 120 bpm with output of 20 mA and sensitivity of 10 mV. Restoration of ventricular rhythm was achieved within 15–20 minutes, and angioplasty was completed without complications. This reinforced TCP's reliability as a life-saving intervention during PCI when sudden bradyarrhythmias or heart block occurs [14].
3. In this study the potential of the TCP was explored by evaluating pacing thresholds, impedance, and R-wave amplitude in normal versus scarred myocardium. In eight patients undergoing PCI, impedance averaged 304.8 ± 74.0 Ω in normal myocardium, 244.1 ± 66.6 Ω in <50% myocardial scar, and 222.3 ± 33.8 Ω in ≥50% scar tissue. Corresponding pacing thresholds were 1.96 ± 1.23 V, 5.01 ± 2.77 V, and 3.95 ± 0.88 V respectively. Significant differences between normal and scarred myocardium ($P = 0.002$) suggest that TCP parameters can potentially reflect myocardial viability intra-procedurally, offering a new physiological insight during PCI [15].

**Advancement of Intracoronary Electrophysiology for Myocardial Viability Assessment**

Building on the concept of intracoronary electrical signals, researchers have explored their utility in determining myocardial viability. In a pilot study, electrical parameters were measured during brief heart pacing using a standard coronary guidewire during percutaneous coronary intervention (PCI). The study focused on three key electrophysiological measurements:

- Pacing threshold: The voltage required to elicit a cardiac contraction.
- Impedance: The resistance to electrical flow within the tissue.
- R wave amplitude: The magnitude of the recorded intracoronary signal.

**Future Perspective:**

Transcoronary pacing represents a novel, minimally invasive procedure that integrates the temporary cardiac pacing with a real-time evaluation of myocardial viability, which is offering the substantial potential to refine interventional decision-making. Future research should be focused on conducting large-scale, multicenter clinical trials to validate the reproducibility and diagnostic accuracy of TCP parameters across varied patient populations and complex coronary anatomies.

Advancements in the guidewire technology, including optimized electrode design, improved insulation, and enhanced signal detection, are likely to increase the reliability and clinical applicability of TCP. Standardized protocols for the intra-procedural myocardial viability assessment could facilitate broader adoption, that enabling clinicians to make immediate, data-driven decisions regarding revascularization strategy.

Furthermore, integration of TCP data with adjunctive imaging and hemodynamic parameters may provide a comprehensive, real-time assessment of myocardial function and perfusion. Exploration of intracoronary electrical mapping to identify arrhythmia-prone substrates offers an additional avenue for research, potentially expanding the role of TCP beyond pacing and viability assessment to arrhythmia risk stratification.

Additionally, the TCP holds considerable promise as a dual-purpose tool in interventional cardiology. With the further technological refinement, rigorous clinical validation, and protocol standardization, it

has the potential to transform intra-procedural cardiac assessment and enhance outcomes for patients undergoing PCI.

## Limitations

Transcoronary pacing (TCP) has significant potential for the temporary cardiac pacing and intra-procedural myocardial viability activity. Variations in guidewire design, electrode contact, and coronary anatomy can all have an impact on pacing performance and the reliability of intracoronary signal recordings. Additionally, standardized protocols for TCP implementation have not yet been created, which could prevent reproducibility and wider the clinical acceptance rate. Comparative data with conventional imaging modalities, such as cardiac MRI or PET, remain limited, and robust evidence confirming the diagnostic accuracy of TCP is still lacking. While short-term safety appears acceptable, long-term outcomes and potential procedure-related complications, including coronary spasm, dissection, or thrombus formation, require further systematic investigation.

## CONCLUSION

Coronary guidewires beyond their traditional role in percutaneous coronary intervention (PCI), show promising potential as dual-purpose tools for temporary cardiac pacing and real-time myocardial viability assessment. Transcoronary pacing (TCP) leverages the metallic core of guidewires to provide immediate pacing support during procedural brad arrhythmias, while simultaneously recording intracoronary electrograms. These signals enable direct evaluation of myocardial viability by assessing parameters such as pacing threshold, impedance, and R-wave amplitude, offering a rapid, minimally invasive, and cost-effective alternative to conventional pacing and advanced imaging modalities like MRI or PET. Although early studies demonstrate safety and procedural efficiency, variability in guidewire design, electrode contact, and coronary anatomy limits reproducibility. Standardized protocols and larger clinical trials are needed to validate diagnostic accuracy and long-term safety. With technological refinement and clinical validation, TCP could integrate pacing, viability assessment, and arrhythmia risk evaluation into a single streamlined intervention, enhancing decision-making and outcomes for patients undergoing PCI.

## *Declaration by Authors*

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