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NOVEL TRANSLATIONAL METHODS

Real-Time Magnetic Resonance Imaging Guidance Improves the Diagnostic Yield of Endomyocardial Biopsy

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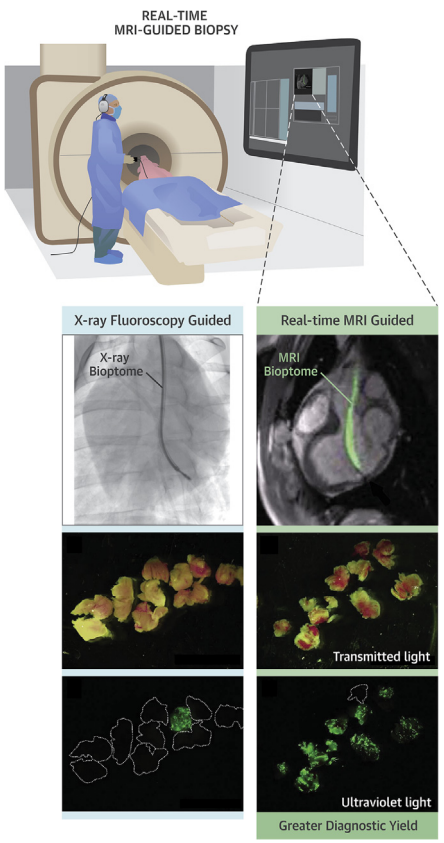
VISUAL ABSTRACT



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HIGHLIGHTS

- **The diagnostic yield of endomyocardial biopsy is low, particularly in diseases that affect the myocardium in a nonuniform distribution.**
- **It is feasible to perform real-time MRI-guided endomyocardial biopsy using a dedicated active-visualization bioptome.**
- **In an animal model of focal myocardial disease, real-time MRI guidance improved the diagnostic yield compared with x-ray fluoroscopy.**

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SUMMARY

Diagnostic yield of endomyocardial biopsy is low, particularly in disease that affects the myocardium in a nonuniform distribution. The authors hypothesized that real-time MRI guidance could improve the yield through targeted biopsy of focal myocardial pathology. They tested this hypothesis in an animal model of focal myocardial pathology using intracoronary ethanol and microspheres. The authors compared real-time MRI-guided endomyocardial biopsy in swine using a custom actively visualized MRI bioptome against x-ray–guided biopsy using a commercial bioptome by skilled operators. Real-time MRI guidance significantly increased the diagnostic yield of endomyocardial biopsy. (J Am Coll Cardiol Basic Trans Science 2016;1:376–83) Published by Elsevier on behalf of the American College of Cardiology Foundation.

ABBREVIATIONS AND ACRONYMS

MRI = magnetic resonance imaging

In contemporary practice, endomyocardial biopsy is still performed with the limited visual guidance afforded by x-ray fluoroscopy or by ultrasound. Technique has changed little since its inception in Japan in 1962 (1) and introduction to the United States in 1973 (2). Regardless of the suspected diagnosis, many operators perform only right ventricular biopsy, and yet the diagnostic yield varies dramatically depending on the distribution of disease (3). Endomyocardial biopsy has fallen somewhat out of favor in recent years, which in part may reflect the low diagnostic yield in patients without transplanted hearts, and the complexity of cardiac histopathology analysis (4). When positive, there is no question that endomyocardial biopsy aids diagnosis and directs therapy in patients with unexplained heart failure (5). In skilled hands, procedural risk of endomyocardial biopsy is low but complications such as cardiac perforation can be life threatening (6). Consequently, guidelines attempt to balance these risks with the potential diagnostic benefit. As a result, the only "strong recommendation" for endomyocardial biopsy in current guidelines is for new-onset heart failure associated with hemodynamic compromise or ventricular arrhythmias (7).

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With better technology, it is conceivable that the diagnostic yield of endomyocardial biopsy could be significantly improved. Developments in real-time magnetic resonance imaging (MRI) pulse sequences enable excellent tissue characterization and visualization of custom-built MRI-conditional devices, while avoiding ionizing radiation (8). We hypothesized that MRI guidance could augment the diagnostic yield of endomyocardial biopsy of focal myocardial pathology. To test this hypothesis, we created an animal model of focal myocardial pathology and compared the yield of x-ray–guided endomyocardial biopsy using a commercial bioptome versus real-time MRI-guided endomyocardial biopsy using a novel MRI-conditional bioptome.

METHODS

The institutional animal care and use committee approved all procedures, which were performed according to contemporary National Institutes of Health guidelines. Five Yorkshire swine with bodyweight 51 (47 to 56) kg were anesthetized with ketamine (25 mg/kg), midazolam (15 mg/kg), and glycopyrrolate (0.01 mg/kg), and maintained on isoflurane (2%) with mechanical ventilation.

ANIMAL MODEL OF FOCAL MYOCARDIAL PATHOLOGY. Animals were pre-treated with amiodarone and heparin, and underwent x-ray–guided selective left coronary artery catheterization from a transfemoral approach using 6-F guide catheters. A ≥2-mm obtuse marginal branch was wired with a 0.014-inch guidewire to position an over-the-wire balloon sized to occlude flow. Three milliliters of fluorescent microspheres (NuFlow Hydrocoat, 15-μm diameter, 5 million spheres/ml) was infused through the balloon guidewire lumen, followed by 2 ml of 100% ethanol to cause infarction within a controlled basal posterolateral distribution. The fluorescent microspheres ensured that tissue within the lesion was tagged for easy identification under ultraviolet light. There was no mortality from this procedure. Animals were survived for 21 (14 to 22) days before undergoing endomyocardial biopsy. Each animal underwent both MRI and x-ray–guided endomyocardial biopsy performed by different experienced operators.

REAL-TIME MRI-GUIDED ENDOMYOCARDIAL BIOPSY. MRI-guided endomyocardial biopsy was performed in a MRI catheterization suite, equipped with a 1.5-T standard diagnostic MRI scanner (Aera, Siemens, Erlangen, Germany), noise-cancelling communication headsets, and video projectors to display