Spectrum of Ventricular Arrhythmias Arising from Papillary Muscle in the Structurally Normal Heart

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KEYWORDS

• Papillary arrhythmias • Papillary muscle • Premature ventricular contraction
• Structurally normal heart • Ventricular arrhythmias • Ventricular fibrillation • Ventricular tachycardia

KEY POINTS

- Ventricular arrhythmias arising from the papillary muscle account for 4% to 12% of arrhythmias in a structurally normal heart and are generally non–life threatening.
- Although distinguishing arrhythmias from papillary muscle and Purkinje tissue is challenging, an attempt should be made because the techniques used in ablation are different.
- Ablation assisted by real-time imaging modalities still has a variable success rate.
- Malignant arrhythmias related to the papillary muscle may be secondary to focal ectopy triggering ventricular fibrillation.

Video content accompanies this article at http://www.cardiacep.theclinics.com.

INTRODUCTION

Papillary muscles are endocardial structures that can harbor arrhythmic substrate in structural heart disease and an apparently normal heart.[1,2] In patients without a prior infarct, papillary muscles account for 4% to 12% of idiopathic ventricular arrhythmias.[3,4] Both the right and left papillary muscles can be arrhythmogenic, although reported cases involving right ventricular (RV) papillary muscles are scarce. Because of the anatomic complex of the papillary muscles, differentiating with other arrhythmias arising from adjacent/close by structures is challenging. In particular, distinguishing myocardial versus fascicular origin is essentially impossible given their close anatomic relationship. However, it is worth attempting because different techniques for ablation of papillary arrhythmias are required and potential complications after ablation may be different between these two entities. Catheter ablation has a fair success rate because of the difficulty in maintaining catheter stability, the thickness of muscle, and its complex anatomy. Published studies regarding approaches for ablation are limited because of its relative rarity.

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ANATOMIC CORRELATION AND PHYSIOLOGIC CONSIDERATION

Papillary muscles are supporting subvalvular structures of the mitral and tricuspid valves.[5] These muscles are a complex pouching of the ventricular wall that often vary in shape. Their thickness (generally equal to the left ventricular [LV] wall) results in higher energy requirement for radiofrequency ablation than the usual dose.[6]

The mitral valve usually has two associated papillary muscles (posteromedial and anterolateral), which are supplied by either the right coronary or the circumflex artery (dependent of the dominance), and dual blood supplies from the left anterior descending and the circumflex arteries, respectively. Hence, the posteromedial papillary muscle is more vulnerable to ischemic injury than the anterolateral muscle. Interestingly, even in patients without a history of infarct or structural heart disease, idiopathic ventricular tachycardia (VT) or premature ventricular contractions (PVCs) tend to originate predominantly from the posteromedial papillary muscle.[7,8]

The posteromedial papillary muscle lies in between the LV septum and posterior free wall, whereas the anterolateral papillary muscle lies on the anterolateral free wall.[7] The locations where their large bases insert the LV wall serve as an anatomic landmark for the beginning of the apical component of the LV. Two papillary muscles are located close to each other, which can cause difficulties in manipulating the catheter (Fig. 1). Furthermore, papillary arrhythmias may exhibit multiple QRS morphologies caused by variable exit sites from an intramural focus or its attachment to false cords.[8]

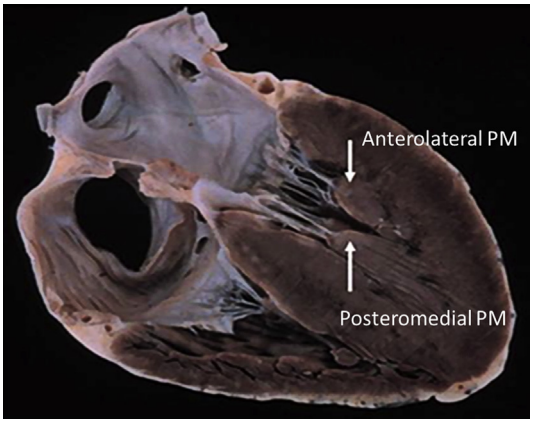

Fig. 1. Anterolateral and posteromedial papillary muscles (PM) of the left ventricle. Note their broad bases that locate close approximation to each other. (*From* Abouezzeddine O, Suleiman M, Buescher T, et al. Relevance of endocavitary structures in ablation procedures for ventricular tachycardia. J Cardiovas Electrophysiol 2010;21(3):246; with permission.)

The RV papillary muscles include the anterolateral, posteromedial, and septal (or medial) muscles (Fig. 2). The latter seems to be the most common site for arrhythmias according to a single available study.[9] Of anatomic importance, the septal muscle arises from the RV outflow tract (RVOT), and is commonly referred to the Lancisi muscle or the conus papillary muscle.[5] Ventricular arrhythmias arising from this location may have a similar QRS complex to that of arrhythmias arising from the RVOT.[5]

The Purkinje fiber–muscular interface that exists within the papillary muscles may play an important role in the genesis of papillary muscle–related arrhythmias.[10] This close relationship between the Purkinje fiber and papillary muscles has made some difficulties to distinguish arrhythmias from the two structures. In a study of heart dissection, there is Purkinje tissue coming from the anterior fascicle at the region of the anterolateral papillary muscle and the left posterior fascicle inserts near the base of the posteromedial muscle.[11,12] The RV papillary muscles also have anatomic relationship to the cardiac conduction system. The right bundle branch becomes more superficial to the subendocardial layer at the base of the septal papillary muscle. A major fascicle of the right bundle branch continues within the moderator band that connects to the anterior papillary muscle where its Purkinje fibers spread out.[13,14]

CLINICAL MANIFESTATIONS

Idiopathic papillary ventricular arrhythmias are commonly induced by exercise and generally have a benign course.[4,8] Syncope and cardiac arrest are rare. The PVCs and nonsustained VT are more common than sustained VT. Frequent papillary PVCs can induce cardiomyopathy that is reversible if suppression of the PVCs is successful.[9] There are also reported cases of PVCs from the papillary muscle triggering VF. In patients with mitral valve prolapse (MVP), the papillary muscle has been reported to be a critical site of ventricular arrhythmias that may lead to sudden cardiac arrest.[15] Malignant arrhythmias related to the papillary muscle are discussed in a latter section.

DIFFERENTIAL DIAGNOSIS

Idiopathic LV arrhythmias arising from the papillary muscles, left fascicles, and mitral annulus, and ventricular arrhythmias arising from the conus