Contemporary Imaging in Takotsubo Syndrome

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KEYWORDS

• Takotsubo syndrome • Stress cardiomyopathy • Apical ballooning syndrome • Echocardiography • Cardiac magnetic resonance • Coronary computed tomography angiography • Single photon emission computed tomography • Positron emission tomography

KEY POINTS

- Transthoracic echocardiography is the first-line noninvasive imaging modality for the early evaluation of patients with suspected Takotsubo syndrome and for monitoring myocardial function and hemodynamic conditions during the acute phase. However, in recent years, cardiac magnetic resonance and coronary computed tomography angiography have been assuming an emerging role to confirm diagnosis because of their unique ability to obtain information about myocardial tissue characterization and coronary artery patency.
- Patients with Takotsubo syndrome typically show the apical ballooning pattern characterized by akinesia or dyskinesia of the apical and midventricular segments of the left ventricle, and hyperkinesia of the base. However, several variant morphologies, such as midventricular, basal, inverted or even focal forms, have also been described.
- A circumferential pattern of regional wall motion abnormalities beyond the territory of a single coronary artery distribution is a distinctive marker of Takotsubo syndrome that can be easily appreciated with both echocardiography and cardiac magnetic resonance.
- Owing to the possibility of detecting mechanical complications, including intraventricular pressure gradients, reversible functional mitral regurgitation, right ventricular involvement, intraventricular thrombi, and pericardial effusion, echocardiography is useful not only for diagnostic purposes but also for risk stratification.
- Molecular imaging has emerged in the last few years for the possibility of assessing functional and molecular processes.

INTRODUCTION

The diagnosis of Takotsubo syndrome (TTS) is based on a series of criteria, including medical history and clinical and instrumental findings.[1–3] In the last decades, the development of sophisticated noninvasive imaging modalities has provided a unique opportunity to improve knowledge about this intriguing syndrome.[1–3]

Taking into account the large amount of data available in the literature on TTS, this article will

No commercial or financial conflicts of interest and any funding sources to declare.
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Heart Failure Clin 12 (2016) 559–575
http://dx.doi.org/10.1016/j.hfc.2016.06.005

review the main noninvasive imaging techniques and their clinical application for diagnostic work-up, risk stratification, and monitoring follow-up.

ECHOCARDIOGRAPHY

Owing to its widespread availability and bedside feasibility even in the acute care setting, transthoracic echocardiography (TTE) is the first-line noninvasive imaging modality for the evaluation of patients with suspected TTS for diagnostic and prognostic stratification and monitoring myocardial function recovery during follow-up.

DIAGNOSTIC MARKERS

Regional Wall Motion Abnormalities

Regional wall motion abnormalities (WMAs) have a typical distribution in patients with TTS. Topography of WMA tends to involve the apical and mid-ventricular myocardial segments circumferentially beyond the territory of a single coronary artery distribution (**Fig. 1**).[1–3] Such circumferential pattern has been considered as a distinctive feature of TTS and included in the differential diagnosis between TTS and acute coronary syndrome.[1] Global longitudinal strain (GLS) can be used to assess regional myocardial function in various conditions, and it has been found to have high sensitivity for the diagnosis of patients with acute myocardial infarctions (AMIs).[4–7] In a recent case series, a characteristic pattern in the GLS polar map of TTS patients that is not typical of any specific coronary distribution has been appreciated; this pattern affects only the apical segments, similar to the known image of the evil eye (**Fig. 2**).[8] This pattern is usually observed in the acute phase of TTS, and its recognition may serve as a potential clinical application in those cases with the classic apical ballooning.[8] Of note, in different studies comparing regional and global alterations of systolic function in TTS versus AMI, it has been demonstrated that in TTS, radial strain is reduced along the entire mid-left ventricular (LV) circumference, and not only in the anterior and anteroseptal wall as in AMI.[9–11] Moreover, in patients with classical TTS, GLS decreased from base (−15.9 + 6.1%) to apex (−1.7 + 7.6, P<.001) at baseline, with a significant apex-to-base gradient, indicating more severe involvement of the apex.[9] However, despite the perception of basal hypercontractility in TTS, often longitudinal strain of the LV base is also diminished during the acute phase. This reduction of basal strain may be related, in part, to sympathetically mediated myocardial stunning, which may also involve the basal myocardium. It is also conceivable that, similar to what has been observed in patients with AMI, remote loading effects of dysfunctional segments, changes in LV geometry with subsequent increase of wall stress in nonaffected myocardium, and tethering of the basal segments by dysfunctional segments all play a contributory role to the observed decrease in basal longitudinal strain.[9] It has also been demonstrated that both global and regional strain pattern alterations occurring in the acute phase of the disease improve at early follow-up (34 ± 16 days).[9] In particular, average longitudinal and radial strains that were −10.6 + 5.5% and 20.1 + 17.3%, respectively, on hospital admission, improved to −17.6 + 3.0%, and 50.2 + 17.0%, respectively (all P<.001) during follow-up.[9] The main differences between echocardiographic findings in TTS versus AMI are summarized in **Table 1**.

Morphologic Patterns

According to the localization of WMA, standard TTE allows one to detect different LV morphologic

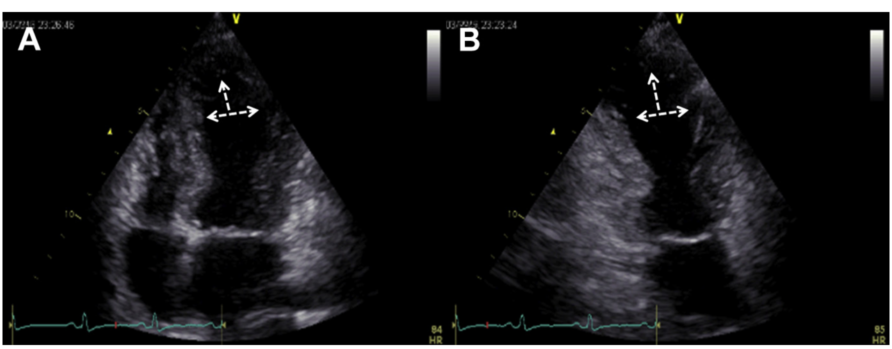

Fig. 1. TTE 4-chamber view (*A*) and 2-chamber view (*B*) of a middle-aged postmenopausal woman admitted to the coronary care unit for chest pain. Note the typical distribution of WMA involving the middle and apical segments of the whole left ventricle (circumferential pattern, see *dotted arrows*), known as apical ballooning associated with hypercontractility of the base.