favorable prognosis with respect to malignant arrhythmia, a finding supported by other studies (4,5). As wall stress also is increased in advanced cardiomyopathy, the association between LGE and wall stress referred to by the authors is not surprising, because LGE also is a feature of advanced cardiomyopathy (4,5).

One would expect that if increased wall stress is the underlying mechanism of myocardial contrast enhancement, it is likely to be diffuse rather than the focal process observed with LGE. Diffuse contrast enhancement cannot be detected with the technique of LGE, because this method requires the presence of apparently normal adjacent myocardium without contrast enhancement. However, because shortened post-contrast myocardial T1 times have been shown to correlate with histological fibrosis (6) in patients with cardiomyopathy, wall stress as the underlying mechanism of contrast enhancement seems unlikely. Interestingly, recent research in hypertensive patients revealed an absence of LGE despite increased wall stress compared with controls (7).

To determine conclusively that wall stress contributes to the presence of LGE in nonischemic cardiomyopathy independently of regional fibrosis would require contemporaneous measurement of LGE and wall stress coupled with histological examination of areas of myocardium in which LGE is present. To our knowledge, this has not been performed, and given the lack of invasive pressure measurement along with the unavailability of histological samples, such analysis is not possible from our study population.

---

**Leah Iles, MBChB**

**Heinz Pfluger, MD**

**Lisa Lefkovits, MBBS**

**Michelle J. Butler, MBBS**

**Peter M. Kistler, PhD**

**David M. Kaye, PhD**

*Andrew J. Taylor, PhD*

*Alfred Hospital and Baker IDI Heart and Diabetes Research Institute*

Heart Centre

Alfred Hospital

Commercial Road

Melbourne 3004

Australia

E-mail: andrew.taylor@bakeridi.edu.au

doi:10.1016/j.jacc.2011.05.035

**REFERENCES**


---

**Dynamic Left Ventricular Outflow Tract Obstruction and Acute Heart Failure in Tako-Tsubo Cardiomyopathy**

Given the relative paucity of data regarding tako-tsubo cardiomyopathy (TC) and the risk of heart failure, Madhavan et al. (1) are to be commended for their work recently published in the Journal.

However, we wish to raise one issue not mentioned in their paper. It is recognized that TC can be complicated by reversible systolic anterior motion (SAM) of the mitral valve (MV) with dynamic left ventricular outflow tract obstruction (LVOTO) (2). This can be associated with significant mitral regurgitation (MR). The pathophysiological basis of this complication remains unknown. Two studies, both including more than 100 patients, each reported an incidence of SAM and LVOTO in more than 10% of TC cases (3,4). Thus, dynamic LVOTO is certainly not a rare phenomenon in association with TC.

Hypotension may develop in patients with TC first due to left ventricular systolic dysfunction, second due to significant MR secondary to SAM of the MV, third due to dynamic LVOTO, or fourth a combination of these factors (5). Alternatively, hypotensive patients presenting with chest pain and ischemic electrocardiographic changes may, of course, have cardiogenic shock due to acute coronary syndrome. It is clinically important to differentiate the cause of hypotension in such patients because the immediate management varies depending on the underlying etiology.

In patients with acute coronary syndrome, intra-aortic balloon pump (IABP) counterpulsation improves coronary perfusion (during diastolic balloon inflation) and reduces systemic afterload (during systolic balloon deflation). The use of positive inotropes can also improve the hemodynamic status. In the patient with suspected TC who is hypotensive, these same therapies can be used if there is no SAM with LVOTO. By contrast, if there is significant LVOTO, both IABP placement and inotropes are relatively contraindicated because they would worsen the dynamic gradient and thereby further jeopardize cardiac function (6).

Therefore, patients with predominant pump failure can safely receive IABP counterpulsation and inotropes, whereas those with significant LVOTO should instead be managed more conservatively with cautious fluids (if no pulmonary edema) and beta-blockers (to increase diastolic filling time and thus end-diastolic volume) (7).

We congratulate the authors on their retrospectively developed and prospectively validated risk scoring system. However, we believe that their final sentence “the use of intra-aortic balloon pump counterpulsation may be the preferred treatment strategy for moderate or severe hemodynamic compromise” would be further enhanced by the addition the important clinical caveat “assuming there is no echocardiographic evidence of LVOTO.” We wonder whether the authors encountered cases of LVOTO in their series, and, if so, what percentage of these patients had acute heart
failure and whether their management was different from that described in their paper?

*Benoy N. Shah, MBBS
Nicholas P. Curzen, PhD

*Wessex Cardiothoracic Centre
Cardiothoracic Administration
Southampton General Hospital
Level E North Wing
Tremona Road
Southampton SO16 6YD
England
E-mail: benoy@doctors.org.uk

doi:10.1016/j.jacc.2011.03.062

REFERENCES


Reply

We thank Drs. Shah and Curzen for their interest in our recent paper (1). Among the 118 patients in our study, 92 underwent left ventriculography, and mitral regurgitation (MR) was quantified as grade 1, 2, 3, and 4 in 27%, 16%, 9%, and 5%, respectively. Grade 3 or 4 MR was associated with lower left ventricular ejection fraction (median 35% [interquartile range: 22% to 44%] vs. 45% [interquartile range: 33% to 51%], p = 0.02), higher incidence of left ventricular outflow tract (LVOT) obstruction (36% vs. 7%, p = 0.02), and heart failure (HF) (62% vs. 39%, p = 0.08). Twelve of the 13 patients with grade 3 or 4 MR underwent echocardiography, which identified LVOT obstruction and systolic anterior motion of the anterior mitral leaflet (n = 4), tethering of the anterior mitral leaflet (n = 5), and degenerative mitral valve disease (n = 3) as the potential mechanisms for valve dysfunction. Follow-up echocardiography demonstrated complete resolution of MR in 54% and mild residual MR in the remaining patients.

LVOT obstruction was detected by echocardiography in 10%. The occurrence of LVOT obstruction was not significantly different among patients with and without HF (8% vs. 13%, p = 0.5). The 4 patients with HF who also had LVOT obstruction all demonstrated grade 3 or 4 MR, and cardiogenic shock developed in 2 patients. An intra-aortic balloon pump was not used in these patients. All 4 had complete resolution of HF at the time of discharge, and a follow-up echocardiogram showed resolution of LVOT obstruction and normalization of left ventricular systolic function.

Thus, we agree with Drs. Shah and Curzen that significant MR may be present and appears to be more prevalent in patients with HF, but it is reversible. LVOT obstruction was noted in 10% of the cohort and when present in patients with HF, coexisted with grade 3 or 4 MR. We recommend that patients with apical ballooning syndrome and severe HF and/or hypotension undergo echocardiography to detect LVOT obstruction because its presence should modify management. These patients are best treated with careful fluid management to avoid excessive preload reduction, beta-blockers (if tolerated), and occasionally peripheral vasoconstrictors.

Malini Madhavan, MBBS
Sorin V. Pislaru, MD
*Abhiram Prasad, MD

*Division of Cardiovascular Diseases
Mayo Clinic
200 First Street SW
Rochester, Minnesota 55905
E-mail: prasad.abhiram@mayo.edu

doi:10.1016/j.jacc.2011.06.015

REFERENCE