See Article page e243.

Commentary: A picture is worth a thousand words: Improving surgical approaches using advanced multimodal cardiac imaging

Ali Fatehi Hassanabad, MD, MSc,
Vishnu Vasanthan, MD, and
Paul W. M. Fedak, MD, PhD, FRCSC, FAHA

At the turn of the century, the editors of the *New England Journal of Medicine* identified diagnostic imaging as one of the top 10 medical advances in the last 1000 years.¹ Indeed, advances in advanced multimodal imaging over the past 5 decades have significantly contributed to continued improvements in clinical outcomes for patients with cardiovascular diseases. From the simple chest radiograph to 4-dimensional flow aortic imaging, we can see health and disease with a depth and clarity like never before.² A better understanding of intracardiac structures and cardiac function was first established by the introduction of echocardiography in 1954.^{3,4} This was followed by the arrival of nuclear medicine,⁵⁻⁷ cardiac magnetic resonance imaging (CMR),⁸⁻¹⁰ and coronary computed tomography (CT).^{11,12} In addition to providing more information, each of these modalities has enhanced the precision and detail that can be accessed by cardiologists and cardiac surgeons. In fact, in some cases, clinical biomarkers based on images can be identified to predict outcomes.¹³ More recently, with the advent of 3-dimensional (3D) printing, clinicians can actualize such images and can best describe and teach cardiac malformations to patients, their families,

From the Section of Cardiac Surgery, Department of Cardiac Sciences, Libin Cardiovascular Institute, Cumming School of Medicine, Calgary, Alberta, Canada.

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Address for reprints: Paul W. M. Fedak, MD, PhD, FRCSC, FAHA, Foothills Medical Centre, C849, 1403 29th St NW, Calgary, Alberta, Canada T2N 2T9 (E-mail: pwfedak@ucalgary.ca).

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Ali Fatehi Hassanabad, MD, MSc, Vishnu Vasanthan, MD, and Paul W. M. Fedak, MD, PhD, FRCSC, FAHA

CENTRAL MESSAGE

Technologic advances with 3-dimensional image reconstruction can help visualize complex patient-specific cardiac anatomy and enhance both patient education and surgical planning.

and clinical trainees.^{14,15} Ideally, cardiovascular clinicians will integrate and combine various diagnostic imaging modalities to highlight normal versus abnormal anatomic variants, plan reparative operations, and anticipate the effect of interventions.

In this edition of the *Journal*, Oberoi and colleagues¹⁶ use multiphasic cardiac computed tomography (CT) to introduce an interactive 3D model of the different phenotypes of hypertrophic cardiomyopathy (HCM). The images were obtained from patients before they underwent septal myectomy, with advanced image processing tools used to segment the ventricles and the myocardium in 2 dimensions and then reconstruct them in 3D from different perspectives.¹⁶ Before this work, visual representations of HCM variants were limited to single-slice CT images. Given the expanding and important role of patient education, the authors' work will be a great help in explaining the morphological differences of HCM variants to patients and more effectively conveying the surgical plan to patients, their families, and trainees. In this era of precision and personalized medicine, the ability to use and combine accurate and descriptive imaging modalities can help facilitate optimal clinical outcomes. Finally, the emergence of virtual reality can take such patient-specific image reconstructions to ever greater heights. Realizing the potential of these powerful tools may help us explore new surgical frontiers for the next 1000 years.

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See Article page e243.

Commentary: Prevention of incomplete resection during septal myectomy: Virtual seeing is actual believing

Edward Buratto, MBBS, PhD,^{a,b,c} and
Igor E. Konstantinov, MD, PhD, FRACS^{a,b,c,d}

Extended myectomy is the gold standard for treating hypertrophic obstructive cardiomyopathy (HOCM), and it can be achieved with low complication rates in high-volume institutions.¹⁻⁵ Of interest, recurrent obstruction is rare in such

Edward Buratto, MBBS, PhD, and Igor E. Konstantinov, MD, PhD, FRACS, at the Royal Children's Hospital, Melbourne.

CENTRAL MESSAGE

The depth, length, and width of septal myectomy are all important to prevent residual obstruction.

high-volume institutions.¹⁻⁵

It is becoming increasingly apparent that the vast majority of so-called “recurrences” are in fact consequences of incomplete initial resection. Conversely, excessive resection may result in conduction abnormalities and iatrogenic ventricular septal defects.² The matter is further complicated by the variable morphology of HOCM and the relative scarcity of these patients at many institutions. Traditionally, septal morphology is assessed primarily with 2-dimensional (2D) echocardiography, with magnetic resonance imaging used in selected cases.⁵ More recently, 3-dimensional (3D) computed

From the ^aDepartment of Cardiac Surgery, Royal Children's Hospital, Melbourne, Australia; ^bDepartment of Paediatrics, University of Melbourne, Melbourne, Australia; ^cHeart Research Group, Murdoch Children's Research Institute, Melbourne, Australia; and ^dMelbourne Centre for Cardiovascular Genomics and Regenerative Medicine, Melbourne, Australia.

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Address for reprints: Igor E. Konstantinov, MD, PhD, FRACS, Royal Children's Hospital, Flemington Rd, Parkville 3052, Australia (E-mail: igor.konstantinov@rch.org.au).

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